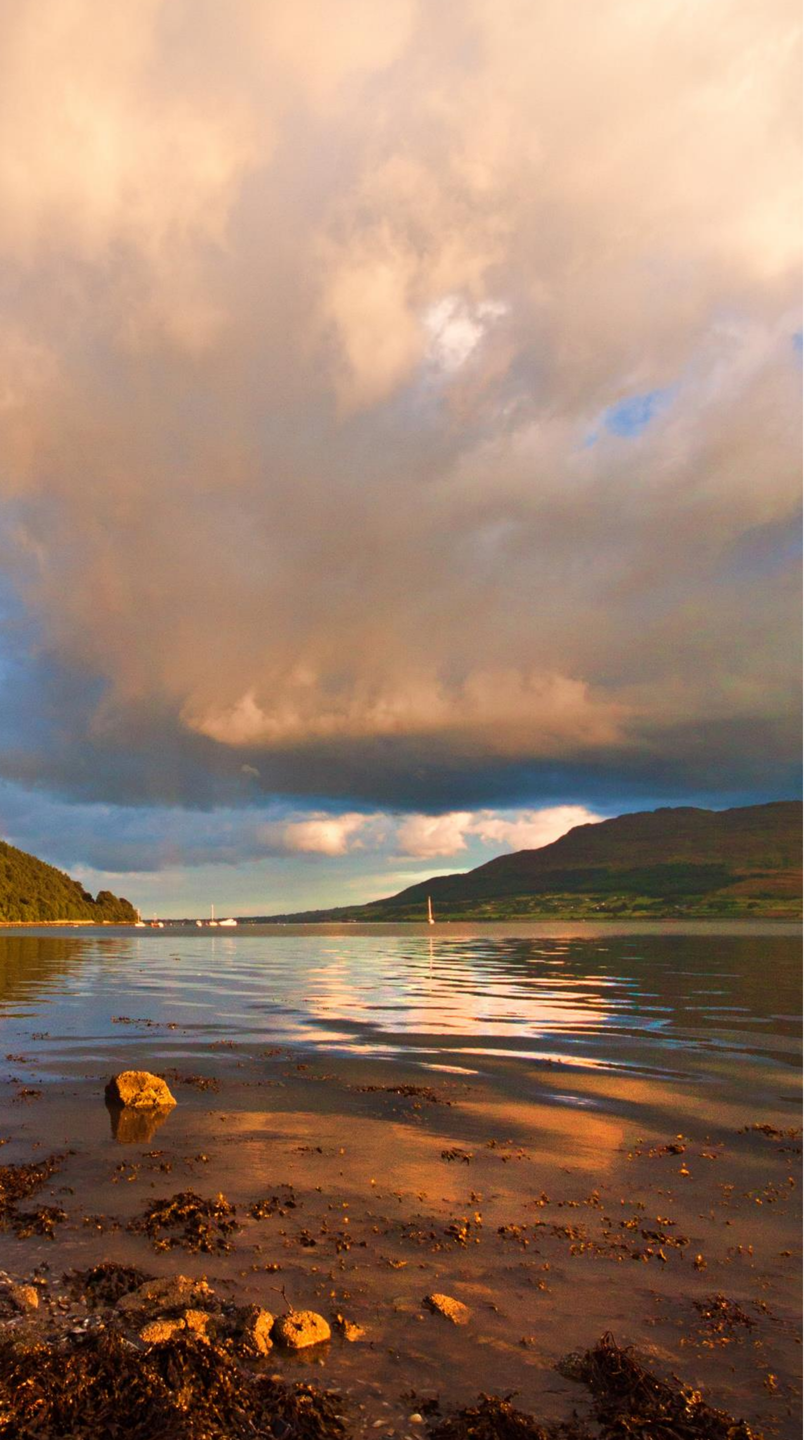
ReMeMaRe Conference 2024

Environment Agency

OCEAN & COASTAL FUTURES

Restoring Estuarine & Coastal Habitats

10 – 11 July 2024

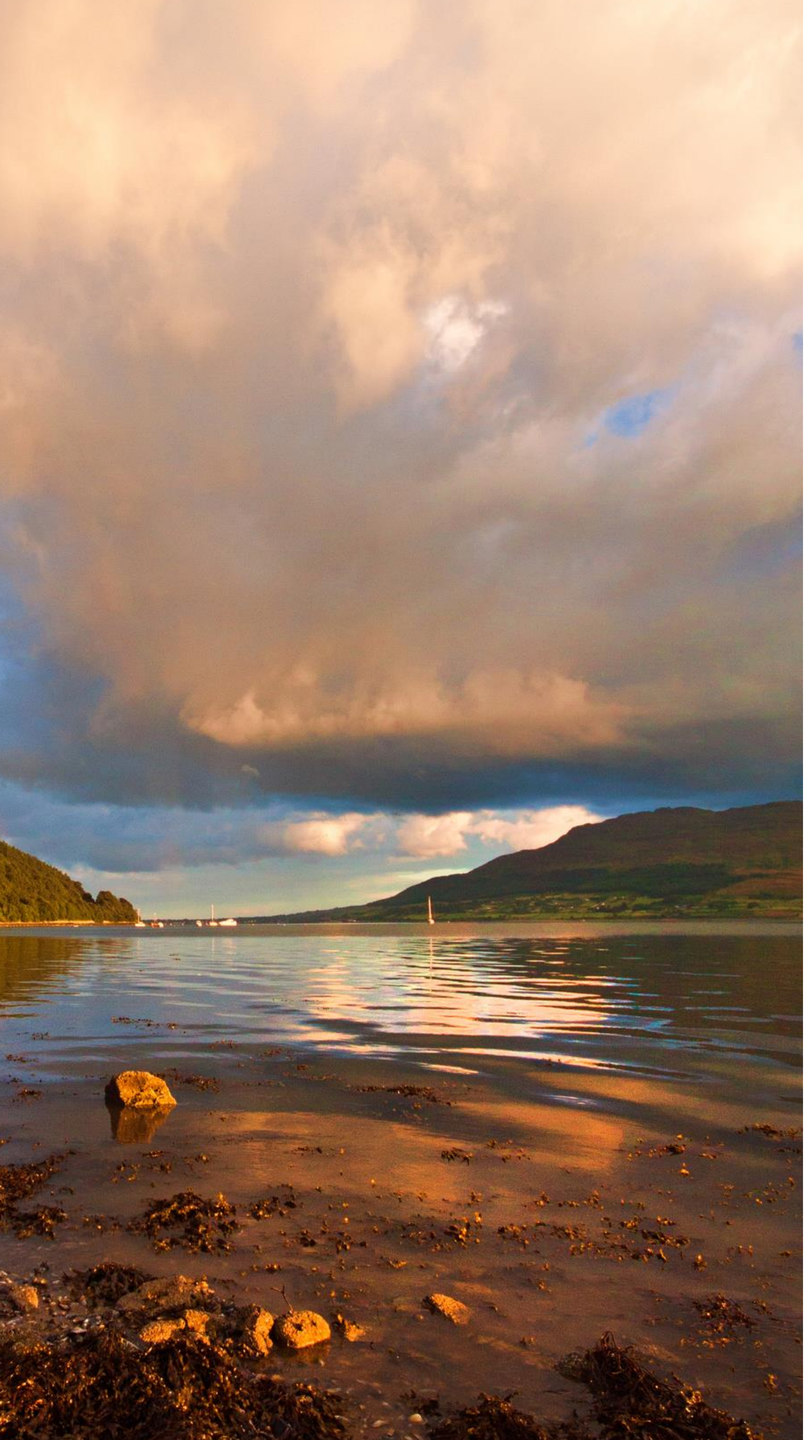


ReMeMaRe Conference 2024

Science Session

Chair: Graham Underwood, University of Essex

- **Mark Parry**, Ocean Conservation Trust
- **Bill Sanderson**, Heriot Watt University
- **Angus Garbutt**, Centre for Ecology & Hydrology
- **Pippa Moore**, Newcastle University
- **Jo Preston**, University of Portsmouth



ReMeMaRe Conference 2024

Science Session

Mark Parry, Ocean Conservation Trust

The current position of UK seagrass science & conservation taken from the 'UK Seagrass Symposium 2023'

Environment Agency

OCEAN & COASTAL FUTURES

THE STATE OF UK SEAGRASS SCIENCE

ocean conservation trust

Mark Parry – Head of Ocean Habitat Restoration

- blue meadows
  - Protection
  - Restoration
  - Mini Meadows®

- LIFE Recreational ReMEDIES
- EU LIFE Funded
  - Restoration
  - Education

Mark Parry gets ready to examine the seagrass meadows.
Photo: Ocean Conservation Trust

THE UNDERWATER GARDENERS

An ambitious and internationally significant project to restore miles of precious underwater meadows is underway in Devon

The current position of UK Seagrass Science

- Proceeding of the inaugural UK Seagrass Symposium
  - Seagrass Ecology and Function
  - Threats and Protection
  - Community Conservation
  - Mapping and Monitoring
  - Restoration
  - Ecosystems Services
  - Finance, Ecosystems Service in Action and Scaling

Seagrass Ecology and Function

- Not all seagrass meadows are equal in their ecological function:
  - Most provide Ecosystems Services that do not have linear relationship to each other.

- When considering where to protect / restore, ecological function and environmental conditions are key to prioritising locations.
  - The data to build understanding is not completely sufficient
    - Salinity, PAR, Temperature, Bathymetry, Sediment Classifications

- Current statutory advice / future aim is for favorable condition of 73 protected sites for seagrasses.
  - Future recovery aims to increase biodiversity – but we must make space for other habitats

- The function / significance of seagrasses is not limited to its conservation status. Sulphate fucans (salt tolerate sugars) could unlock salt tolerate crops.

Seagrass Ecology and Function

- Blue Green Biochemistry from the Beautiful Briny Sea
  - Dr Thomas Torode – Keele University
  - The Dream – Hydroponics using nutrient rich seawater!
- Natural England's Vision for Seagrass Recovery
  - Dr Hazel Selley – Natural England- Senior Specialist – Marine Ecology and Evidence
  - Future Recovery – For Biodiversity
- Quantifying Ecosystems Services
  - Dr Richard Unsworth – Swansea University / Project Seagrass
  - Seagrass has lots of important values – Globally seagrasses have huge Ecosystems Values
- Habitat Suitability Modelling for Informing Decisions
  - Dr Chiara Bertelli - Swansea University / ReSOW
  - Different sites have different drivers for seagrass recruitment

UK Seagrass Symposium

Session Chair – Mark Parry

Threats and Protection to Seagrasses

- Seagrasses are fragile to environmental change; they act as a barometer to coastal environmental quality.
    - Seagrasses establish in areas with low levels of nutrient enrichment and other contaminants, in regions with high water clarity which enable a high degree of light penetration.
    - Water Quality - Eutrophication is more detrimental to seagrass than dredging.
- Industry sponsored programmes are retuning positive results with successful trials of AMS and planting programmes.
    - The funding is short lived and requires long-term funding is required to fulfil ambitious targets to reverse environmental degradation.
- Large-scale central initiative such as LIFE Recreational ReMEDIES as well as NGO initiatives are working to change social values, create pro-ocean behaviors and take concrete conservation actions are turning the tide on deterioration.
    - A key output to these projects must be learning lessons and sharing findings and best practice.

UK Seagrass Symposium

Threats and Protection to Seagrasses

- Success of Advanced Mooring Systems (AMS) in Plymouth: An engineering and ecological solution
  - Dr Jean-Luc Solandt – Marine Conservation Society
  - An amazing 212% increase in seagrass cover!

- Recreational ReMEDIES- Reducing and Mitigating Erosion and Disturbance Impacts affEcting the Seabed
  - Fiona Tibbit– Natural England- Project Manager
  - Learning lessons and sharing findings and best practice

- Environmental conditions determining the development of seagrass beds.
  - Dr Andy Rees –Plymouth Marine Laboratory
  - Establish in areas with low levels of nutrient enrichment and other contaminants, in regions with high water clarity which enable a high degree of light penetration

UK Seagrass Symposium

Session Chair – Dr Leanne Cullen-Unsworth

Threats and Protection to Seagrasses

We should view humans as part of the ecosystem and move beyond viewing humans the treat.

These are systems that can, and should, be used to fish, snorkel, explore, and access as a safe haven.

Where networks are in place and communication is sound, there has been a shift, communities are self-policing, boaters educating boaters and all stakeholders sharing knowledge through stories and educating each other. These things are already happening, but we need to scale local stewardship for long term and inherent sustainability practice.

'Leanne Cullen-Unsworth'

UK Seagrass Symposium

Community Conservation

- Armies of volunteers mobilising to contribute where possible in the recovery of Nature.
    - Where once seagrass habitat was seen as the hidden habitat public opinion has changed.
    - Seagrass is the only habitat that has its own United Nations awareness raising day.

- Volunteers are developing technical skills in conservation / habitat restoration & monitoring that is invaluable to the long-term health of Ocean ecosystems.

- Seagrass science is providing a positive impact on peoples lives and mental well being, providing a mechanism to manage climate anxiety. Community cohesion is expanding, and some threats are becoming to be managed by the community.

- These efforts are UK wide!!!

UK Seagrass Symposium

Community Conservation

- Amber Gould – The Wildlife Trusts
- Katie Bellman – Cornwall Wildlife Trust
- Clare Marshall – Bailiwick Eelgrass Exploration Project
- Sara Parker – Studland Bay Marine Partnership
- Garance d'Alverny –blue meadows
- Danny Renton – Seawilding
- Kate Baxter – Tees Rivers Trust
- Vicki Spooner – Falmouth Harbour
- Jenny Murray – Blue Marine Foundation
- Lara Howe – Manx Wildlife Trust

Session Chair – Dr Richard Lilley & Nicola Bridge

UK Seagrass Symposium

Mapping and Monitoring

- Mapping is beyond an assessment of condition / conservation status
    - Informs decision-making processes
        - Marine Development
        - Investment in protection & restoration

- Drive for effective, accurate automated acoustic imagery.
    - Existing echosounder technology applied to marine surveys
    - Machine learning
    - Shorter acquisition time = increased frequency
    - Removes the requirement for good water visability

- Environmental DNA
    - Assess the biodiversity or functioning of a habitat with the smallest water or sediment sample

UK Seagrass Symposium

Mapping and Monitoring

- Using an ‘off the shelf’ single beam acoustic solution to map and monitor sea grass extents around Cornwall
  - Colin Trundle - Colin Trundle - Principal Scientific Officer
  - Found the 2 huge seagrass meadows in Cornwall

- EA Seagrass Surveying/ Monitoring
  - Sue Davey - Environment Agency
  - Creation of the National Seagrass Layer

- Shallow water seagrass mapping: USV-based acoustics, deep learning and cloud-based hosting to support seagrass monitoring.
  - Tim Scott - University of Plymouth
  - Development of machine-learning

- The power of eDNA in monitoring coastal habitats
  - Samantha Howlett – NatureMetrics
  - eBioAtlas jointly set up by IUCN and NatureMetrics

UK Seagrass Symposium

Session Chair – Ben Green

Restoration of Intertidal & Subtidal Seagrasses

- Method depends upon various factors.

- Suitability modeling helps drive technical approach.
  - Various methods are showing positive results.
  - Bare root / sediment plugs, juvenile plants seed injections.

- Planting catalyst for expansion will work if the Ocean environment is not to degraded.
  - Preforming this work in these environments is harsh.

- The application of low-cost methods of seed dispersals is being tried around the UK.
  - A cost-effective method opens the process to larger scale.

UK Seagrass Symposium

Restoration of Intertidal & Subtidal Seagrasses

- Decades of terrestrial planting have developed simple and effective tools for seed and sod transplant.
- Seed broadcast of packages of 100% biodegradable materials are showing positive success in the intertidal massive volunteer participation
- Ex-situ growth has now become a common thing.
- The microbiome is not understood but sediment particle size appears to be a driver for successful establishment.
- Techniques are being shared & adapted with each iteration we evidence greater success.
- Currently manual work – automation is necessary.

UK Seagrass Symposium

Restoration of Intertidal Seagrasses

- Seeding Change Together: Intertidal *Zostera noltei* restoration trials on the Fal Estuary
  - Sophie Pipe - Cornwall Wildlife Trust
  - Seed Broadcast

- Seagrass Seeds of Recovery (SSoR): Exploring *Zostera noltei* restoration in Essex
  - Emma Fox - Project Seagrass
  - Varying methodology

- Site Selection & Small-Scale Variability Control Intertidal Seagrass Restoration
  - Esther Thompson Project Seagrass
  - Firth of Forth

- Ørsted, Yorkshire Wildlife Trust, and seagrass Restoration
  - Jemima Wakelin & Andrew Jayes Yorkshire Wildlife Trust
  - Application of terrestrial methods

- Seagrass Restoration in the Solent
  - Tim Ferrero Hampshire & Isle of Wight Wildlife Trust

UK Seagrass Symposium

Session Chair – Duncan Vaughan

Restoration of Subtidal Seagrasses

- Restoration of *Zostera marina* Success with LIFE Recreation ReMEDIES
    - Amelia Newman - Ocean Conservation Trust
    - Seed and seedling 🌱 methodology. Ex-situ translocation
- The influence of natural seagrass sediments and microbial communities on Zostera marina germination, growth and survival
    - Emma Ransome - Imperial College London

Session Chair – Duncan Vaughan

UK Seagrass Symposium

Ecosystems Services

- Seagrasses are recognised as having exceptional ecosystem service value
  - Carbon sequestration, climate mitigation, nutrient cycling, fisheries production, seabed stabilisation and coastal production, biodiversity enhancement.

- Zostera Experimental Network – Not all seagrass meadows are equal
  - Ecosystems services alter geographically and no liner relationship between interactions of these services.

- Recent focus has been C stocks
  - Driver – requirement to mitigate business activity
  - Estimates of greenhouse gas emissions from seagrass meadows, and an understanding of how this could offset carbon sequestration is severely lacking.
  - Work has been limited to C stock
    - Innovative work to understand uptake and emissions on the intertidal

- Recovery of Seagrass for Ocean Wealth UK (ReSOW)
  - National Seagrass Natural Capital Assessment
  - Cultural and Wellbeing Services

- Largest Assessment to create a contemporary picture of economic value of seagrass meadow provisioning services.
  - Fisheries Value

- Greater understanding is needed to match standards of nature-based solution credit market

Ecosystems Services

- Quantifying blue carbon storage in Plymouth Sound seagrass beds to support development of a Carbon Code
  - Jessica Cramp University of Plymouth & Ocean Conservation Trust
  - Temporal C assessments

- Intertidal seagrass as a nature-based solution: a case study of Zostera noltei
  - Alice Malcolm-Mackay University of Essex
  - Fluxes in sequestration and emissions

- Finding the supporting and provisioning services value provided by seagrass meadows to UK commercial fisheries
  - Anouska Mendzil University of Swansea & Project Seagrass
  - Seagrass Residency Index

- Seagrass Ecosystems 'Secret' Services
  - Claire Evans National Oceanography Centre

Session Chair – Prof Martin Attrill

UK Seagrass Symposium

Finance, Ecosystem Services in Action and Scaling

- **Natural Capital Approach**
  - Critical for Unlocking Private Finance Options

- **Development of Seagrass Credits**
  - Role of codes and standards to drive high-integrity outcomes has been emphasised by both ecologists and investors alike
  - Stacking and bundled benefits
  - Need to demonstrate additionality and avoid double counting
  - Step forward in unlocking finance for restoration

- Seagrass Token
  - Simple – Voluntary
  - Community Ownership
  - Bundled Benefits

UK Seagrass Symposium

Finance, Ecosystem Services in Action and Scaling

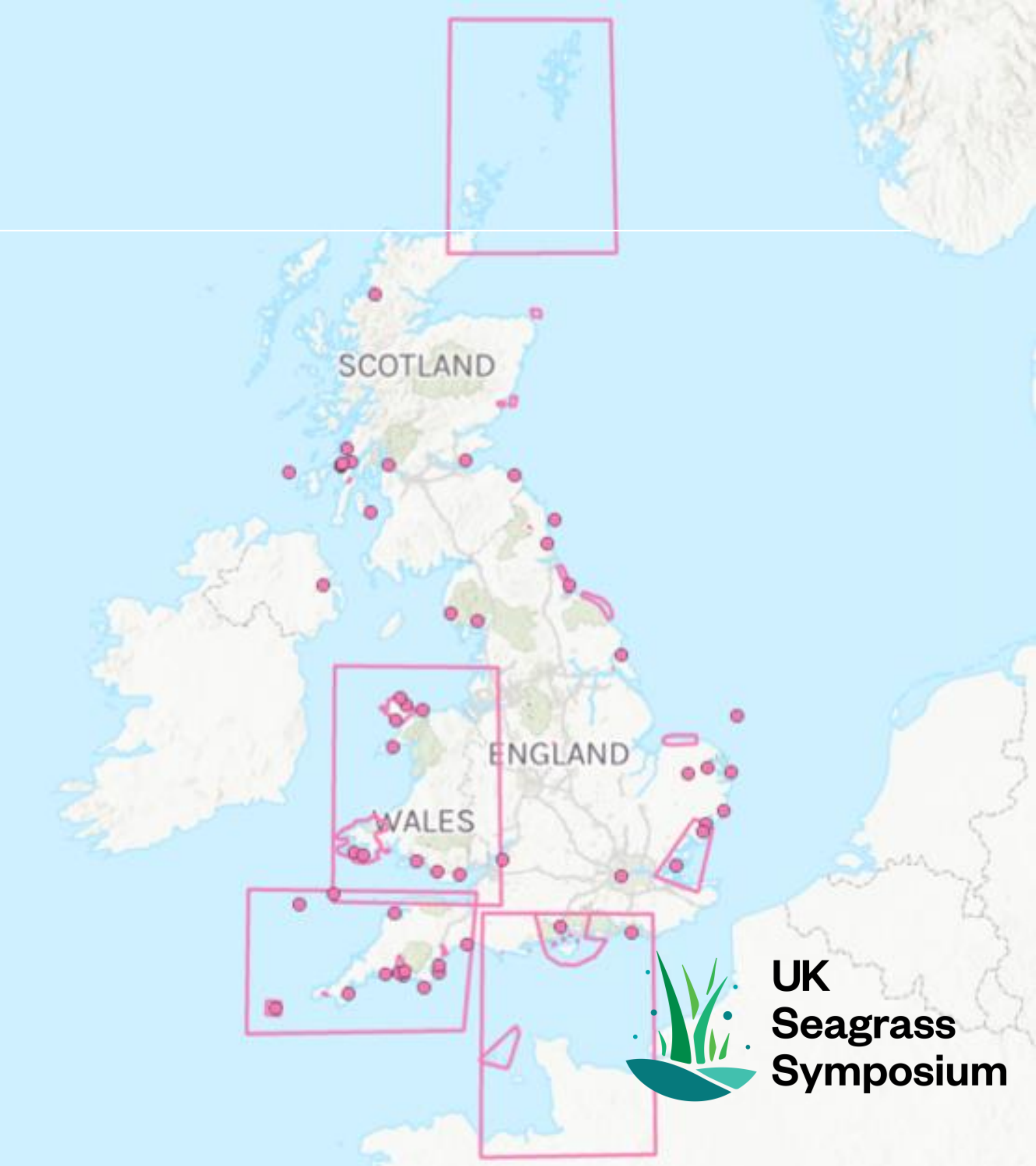
- Plymouth Sound Seagrass Natural Capital Asset and Risk Register
  - Sian Rees University of Plymouth
  - High-integrity
- Developing a UK Seagrass Carbon code
  - John Lynch University of Oxford

- Developing the business model for funding Seagrass Restoration
  - Alex Hume Finance Earth
  - Work performed with Ocean Conservation Trust and partners in NEIRF

UK Seagrass Symposium

Session Chair – Caroline Price

Maps & Gaps



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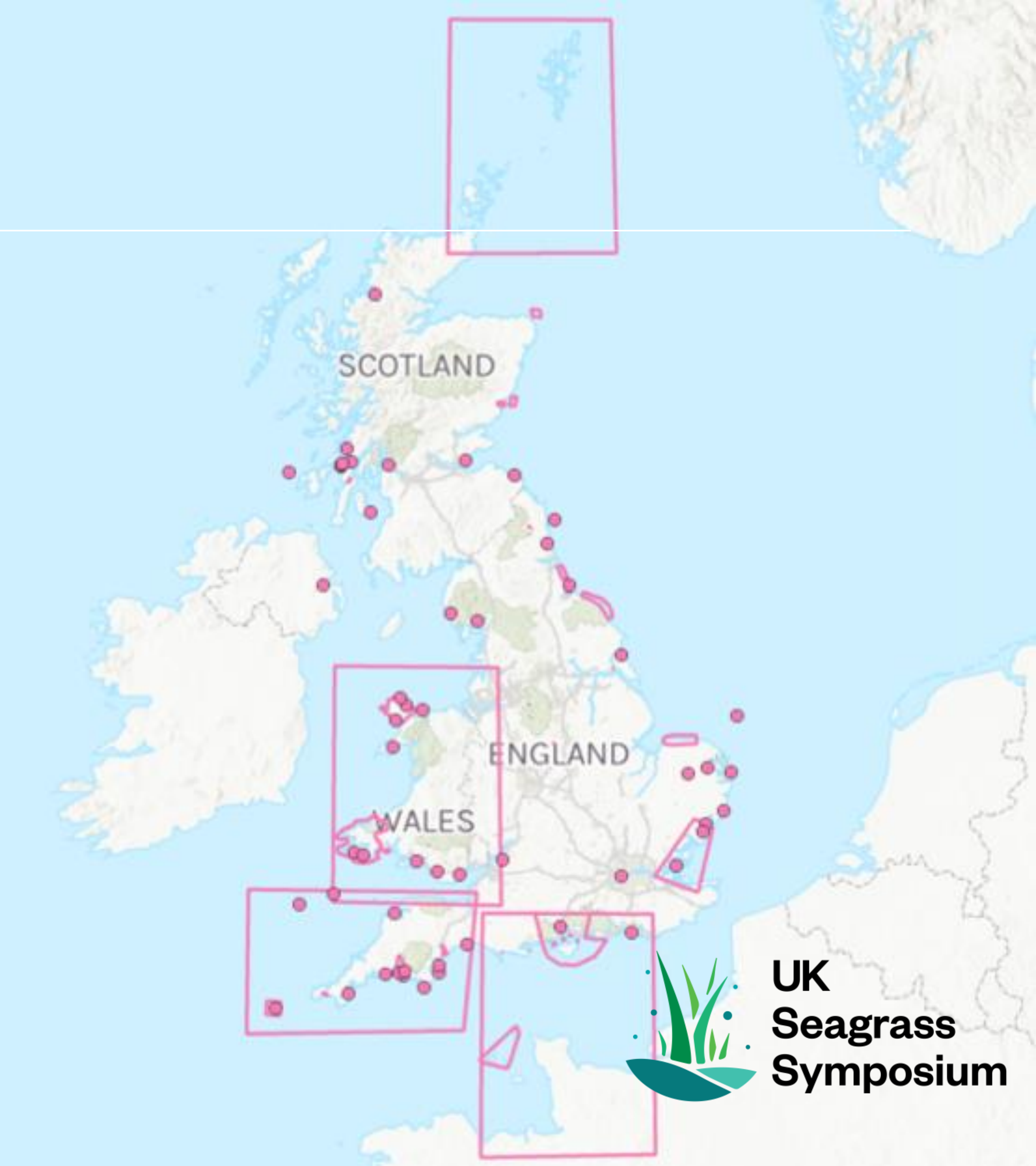
Maps & Gaps

Project Type	Total
Monitoring	155
Community Engagement	98
Restoration	58
Other	87



UK Seagrass Symposium

How do we improve 'The State of UK Seagrass Science'

- ✓ The legal framework does not easily facilitate Protection and Restoration in the Ocean Environment
  - Current presumption of harm
  - The Marine and Coastal Access Act 2009
  - The UK is not an isolated circumstance
- ✓ Remove Silo Working. On all Levels
- ✓ Creation of sustainable long-term funding mechanisms to support study of areas of uncertainty
- ✓ Attract more plant 🌱 scientists into area of study
- ✓ Knowledge exchange

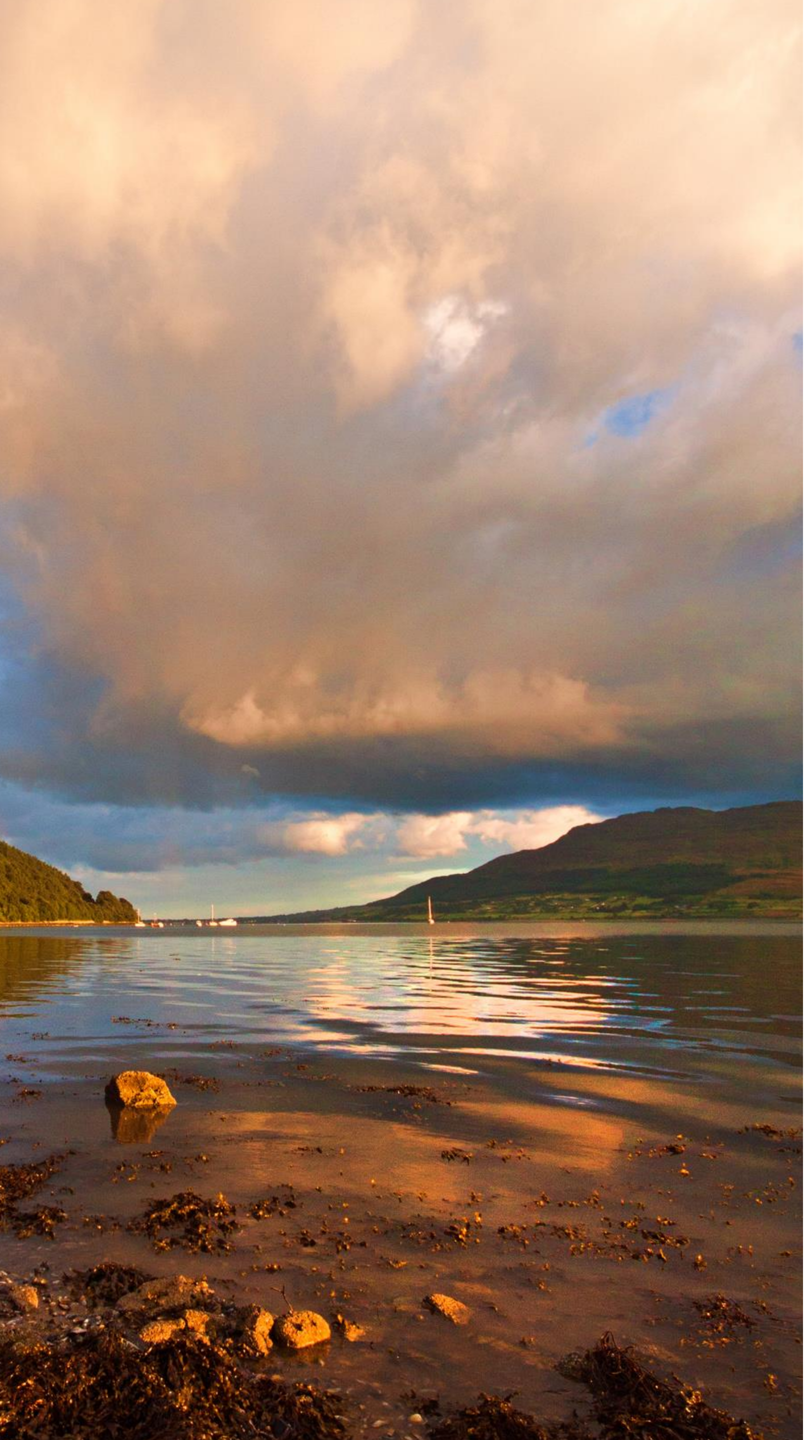
ocean conservation trust

Future Steps

- LIFE Recreational ReMEDIES end of project conference
  National Marine Aquarium
  1st October 2024
  Please contact Fiona Tibbitt to attend:
  Fiona.Tibbitt@naturalengland.org.uk

- UK Seagrass Symposium 2025
  Hosted by Wales
  Date & Location to be announced

Thanks for listening please find me over coffee if you have any questions.
mark.parry@oceancosnervationtrust.org



ReMeMaRe Conference 2024

Science Session

Angus Garbutt, Centre of Ecology and Hydrology

Saltmarshes: advances and future evidence needs for science, delivery and policy

Environment Agency

OCEAN & COASTAL FUTURES

Salt marshes: advances and future evidence needs

Angus Garbutt and delegates of the UK Saltmarsh Forum 2024

ReMeMaRe Conference 2024

Scarborough

July 2024

UK Centre for Ecology & Hydrology

UK Saltmarsh Forum 2024, Dumfries.

Opening address by Cabinet Secretary for Net Zero and Energy.

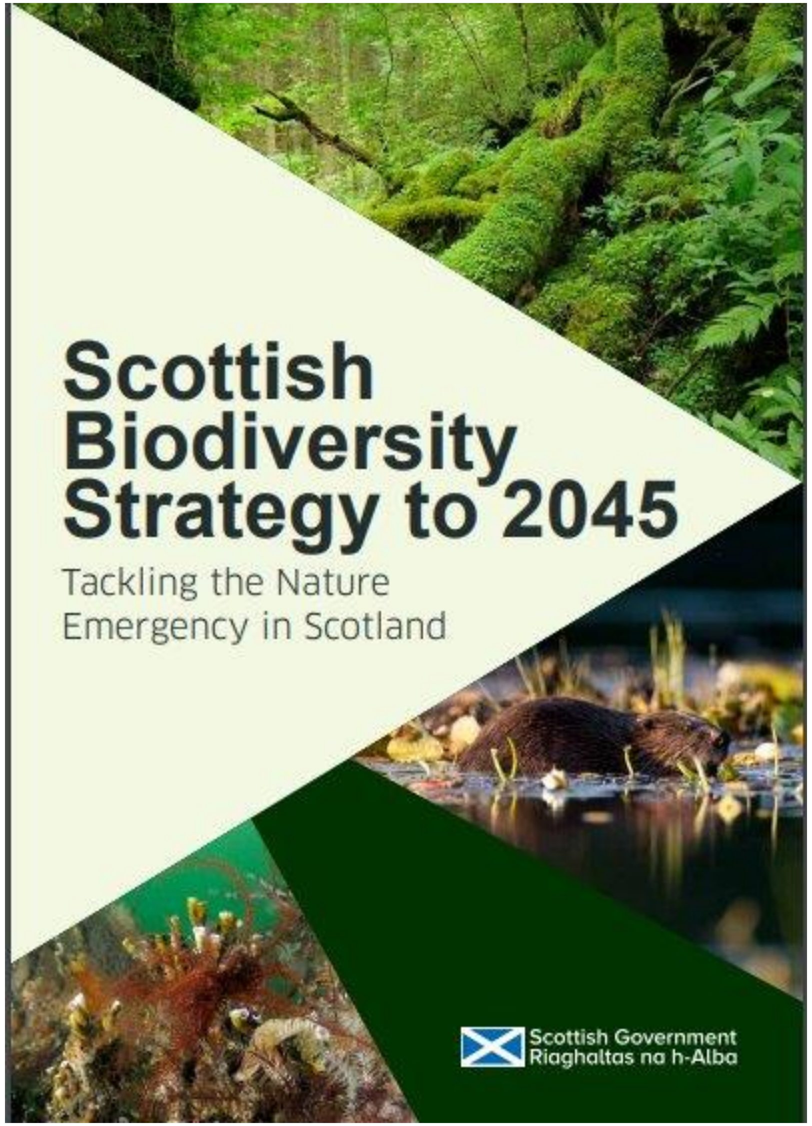
120 delegates over two days hosted by The Solway Firth Partnership and WWT.

49 talks on:

- UK Agency & project updates
- Carbon
- Biodiversity
- Society
- Processes

NatureScot updates

Credit: Corallie Hunt, NS



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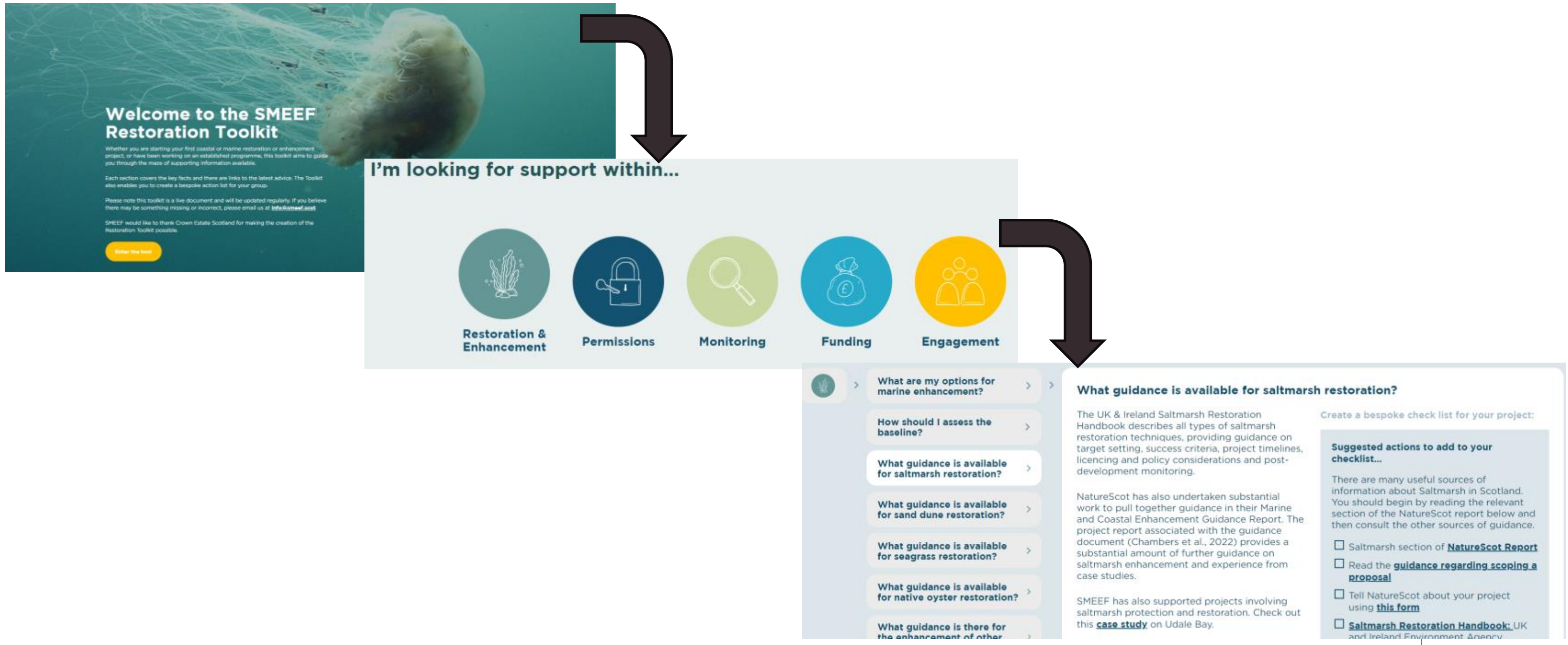
Coastal and Marine Actions

Total of 60 actions for coast and/or marine

Varied actions including:

New commitments - e.g., programme of ecosystem restoration; safeguard space for coastal habitat change

Funding for Nature – **SMEEF:** Transparent, robust, effective way for businesses to demonstrate their commitment to healthier coasts/seas by investing in nature recovery



Credit: Nick Chisholm,
D&G Council

SCAMP

SOLWAY COAST AND MARINE PROJECT

200 miles of north Solway Firth coast - Loch Ryan to Gretna, South West Scotland.

Monitor, restore & protect coast & marine habitats for people, nature & climate resilience

5 habitats – Native oysters, Seagrass, Saltmarsh, Dunes & coastal woodlands

10-15 year project
£20M +

Crown Estate Scotland
Oighreachd a' Chrùin Alba

Dumfries & Galloway Council

Solway Firth Partnership

Net Zero Scotland
Scottish Government

NatureScot NàdarAlba

A' Mhaoin-Dualchais Heritage Fund

THE GLOBAL GOALS

SOUTH of SCOTLAND ENTERPRISE

UK Centre for Ecology & Hydrology

This project is supported by NatureScot in collaboration with The Scottish Government and in partnership with the National Lottery Heritage Fund.'

UK Agencies Evidence Gaps

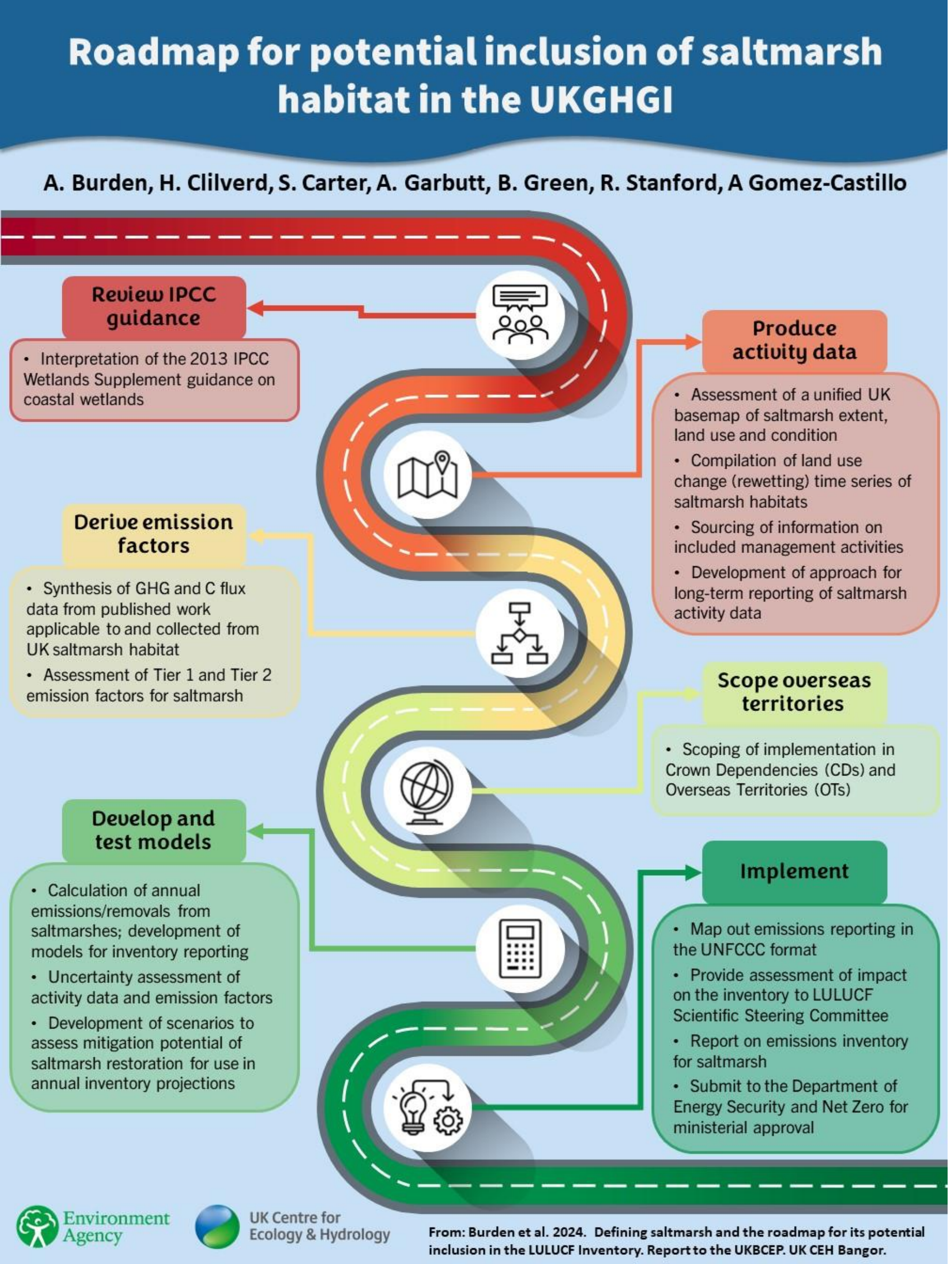
Credit: Louise Denning: NE

Research title	Organisation/ Lead proposer	Main habitat	Description of work required/ research questions
Coastal Riverscapes - The role of habitat migration corridors in adaptation to sea level rise	Natural England / Marina Pugh	Freshwater/ coastal habitat	As the rate of sea level rise accelerates in response to climate change, coastal wetland resources could be lost in areas that lack space for landward migration.
Saltmarsh food webs	Natural England/ UKCEH Angus Garbutt	Saltmarsh	We need a greater understanding and an ability to describe food webs for saltmarshes through the trophic levels and how changes (sea level rise, increased storminess) might disrupt these
To what extent do coastal habitats act as natural sea defences in terms of function and resilience?	Natural Resources Wales / Heather Lewis & Julie Creer	All coastal habitat	To identify the system thresholds which govern the role of coastal habitats as sea defences and impact resilience.
Vertical limit of halophytes on saltmarshes	NatureScot/ Stewart Angus	Saltmarsh	With RSLR there are many attempts to model changes to saltmarsh. Unless we have accurate information on the uppermost altitude of halophytes, this is impossible to predict. Possibility that this is variable across UK and could also be affected by tidal range

NRW: Severn Estuary Polders project

Credit: Heather Lewis, NRW

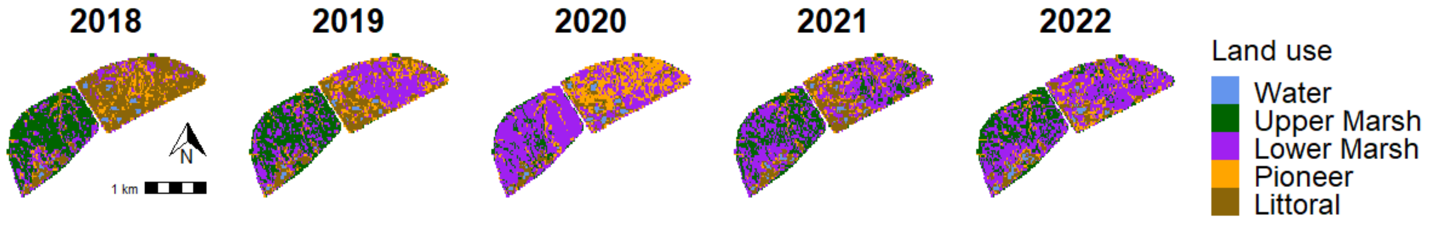
- Baseline vegetation monitoring carried out in September 2023
- On-going geomorphological monitoring
- Marine license application
- Likely to award contract shortly
- Construction to take place over 10 weeks July to September this year in conjunction with some comms to keep public informed.



Activity data – current work

- Unified UK map of saltmarsh (datasets reviewed in *Burden and Clilverd 2022*, *https://naei.beis.gov.uk/reports/reports?report_id=1079*)

- Timeseries of saltmarsh restoration (pilot study – *Clilverd et al. 2024.* Monitoring saltmarsh restoration using Google Earth Engine. UKCEH report).



The Saltmarsh Code: Next phase

Four objectives:

1. Testing (piloting) the draft Code
   - Development auditing protocol
   - Work with VVB to pilot code

2. Refining the draft Code
   - Gather feedback on all guidance, protocols, tools
   - Review and incorporate into documentation

3. Establishing Governance of the Saltmarsh Code
   - Continue discussions with potential hosts.
   - Consider the Executive and Technical Advisory Board – remit, etc

4. Developing the Business Plan and Financial Model
   - Operational plan and funding need + Financial plan and model =
   - Business model to ensure long-term financial sustainability

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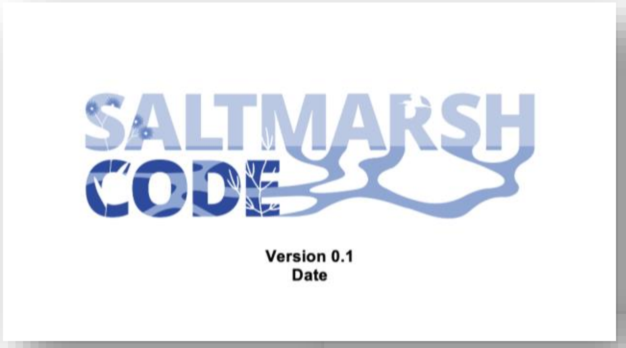
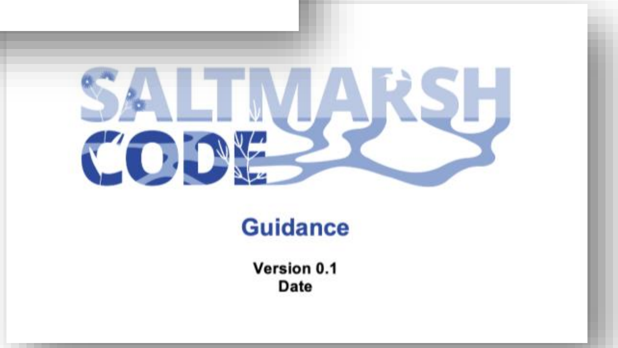
The Saltmarsh Code: Progress update





Additionality

Stacking and bundling

Registry and ownership of units

Leakage

Permanence

Buffer

Monitoring, Reporting, and Verification (MRV)

Step 1 Define strata and measure area

Step 2 Collect samples within strata
- Sediment accumulation
- Surface organic carbon fraction
- Surface inorganic carbon fraction
- Deeper carbon fraction
- Sediment bulk density

← Biomass per strata

← GHG fluxes per strata

Step 3 Calculations of
- Carbon density
- Deductions for uncountable carbon

← Site-specific deduction of unreactive allochthonous carbon

Interim outputs: Amount countable organic carbon per unit area of each strata

Step 4 Extrapolate amount of carbon using area of each strata

Final output: Total countable carbon stored

← Site-scale GHG fluxes

Risk Tool

Carbon Calculator

Market assessment/Finance/Business model

Assessment of saltmarsh restoration methods (other than MR)

- To review salt marsh restoration options (other than MR) in the UK and NW Europe, considering:
- Describe the relative merits of different techniques to deliver climate mitigation, biodiversity gain and other ecosystem services.
- Provide a critical assessment of restoration options in the UK and relative confidence in successful delivery of salt marsh goods and services.

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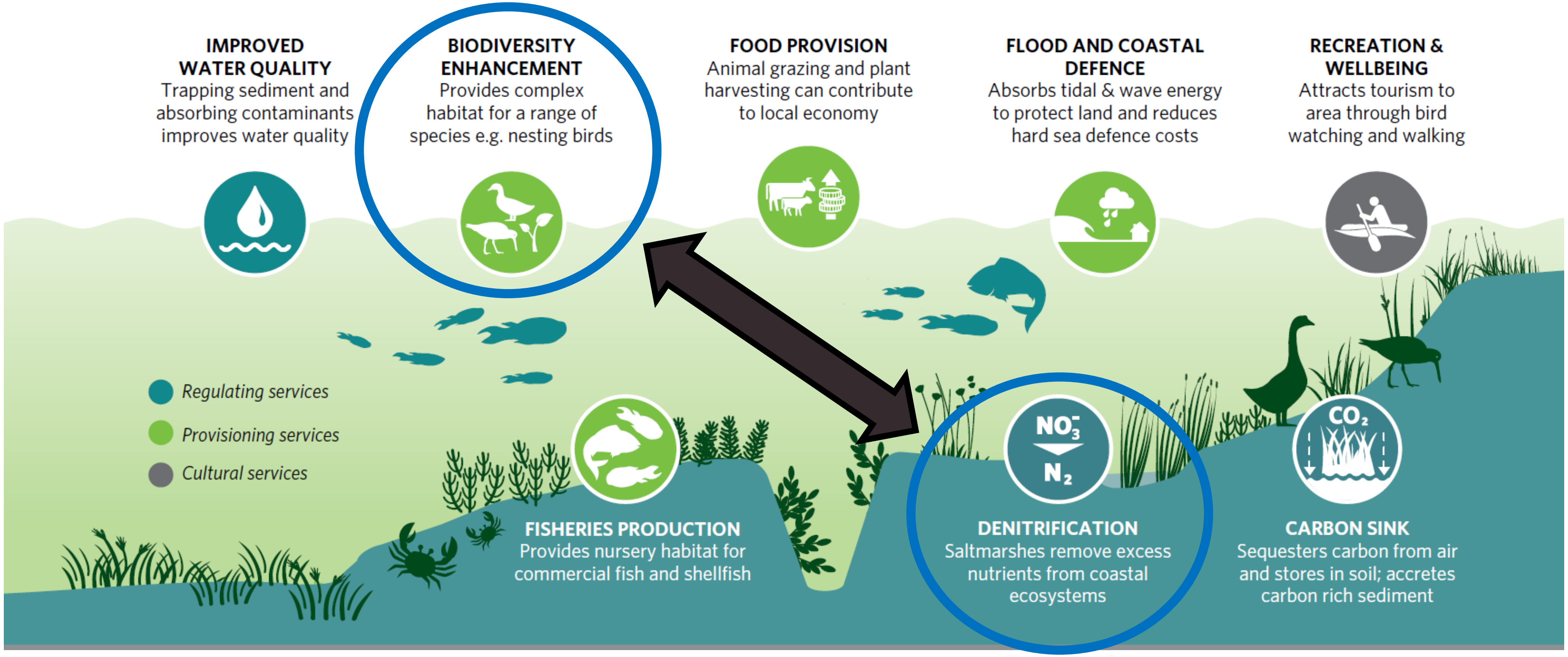
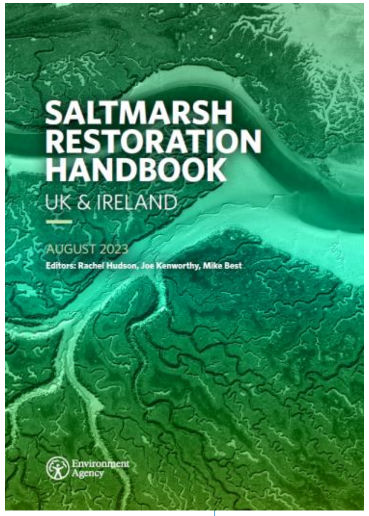
Saltmarsh nutrients





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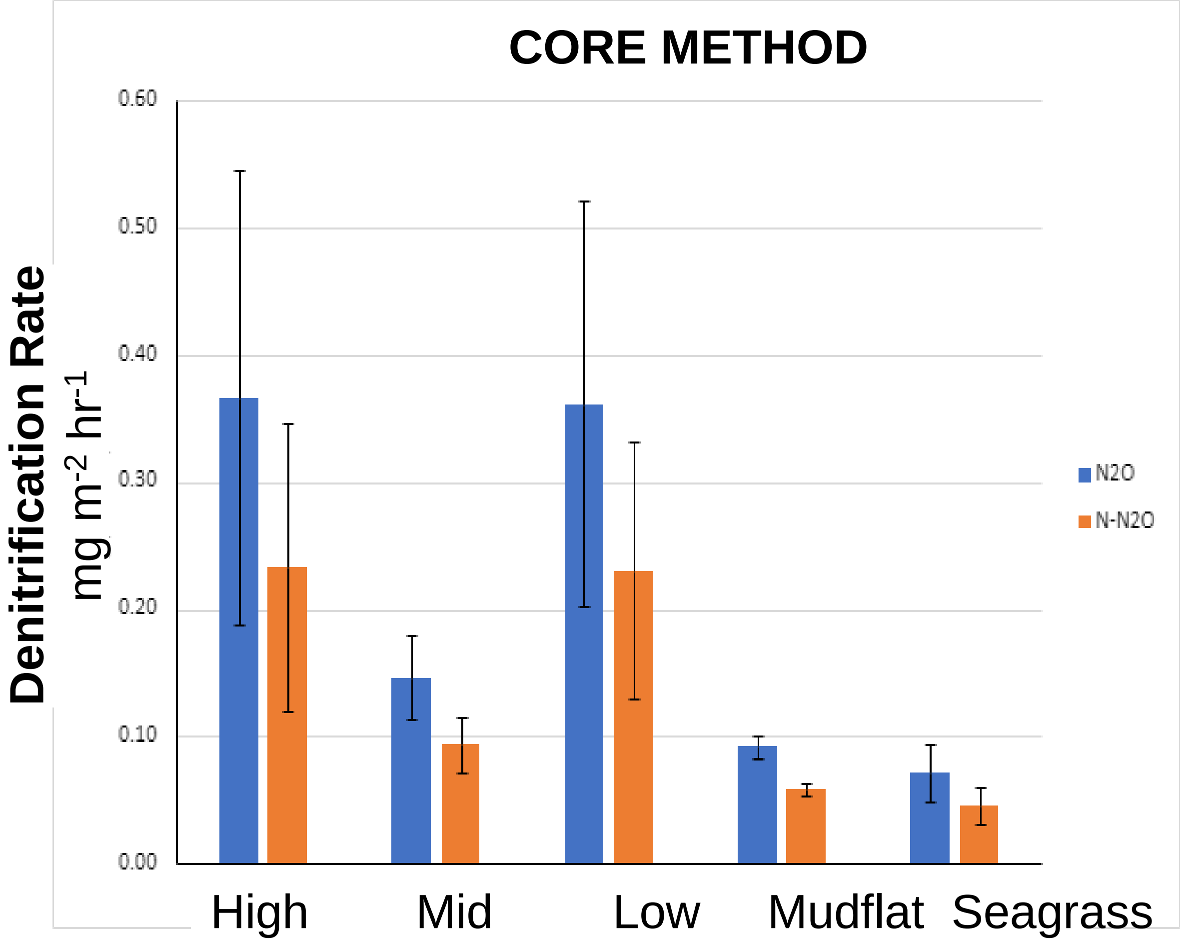
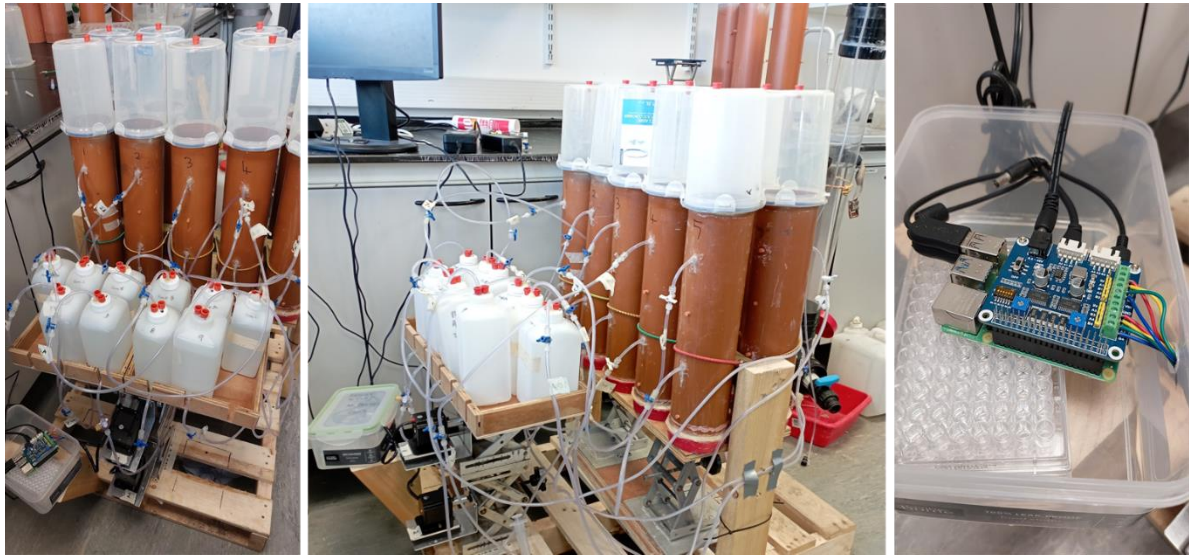
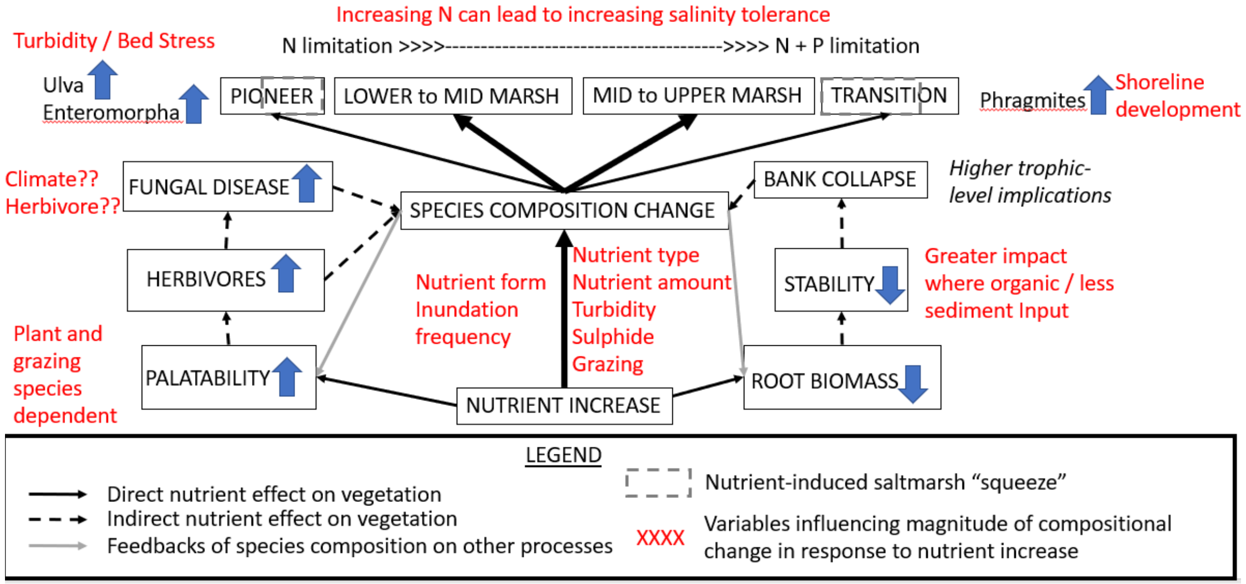
Salt marshes and nutrients







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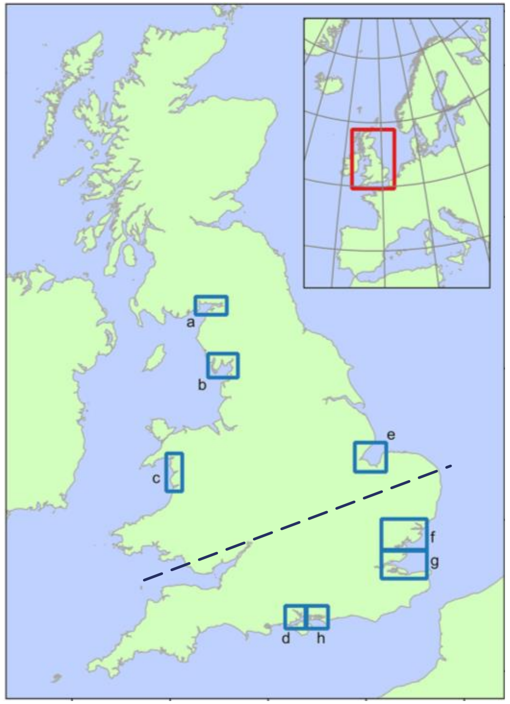
Environment Agency

Thriving Nature for people and planet

NATURAL ENGLAND

Regional differences in changing salt marsh extent



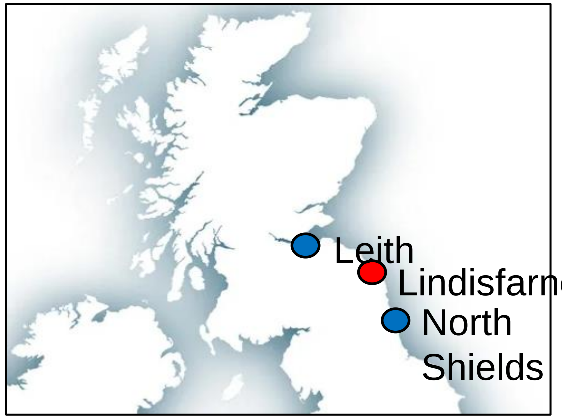
Region	Lateral expansion (ha/year)	Accretion balance (mm/year)
Solway	0.88 ± 1.17	15.41 ± 14.53 (Marshall, 1962)
Morecambe	2.94 ± 0.37	No data
Cardigan	2.31 ± 1.37	8.25 ± 4.06 (Kestner, 1975)
Wash	1.27 ± 0.00	46.17 ± 26.87 (Shi, 1993)
Essex-Kent	−6.42 ± 3.55	3.20 ± 3.56 (Cundy & Croudace, 1996)
Solent	−3.59 ± 1.65	2.91 ± 0.84 (van der Wal & Pye, 2004)

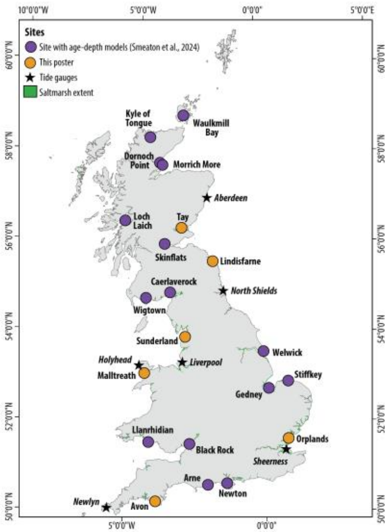
Ladd et al. (2019) ‘Sediment supply explains long-term and large-scale patterns in salt marsh lateral expansion and erosion’ *Geophys Res Lett*

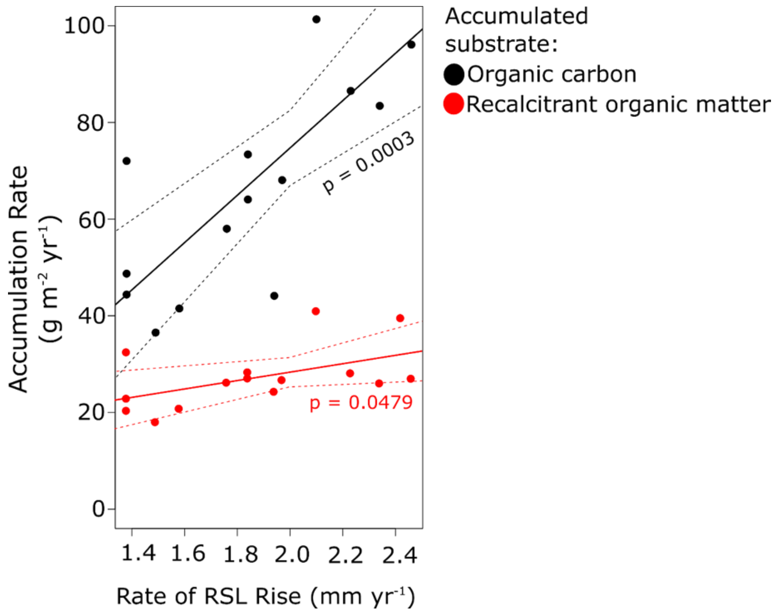
UK Centre for Ecology & Hydrology

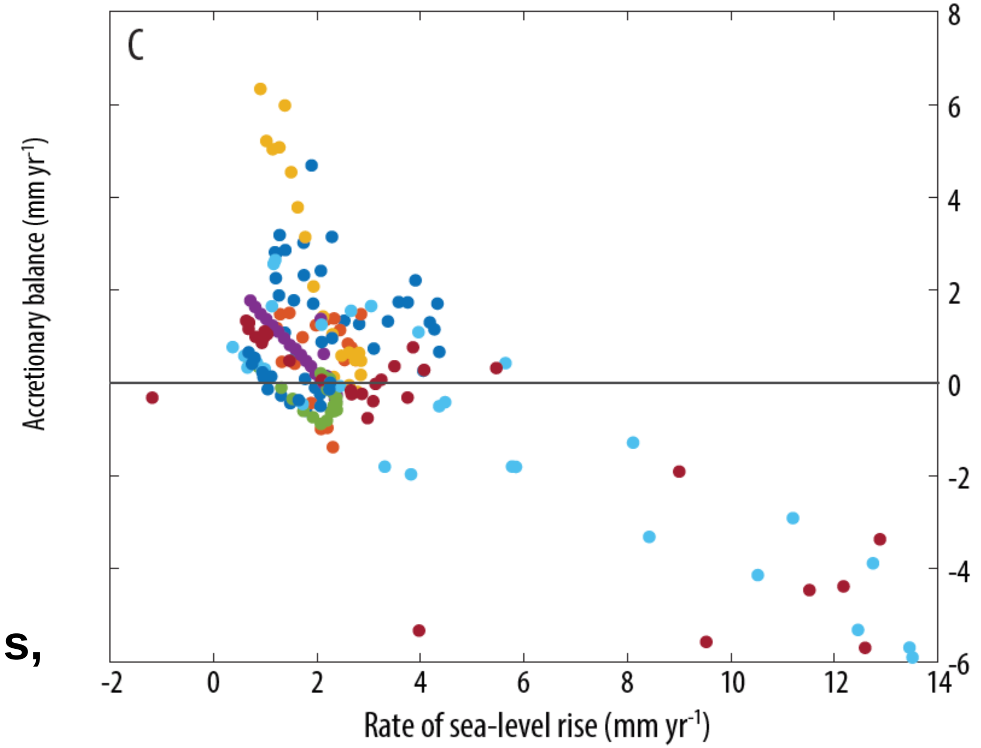
Credit: Cai Ladd, Swansea University

Sea level rise leads to carbon storage; BUT don't keep up with SLR over 6mm/ yr.









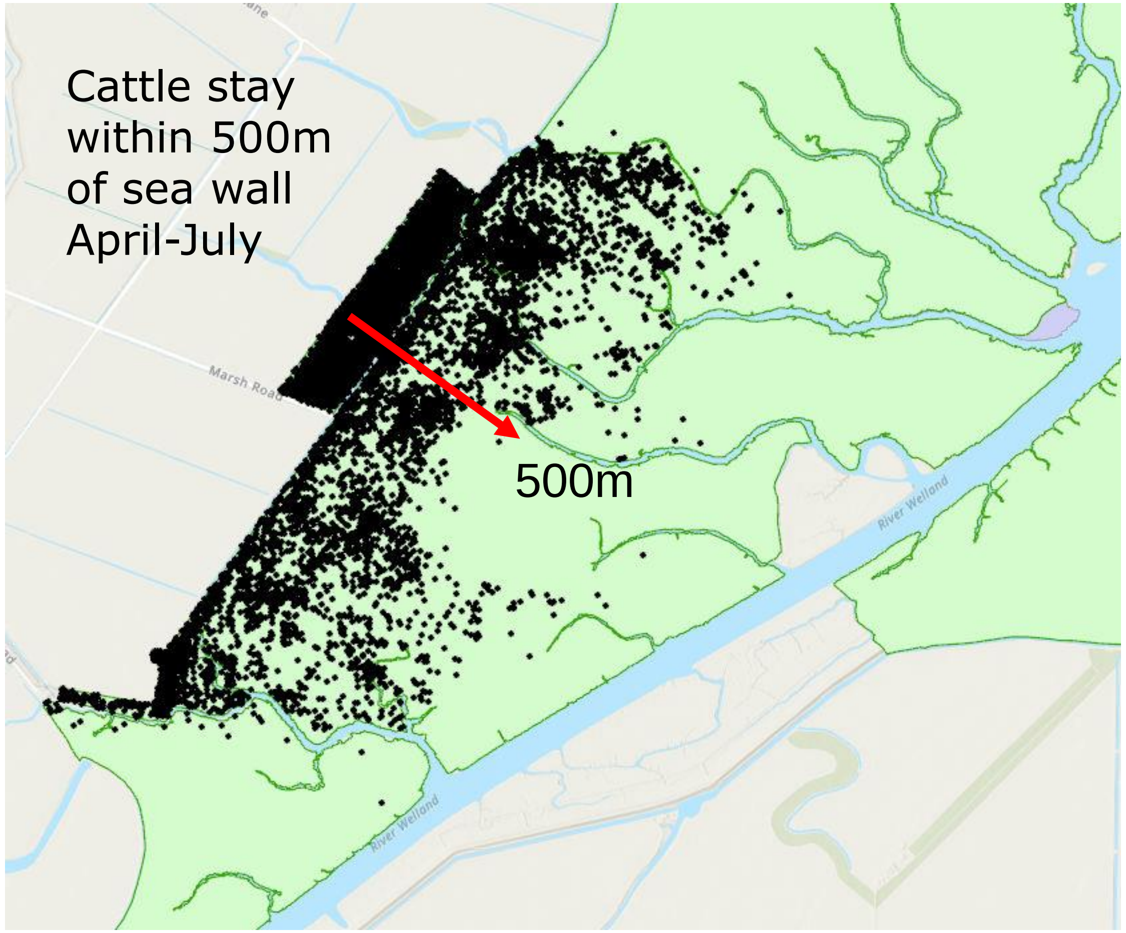
UK Centre for Ecology & Hydrology

UKRI Natural Environment Research Council

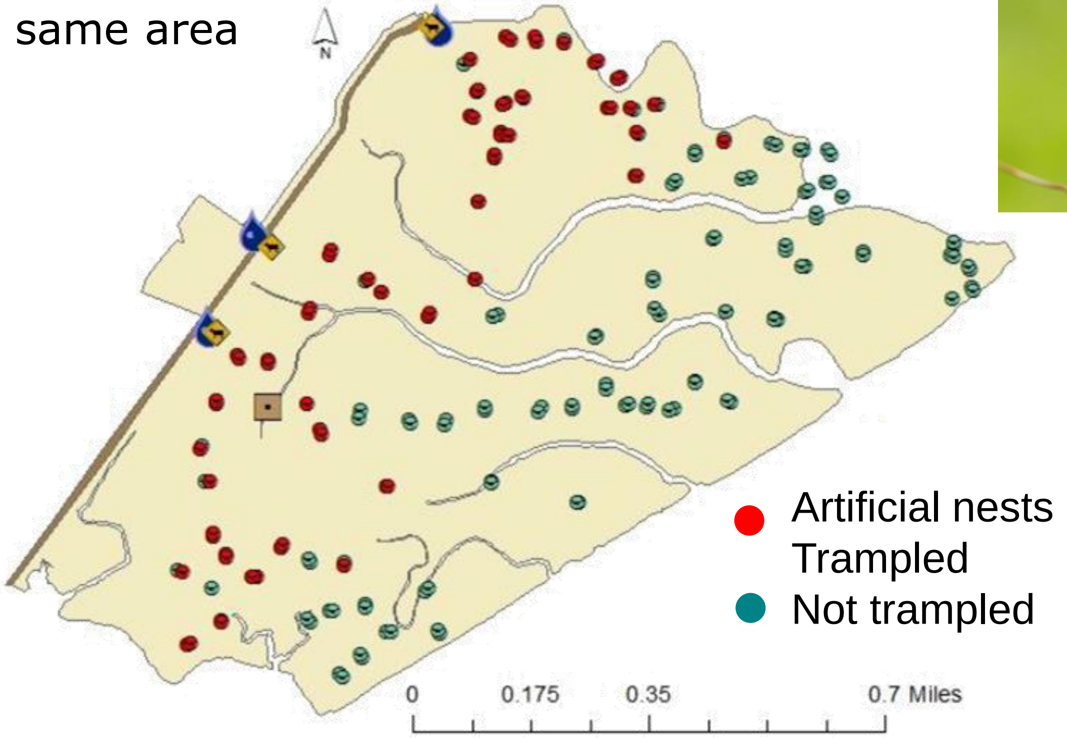
C-SIDE

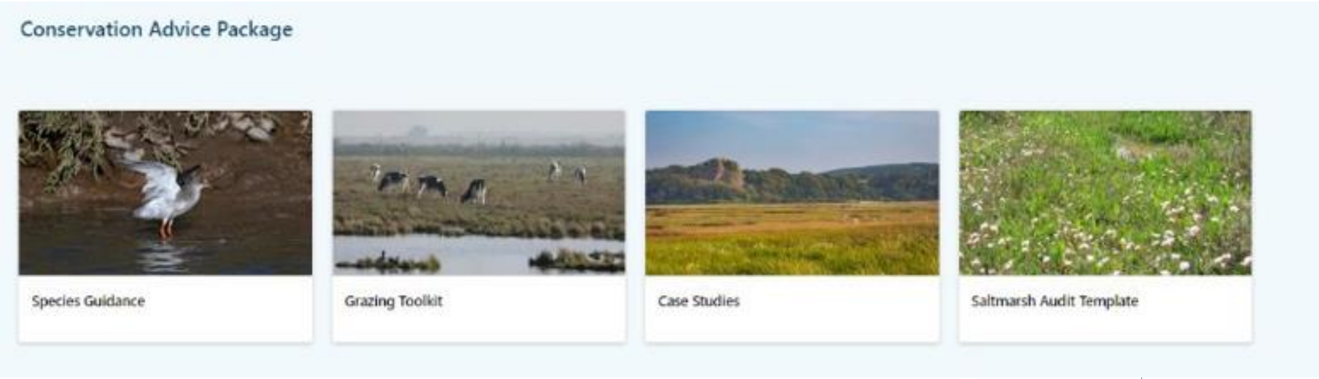
Credit: Roland Gerhels, York University

Light grazing is an ecological trap for redshank



Redshank nest in the same area





Elwyn Sharps PhD and papers (2015, 2014, 2016 & 2017); Kate Jones (2014) MSc thesis

UK Centre for Ecology & Hydrology

Credit: Lucy Mason, RSPB

The Natterjack Toad (Epidalea calamita)
A species on the edge

- Scotland's rarest amphibian
  - Only found in a handful of sites situated along the Solway coast
  - **Closely associated with** coastal environments such as dune slack, lowland heath and **upper salt marsh (or ‘merse’)**

- Pioneer species thriving in early successional or ‘dynamic’ habitat
  - Prefers to breed in ephemeral ponds, either those that dry up in late summer or that become inundated by tidal water in winter
    - Specially adapted behaviour to avoid predator burden and pressure from competitors
    - Risky strategy in the context of natural phenomena such as drought and sea-level rise

Ian Lea

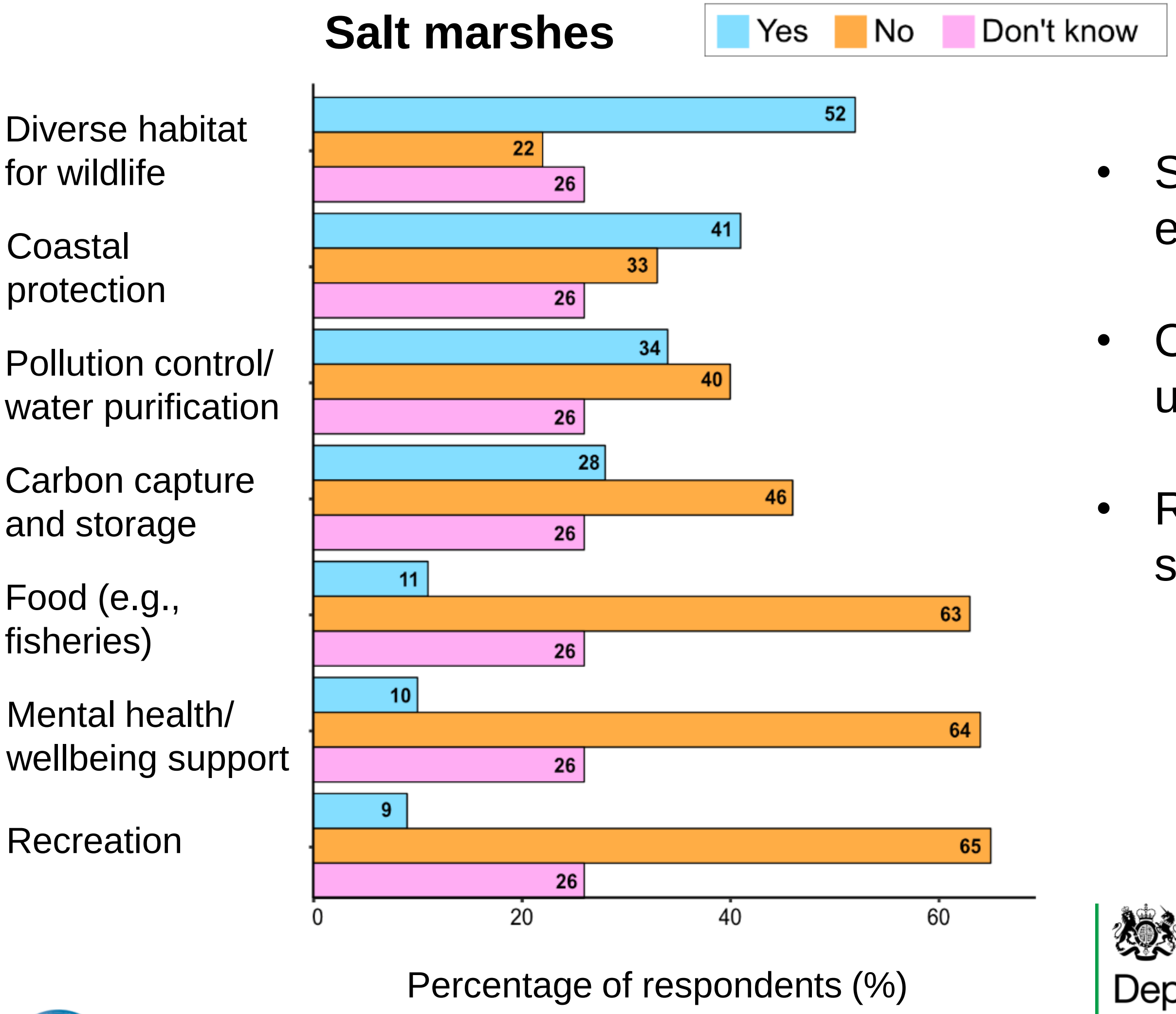
UK Centre for Ecology & Hydrology

Credit - Liam Templton:
Amphibian and Reptile Conservation

SPECIES on the EDGE

Public perceptions, Knowledge and Attitudes

Credit –Lucy McMahon



- Saltmarshes among the least visited marine environment (38% have never knowingly visited)
- Only 4% of respondents reported to know and understand the term 'Blue Carbon'
- Respondents asked whether a range of ecosystem services could be provided by saltmarsh habitats
  - 26 % of respondents answered "Don't know"

UK Centre for Ecology & Hydrology

Department for Environment Food & Rural Affairs

University of York

Manchester Metropolitan University

2030 Breakthroughs

The 2030 Breakthroughs [. . .] highlight key milestones and key actions that different actors can and must contribute to drive progress along Climate Action Pathways, which set out sectoral visions for achieving a 1.5° C resilient world in 2050.

Credit: Tom Brook: WWF

What are the 2030 Breakthroughs?

Built Environment
Open Waste Burning
Cooling

Aluminium
CCS/U Networks
Cement/Concrete
Chemicals
Metals & Mining
Plastics
Steel

The Mangrove Breakthrough
The Coral Reef Breakthrough
Ocean Renewable Energy
Aquatic Food
Coastal Tourism

Aviation
Road Transport
Shipping

Clean Power
Green Hydrogen
Oil & Gas
Clean Cooking
Electrification
Oil & Gas CH4 Reduction

NBS: Land Use

Water

Carbon Removals

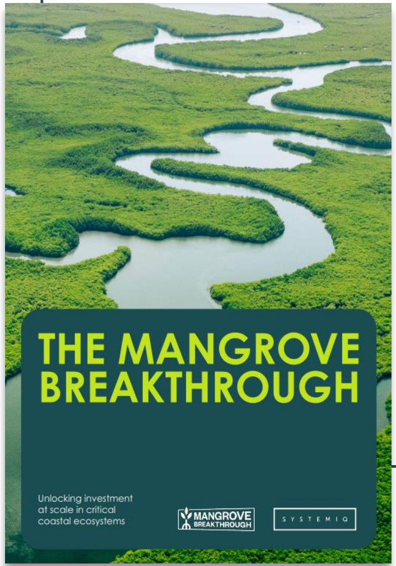
UK Centre for Ecology & Hydrology

What are the conservation breakthrough's trying to achieve?

Mangroves

$4 billion (USD) investment needed to 2030 to secure 15 million hectares of mangroves, of which:

- $1.2 billion from commercial sources
- $2.8 billion in philanthropic, development, and public finance



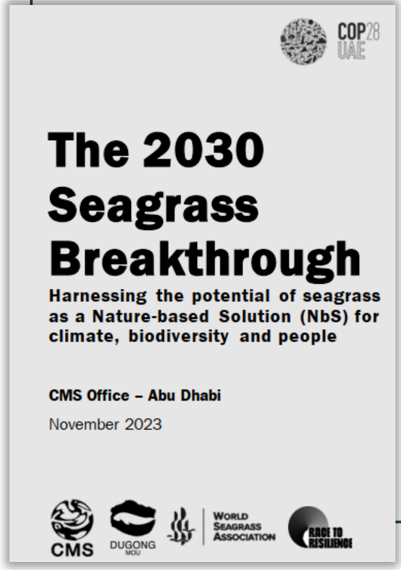
GOALS:

- Halt loss
- Double protection
- Restore half
- Mobilise long-term finance

Seagrass

$122 million (USD) investment needed to 2030*

*Tentative target, pending expert review and formal launch of breakthrough


COP28 UAE

The 2030 Seagrass Breakthrough

Harnessing the potential of seagrass as a Nature-based Solution (NbS) for climate, biodiversity and people

CMS Office – Abu Dhabi

November 2023

CMS DUGONG MOU WORLD SEAGRASS ASSOCIATION RACE TO RESILIENCE

GOALS:

- Halt loss
- Double protection
- Restore one-fourth
- Mobilise long-term finance

Saltmarsh

?

UK Centre for Ecology & Hydrology

The 2030 Saltmarsh Breakthrough:

A global initiative for saltmarsh ecosystem conservation

United Nations Framework Convention on Climate Change (UNFCCC)

Convention on Biological Diversity (CBD), GBF 2020

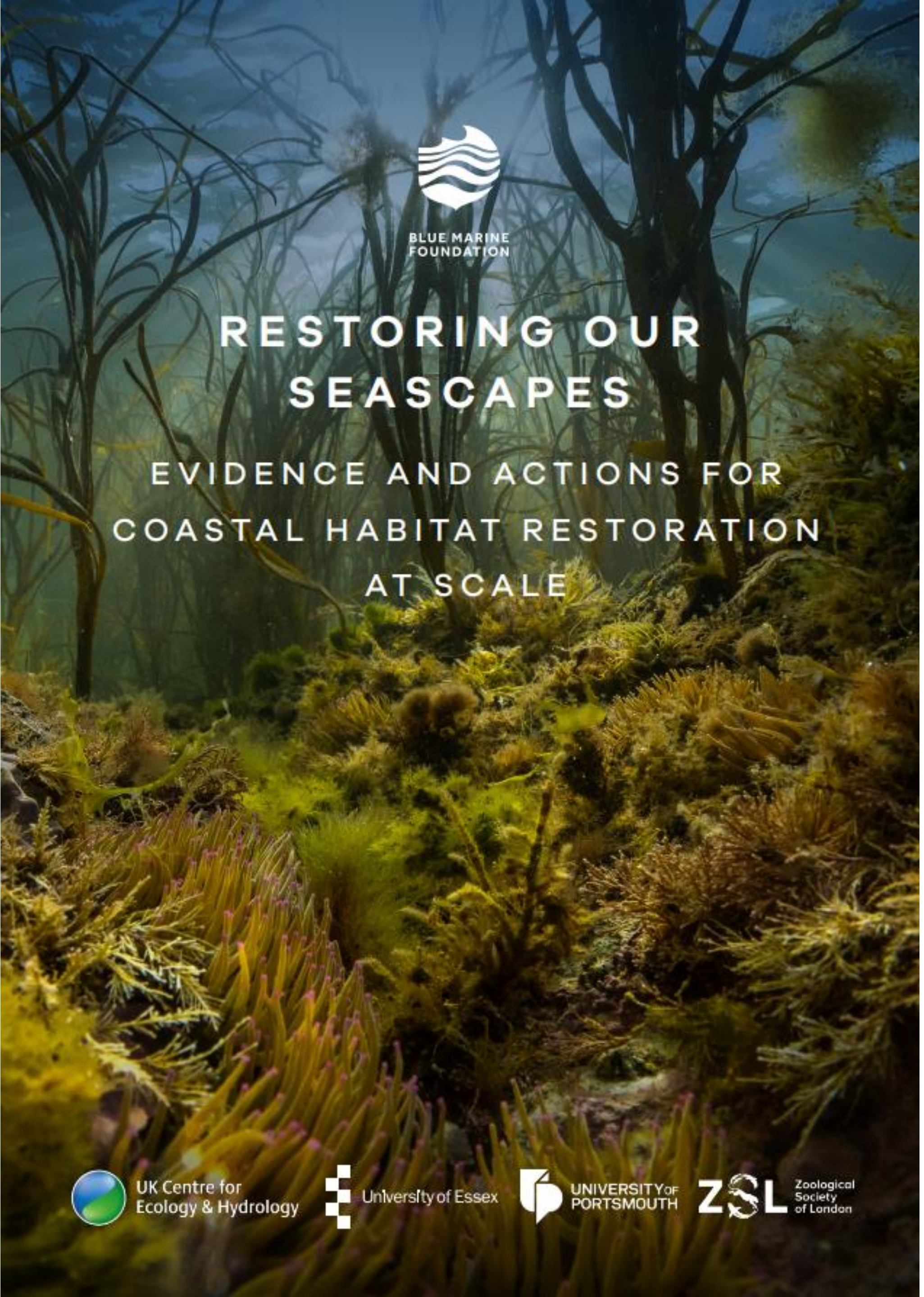
United Nations Decade of Ocean Science for Sustainable Development (2021 – 2030)

Convention on Migratory Species (CMS)

UN Decade on Ecosystem Restoration (2021 – 2030)

The Sendai Framework for Disaster Risk Reduction (2015 – 2030)

UK Centre for Ecology & Hydrology



Seascapes: restoration at scale

Recommendations:

1. The UK should set a long-term national vision to enable strategic seascape restoration and move towards seascape-scale natural capital projects, supported by high-quality data, to create multifunctional and healthy ecosystems for people and nature.

2. The UK and devolved Governments should adopt a whole site approach to designating marine protected areas, analysing and prioritising connectivity between features for maximum ecosystem health.

3. The UK Governments should reform the marine licensing process for seascape restoration projects creating a new ‘seascape scale’ licence to enable efficient ecosystem recovery.

Thank you

For more information please contact:

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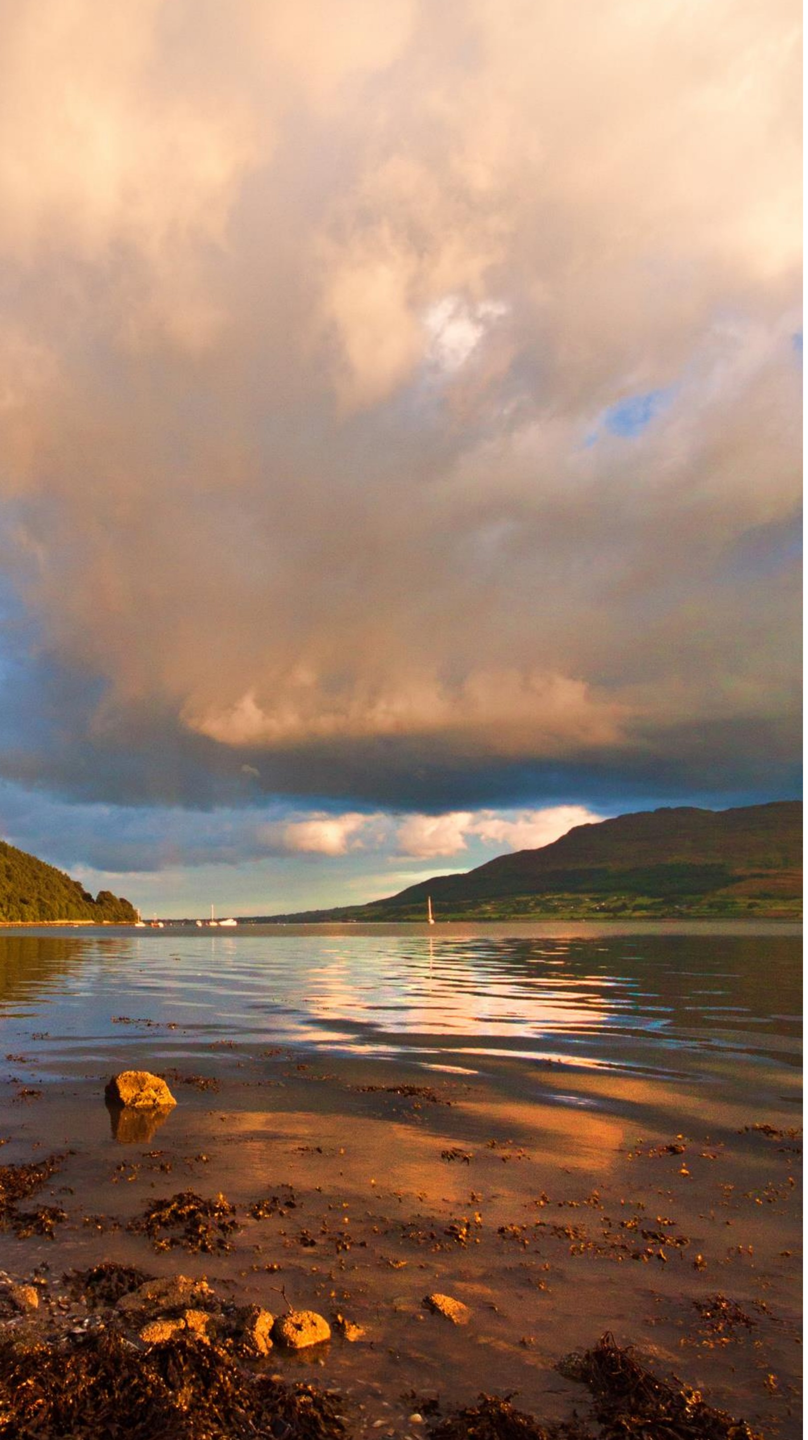
UK Centre for Ecology & Hydrology



ReMeMaRe Conference 2024

Science Session

Bill Sanderson, University of Heriot Watt

Everything, everywhere, all at once: where are we with European oyster restoration, and how can it move to scale?

Environment Agency

OCEAN & COASTAL FUTURES

Everything everywhere, all at once:

Where are we with European oyster restoration, and how can it move to scale?

William G. Sanderson, Preston J. & zu Ermgassen P.S.E.

Professor Marine Biodiversity, Heriot-Watt University
DEEP Research Director
Restoration Forth Oyster Research Lead

Dornoch Environmental Enhancement Project

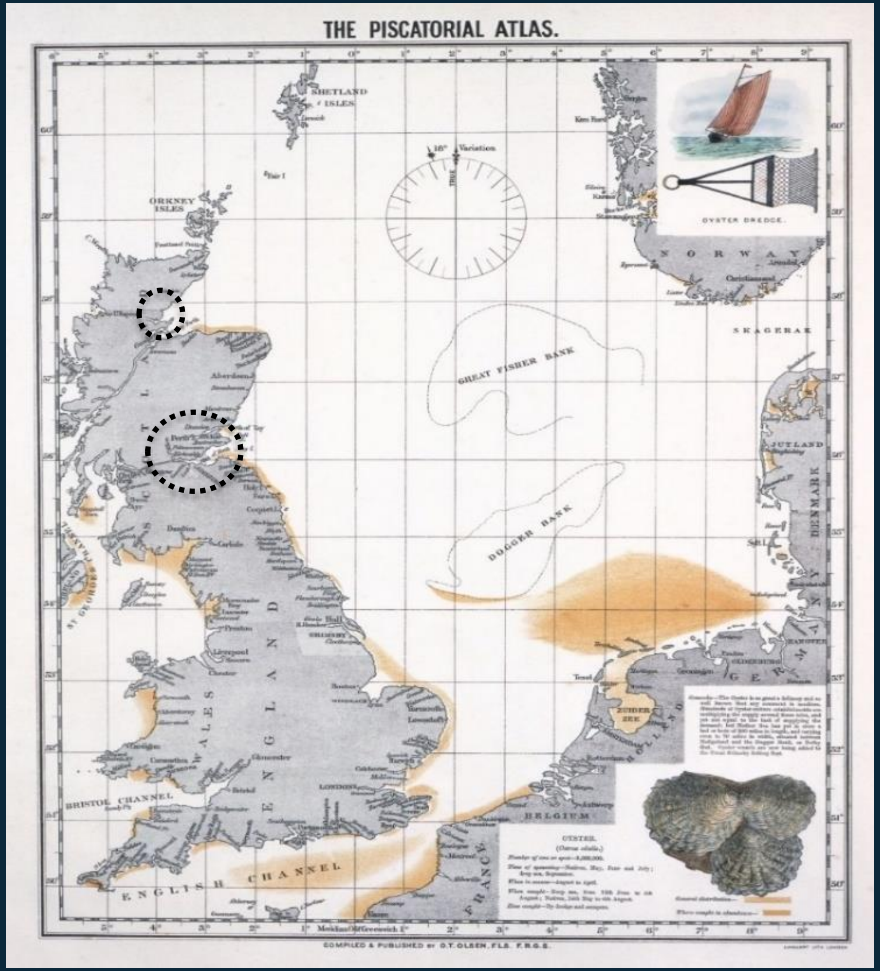
- Started 10 years ago
- Former presence
- Survival
- Optimisation
- Moving to scale (40ha)

Restoration Forth

- Started 3 years ago
- Consortium
- Supports community restoration
- Oyster and seagrass habitats
    - Integrated restoration
    - Influence policy for restoration

Oyster habitats are functionally extinct

- Native European Oysters
  - Abundant on all coasts
- Firth of Forth:
  - Extensive beds (~311km²*)
  - About the size of Edinburgh
  - Now all gone

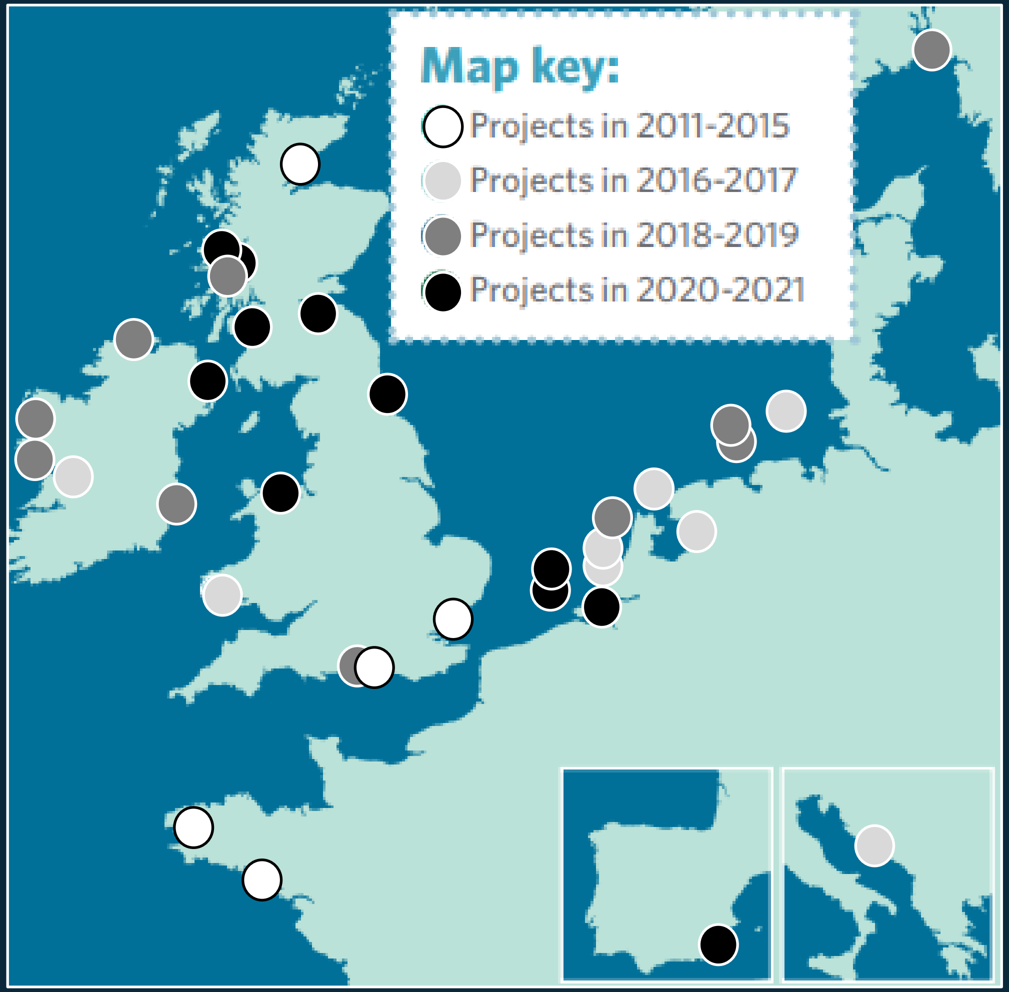


Olsen, O.T., 1883. *The Piscatorial Atlas of the North Sea, English and St. George's Channels….*

*Thurstan, R.H., Hawkins, J.P., Raby, L. and Roberts, C.M., 2013. Oyster (*Ostrea edulis*) extirpation and ecosystem transformation in the Firth of Forth, Scotland. *Journal for nature conservation*, *21*(5), pp.253-261.

Oyster restoration increasingly popular

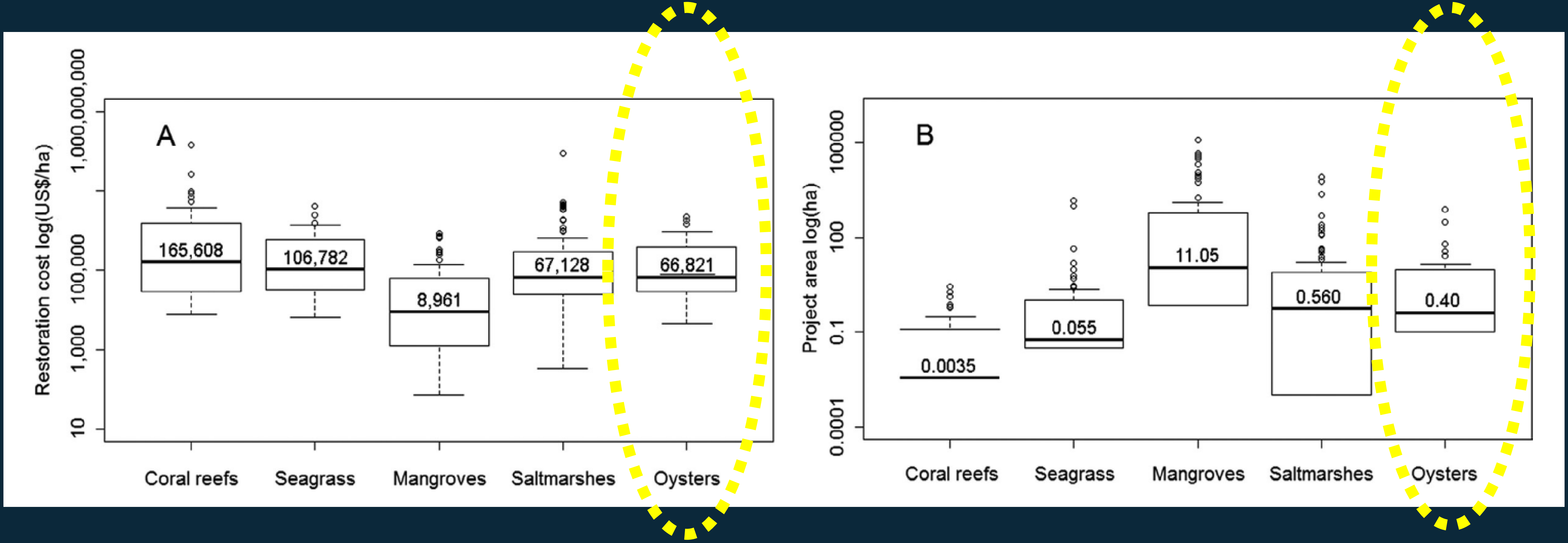
- In Europe, mostly <10yrs old
- Now 30+ projects
- Emergence of NORA
- 2021 - UN Decade on Ecosystem Restoration
- 2024 -EU Nature Restoration Law



Pogoda, B., Boudry, P., Bromley, C., Cameron, T.C., Colsoul, B., Donnan, D., et al., 2020. NORA moving forward: Developing an oyster restoration network in Europe to support the Berlin Oyster Recommendation. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *30*(11), pp.2031-2037.

zu Ermgassen, P.S., Bos, O., Debney, A., Gamble, C., Glover, A., Pogoda, B., Pouvreau, S., Sanderson, W., Smyth, D. and Preston, J., 2021. European Native Oyster Habitat Restoration Monitoring Handbook. The Zoological Society of London.

Global marine restoration is mostly small-scale

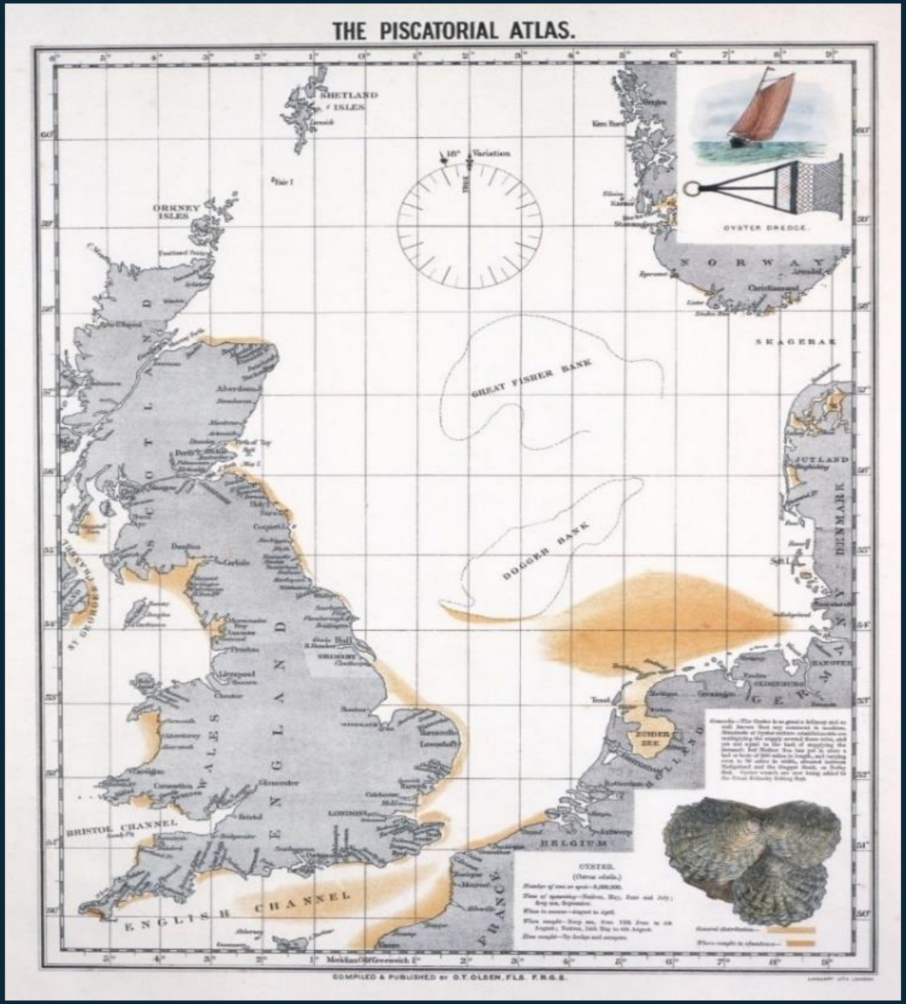


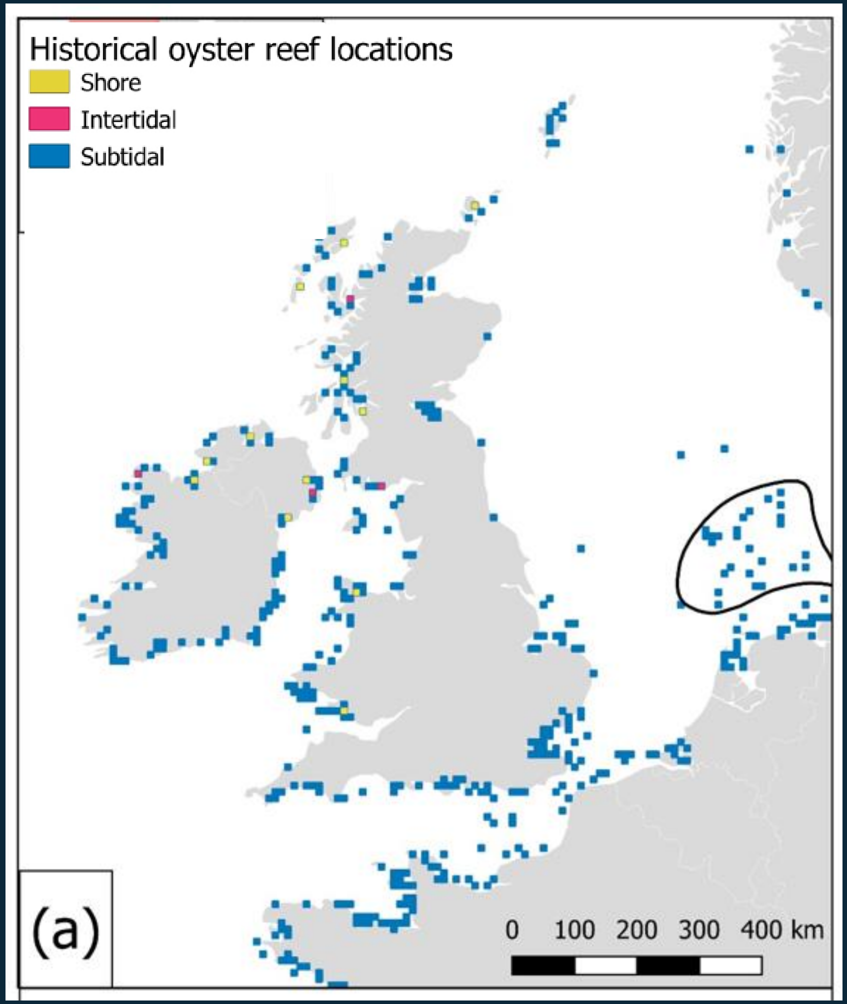
- Most oyster projects cost $10k-100k
- Most projects < 0.5 km^2

Bayraktarov, E., Saunders, M.I., Abdullah, S., Mills, M., Beher, J., Possingham, H.P., Mumby, P.J. and Lovelock, C.E., 2016. The cost and feasibility of marine coastal restoration. *Ecological Applications*, *26*(4), pp.1055-1074..

Ambition

Growing confidence around how widespread habitat was





Thurstan, R.H.,…Preston, J.…zu Ermgassen, P.S.E. Records reveal the vast historical extent of European oyster reef ecosystems. (In Press), Nature Sustainability

Ecosystem recovery must have meaningful scale

- *Self-sustaining ecosystems* commonly cited ambition:

- 20% EU's land & sea by 2030

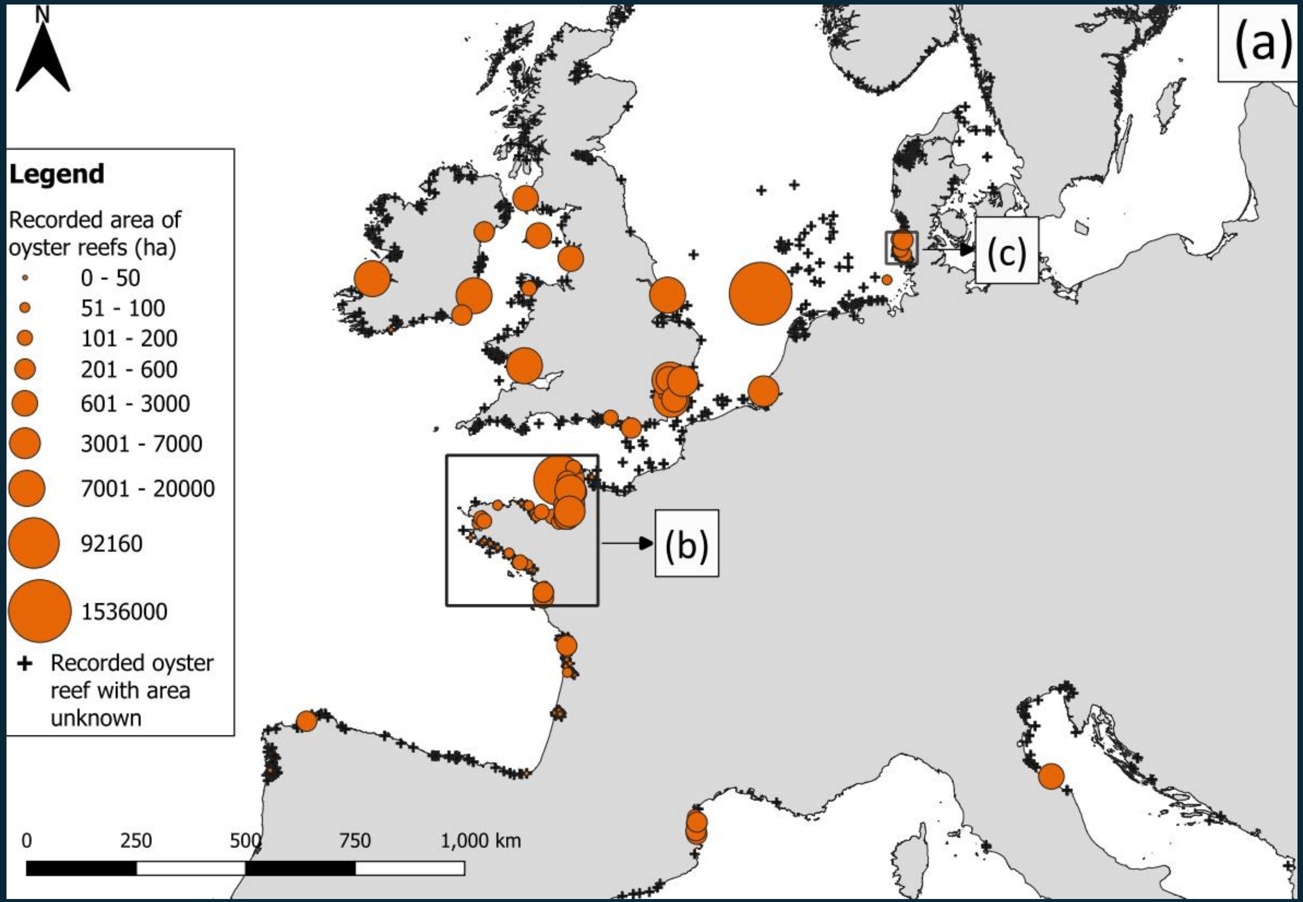
- "...restoring marine habitats such as seagrass beds or sediment bottoms that deliver significant benefits..."

European Commission 2024. Nature Restoration Law. https://environment.ec.europa.eu/topics/nature-and-biodiversity/nature-restoration-law_en.

Kennon, N.A., Robertson-Jones, A., Jemmett, S., Hugh-Jones, T., Bell, M.C. and Sanderson, W.G., 2023. Rotational fishing enables biodiversity recovery and provides a model for oyster (*Ostrea edulis*) habitat restoration. PloS one, 18(3), p.e0283345.

What might a 20% target for oysters look like?

- Historical documents indicate oyster reef ecosystems >1,773,505 ha
- [20% = 3547 km^2]
- >8km wide here to Amsterdam (410km)
- Historical extent is rarely a desirable or achievable goal
- Ecologically informative reference



Thurstan, R.H.,…Preston, J.…zu Ermgassen, P.S.E. Records reveal the vast historical extent of European oyster reef ecosystems. (In Press), Nature Sustainability

Restoration at scale requires networks

- Oysters:
  - can aggregate in large numbers
  - have planktotrophic larval dispersal
  - predominantly subtidal

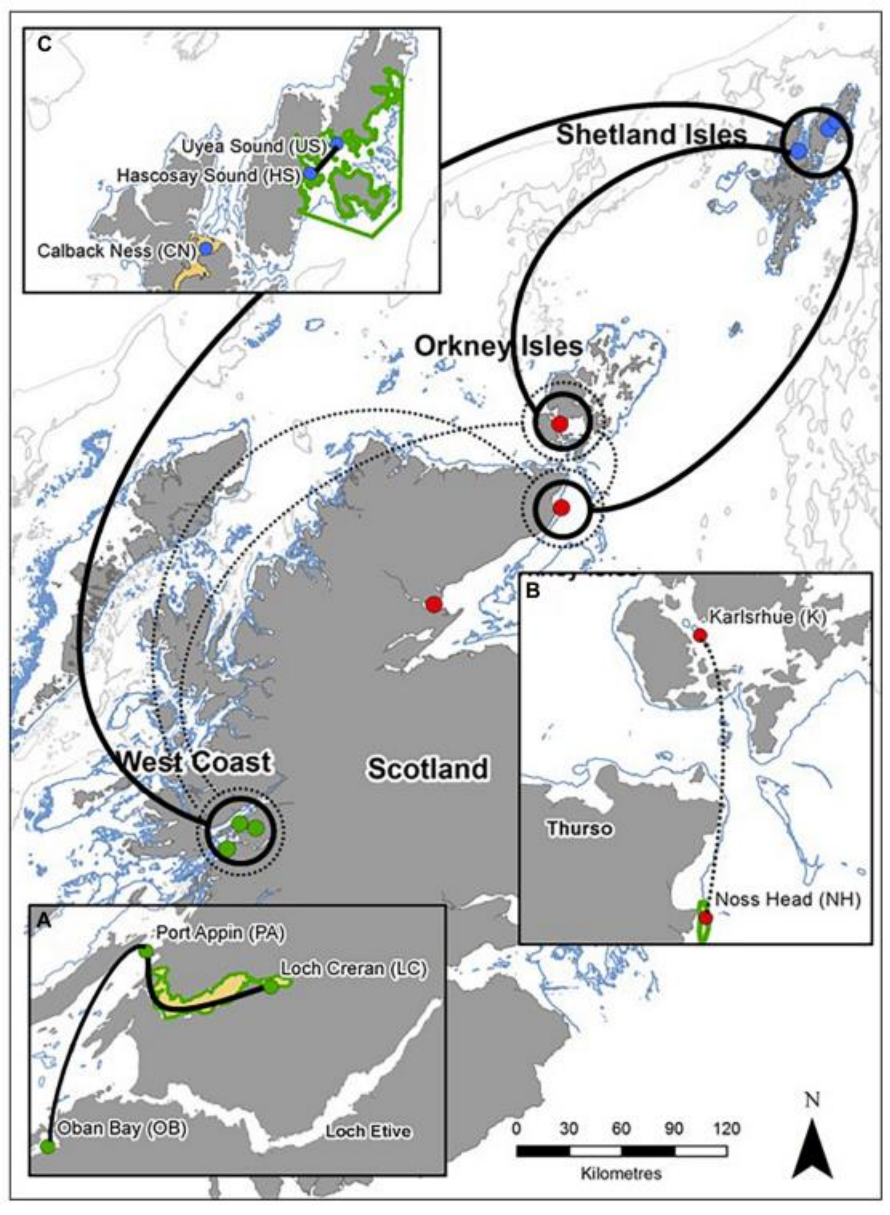
- Analogue is horse mussel (*Modiolus modiolus*) habitats

- Both *O. edulis* and *M. modiolus* are subtidal bivalve habitat engineers

Fariñas-Franco, J.M., Cook, R.L., Gell, F.R., Harries, D.B., Hirst, N., Kent, F., MacPherson, R., Moore, C., Mair, J.M., Porter, J.S. and Sanderson, W.G., 2023. Are we there yet? Management baselines and biodiversity indicators for the protection and restoration of subtidal bivalve shellfish habitats. *Science of the Total Environment*, *863*, p.161001.

Connectivity

- Horse mussel populations show close genetic connectivity over hundreds of kilometres or tens of kilometres
- ...but conversely other populations show comparatively poor genetic connectivity at both of the same scales



Mackenzie, C.L., Kent, F.E., Baxter, J.M., Gormley, K.S., Cassidy, A.J., Sanderson, W.G. and Porter, J.S., 2022. Genetic Connectivity and Diversity of a Protected, Habitat-Forming Species: Evidence Demonstrating the Need for Wider Environmental Protection and Integration of the Marine Protected Area Network. Frontiers in Marine Science, p.139

Practicality

Supply chain

- Aquaculture businesses orientated on the Pacific oyster (*Magellana gigas*) since the 1970’s

- Sporadic and relatively few sources of *Ostrea edulis* spat

- Many restoration projects rely on translocated young or adult oysters from aquaculture businesses

Moving large volumes

- Translocation requires biosecurity
- Invasive species and disease
- Labour intensive and not ‘scalable’
    - (ambition identified above)

Moving large volumes at larval stage

- Movement of larvae to the restoration site to avoid the biosecurity in translocation
- Localised (to the restoration site) production
- required volume-improvements
- Remote set for *Ostrea edulis*?

Woods Hole Sea Grant Program 2008. Restoring Oysters Through Remote Set. Marine Extension Bulletin

Congrove, M.S, Wesson J.A., S.K. Allen 2009. A Practical Manual for Remote Setting in Virginia. Virginia Fishery Resource Grant Program, Virginia Institute of Marine Science.

Oyster restoration areas are recruitment and/or substrate limited

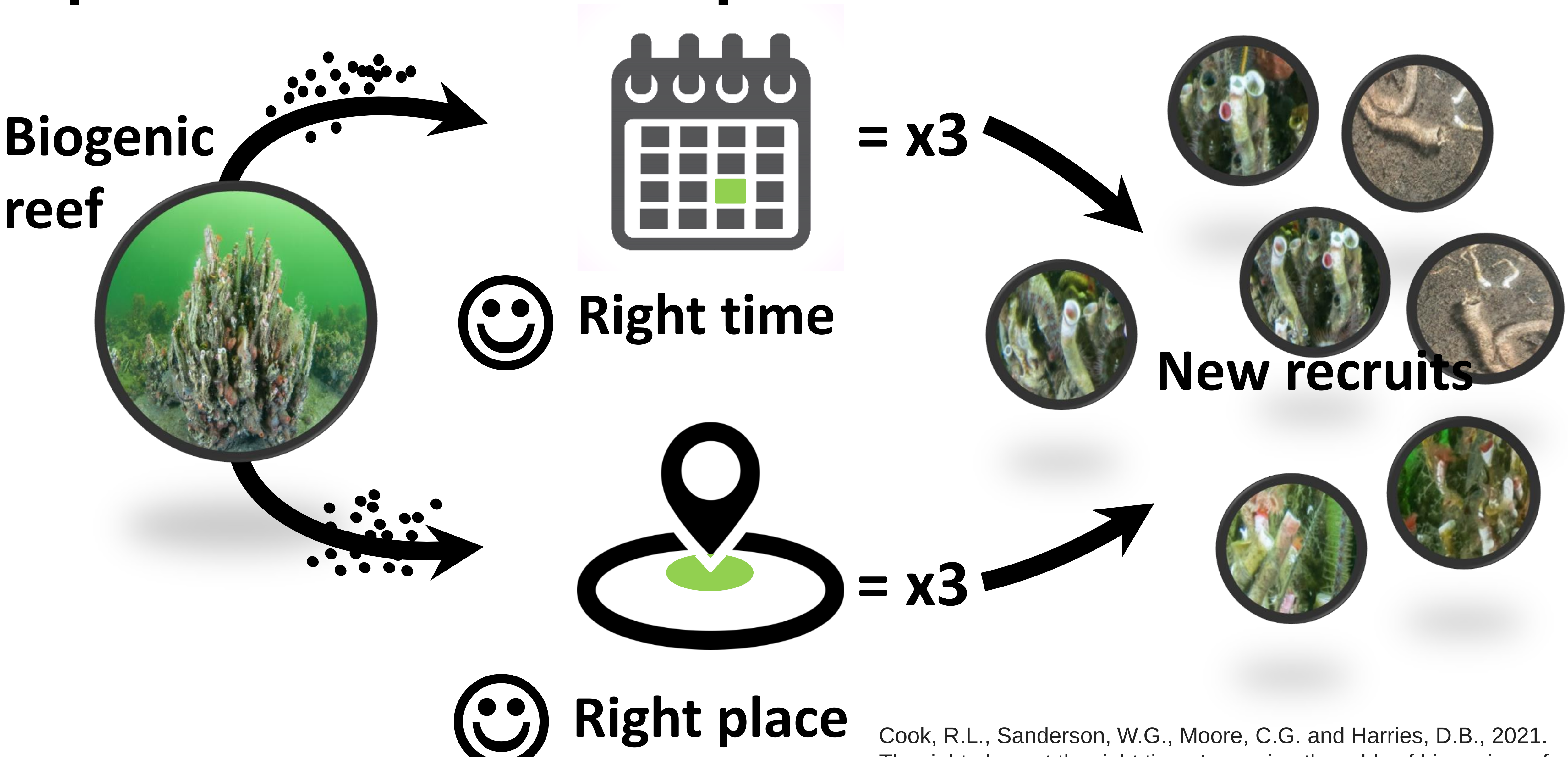
Photo: Joe Rieger

- Barge deploying shell
- Chesapeake Bay, USA.
- Routine practical aspects of this not yet in place for European Native Oyster

Westby, S., Geselbracht, L. and Pogoda, B., 2019. Shellfish reef restoration in practice. In *Restoration guidelines for shellfish reefs* (pp. 36-48). The Nature Conservancy.

Expense

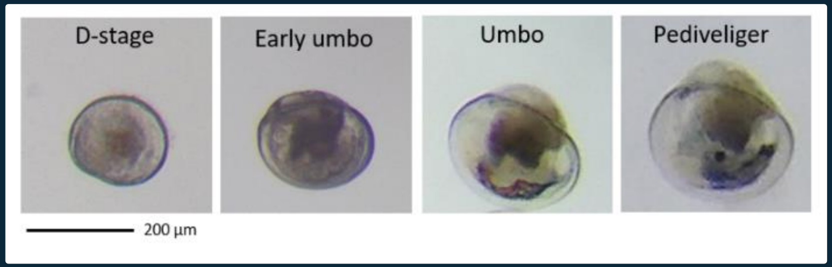
Optimise to reduce expense

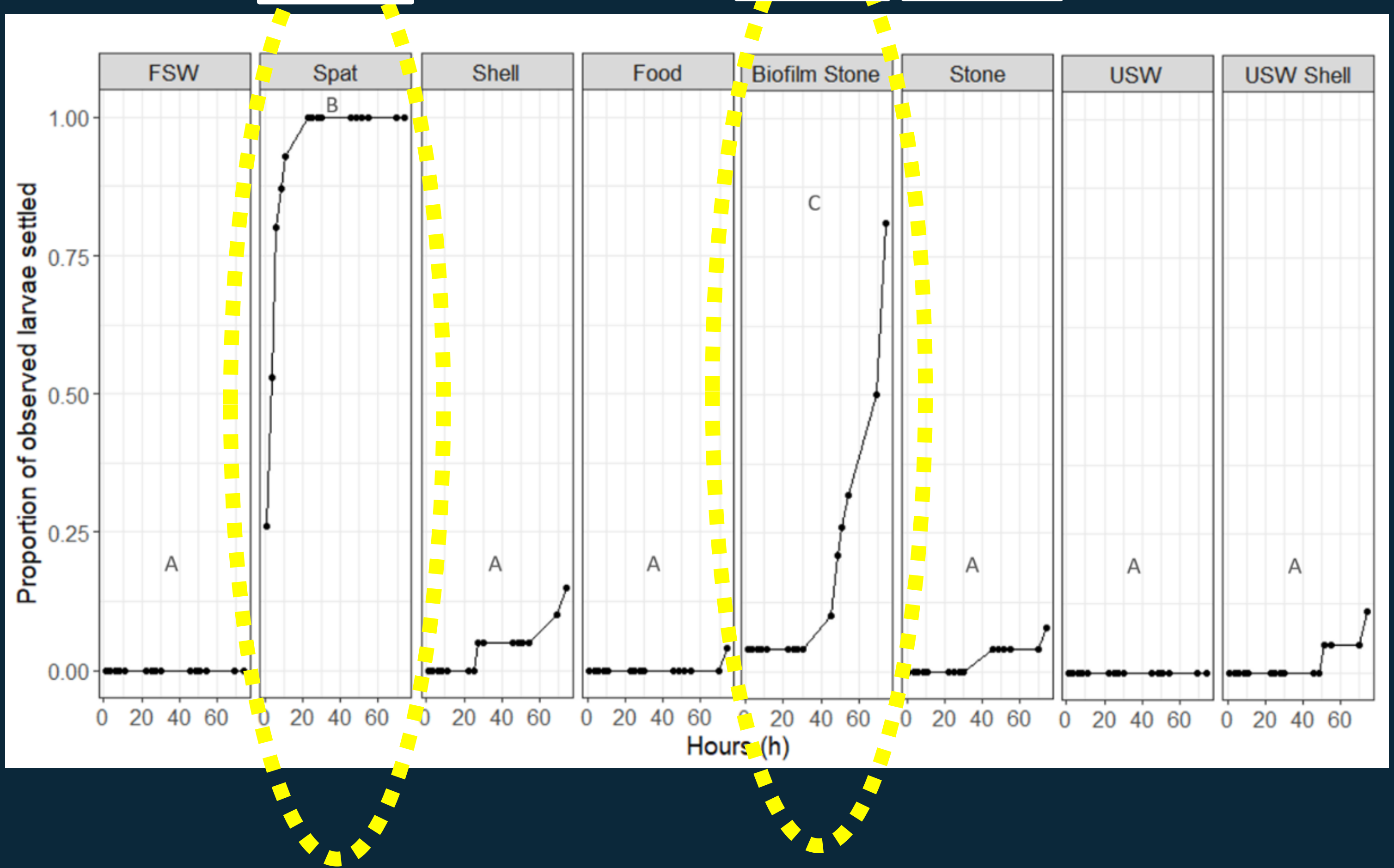


Cook, R.L., Sanderson, W.G., Moore, C.G. and Harries, D.B., 2021. The right place at the right time: Improving the odds of biogenic reef restoration. *Marine Pollution Bulletin*, *164*, p.112022

Icons from http://www.onlinewebfonts.com and Vecteezy.com.
Photography: Robert L. Cook

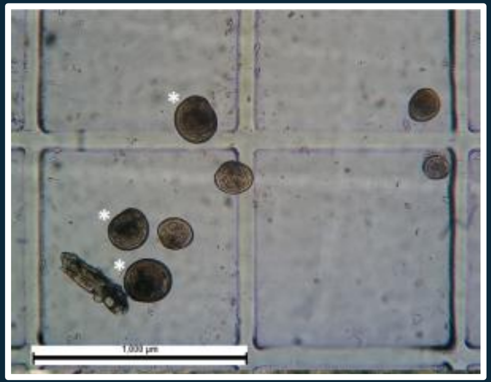
Oysters prefer to settle amongst other oysters





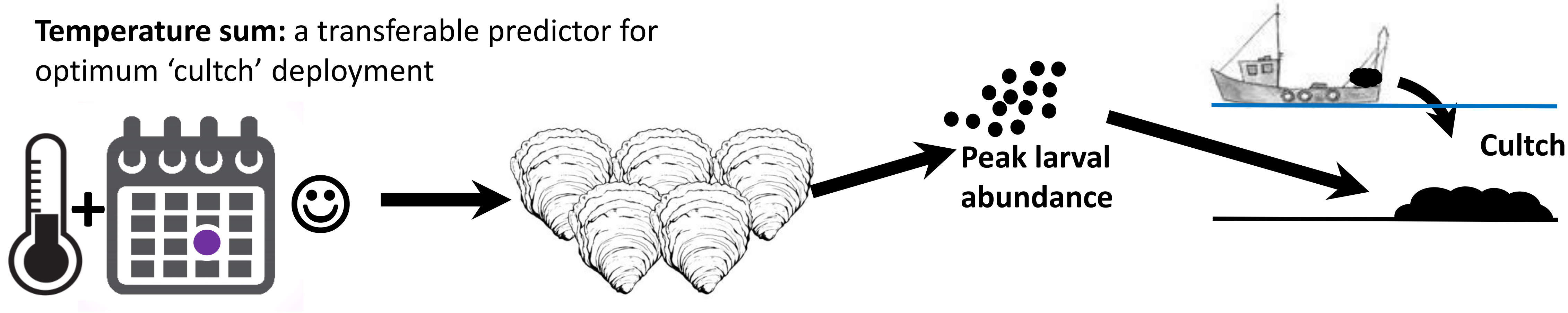
Rodriguez-Perez, A., James, M., Donnan, D.W., Henry, T.B., Møller, L.F. and Sanderson, W.G., 2019. Conservation and restoration of a keystone species: Understanding the settlement preferences of the European oyster (*Ostrea edulis*). *Marine pollution bulletin*, *138*, pp.312-321.

Deployment timing



- Temperature sum
- Sum total of degrees per day above 7°C in a calendar year
- **Best time to deploy cultch**

Temperature sum: a transferable predictor for optimum ‘cultch’ deployment

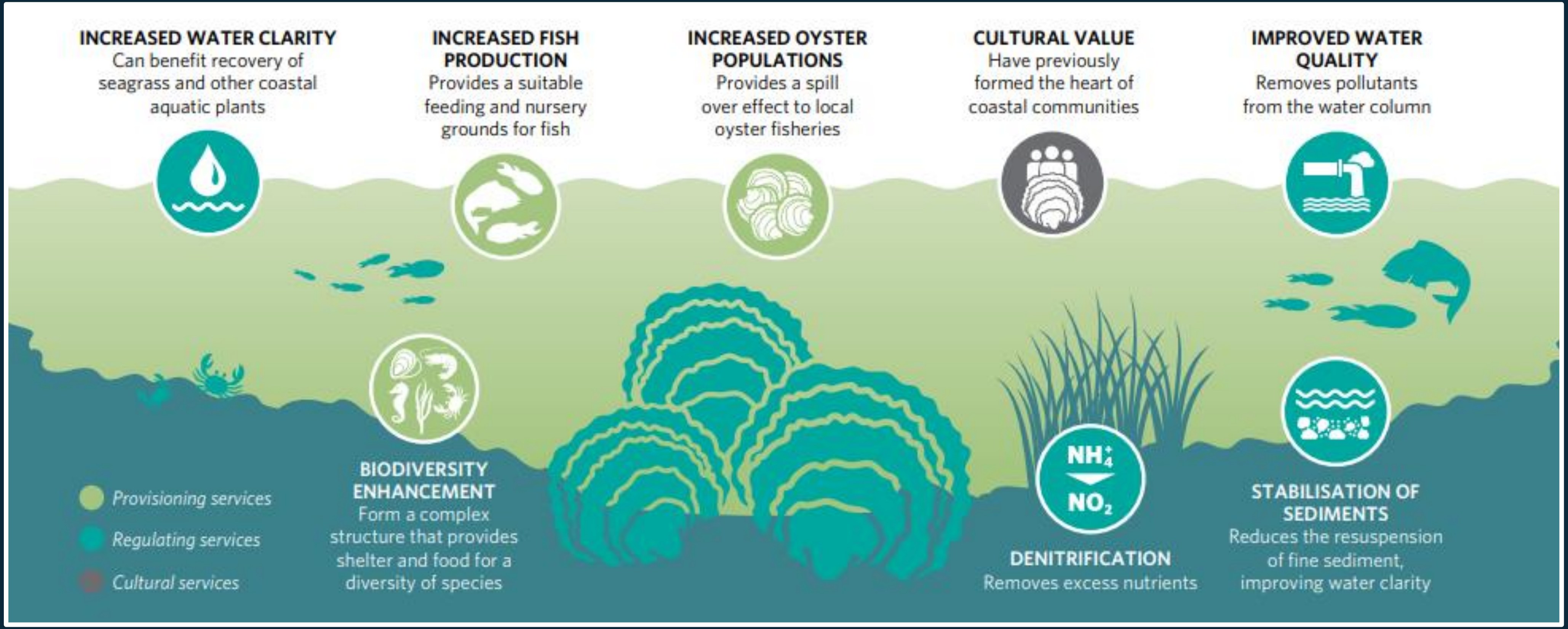


Thanks to: http://www.onlinewebfonts.com and Vecteezy.com

Chapman, E.C., Rodriguez-Perez, A., Hugh-Jones, T., Bromley, C., James, M.A., Diele, K. and Sanderson, W.G., 2021. Optimising recruitment in habitat creation for the native European oyster (*Ostrea edulis*): Implications of temporal and spatial variability in larval abundance. *Marine Pollution Bulletin*, *170*, p.112579.

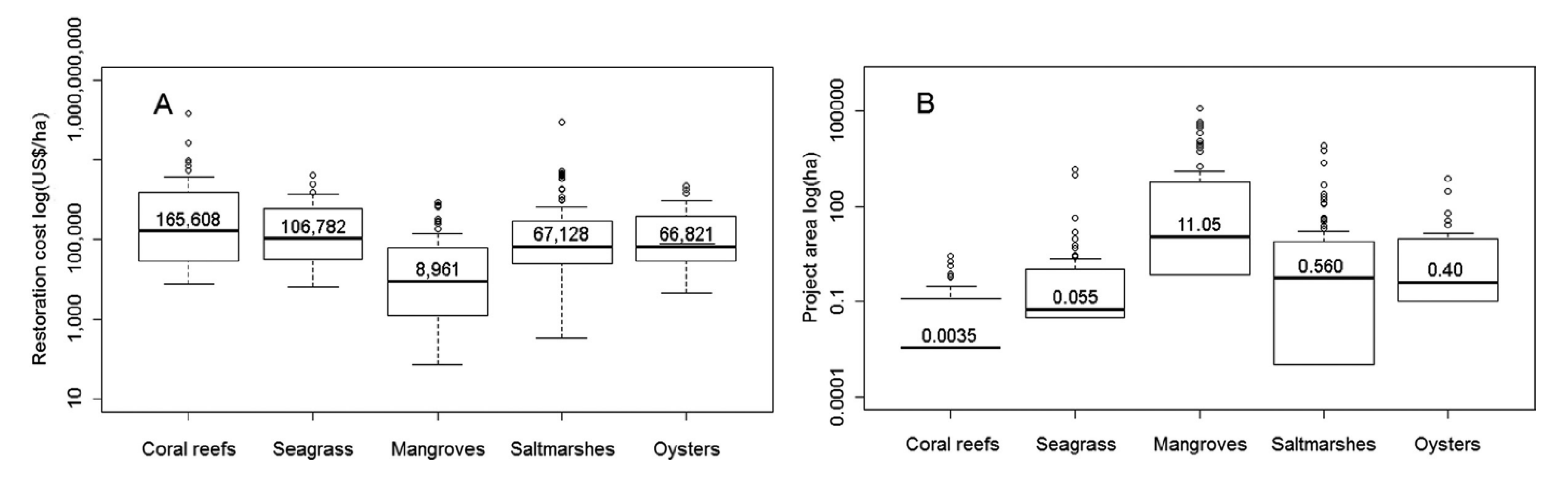
Clarifying benefits to drive investment (Ecosystem Services)

Ecosystem Services



Preston, J., Gamble, C., Debney, A., Helmer, L.D., Hancock, B. and zu Ermgassen, P., 2020, November. European Native Oyster Habitat Restoration Handbook. Zoological Society of London.

It's costly…… right?



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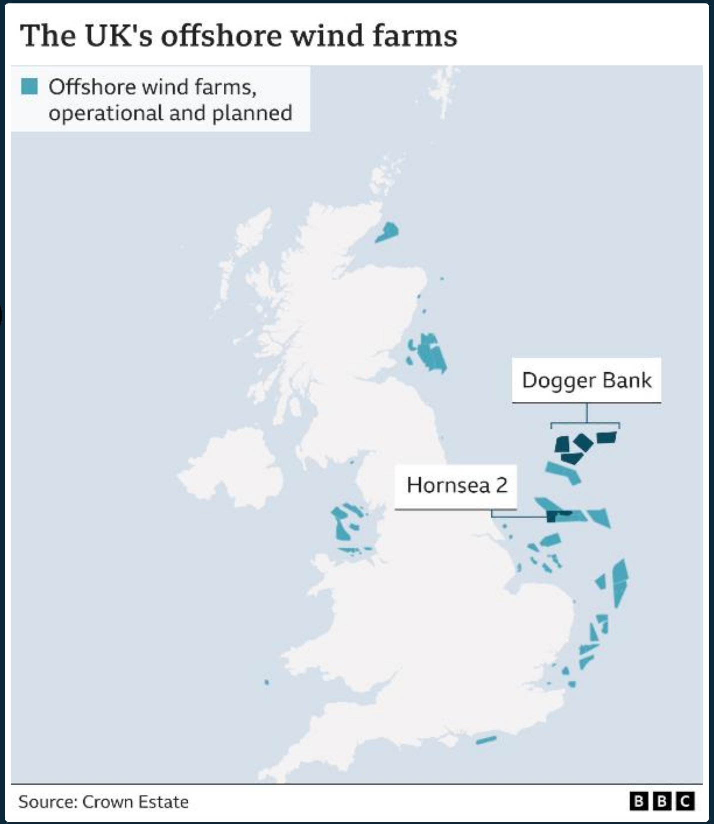
We build when costs and benefits are clear

- The worlds biggest OWF…
- Several £ billions
- …and Dogger will be even bigger

Dogger Bank Phase B, May 2024
https://doggerbank.com/about/



BBC 2022a. Hornsea 2: North Sea wind farm claims title of world's largest. https://www.bbc.co.uk/news/science-environment-62731923
BBC 2022b. Dogger Bank: Work starts on 'world's largest' offshore wind farm. https://www.bbc.co.uk/news/uk-england-humber-62307813

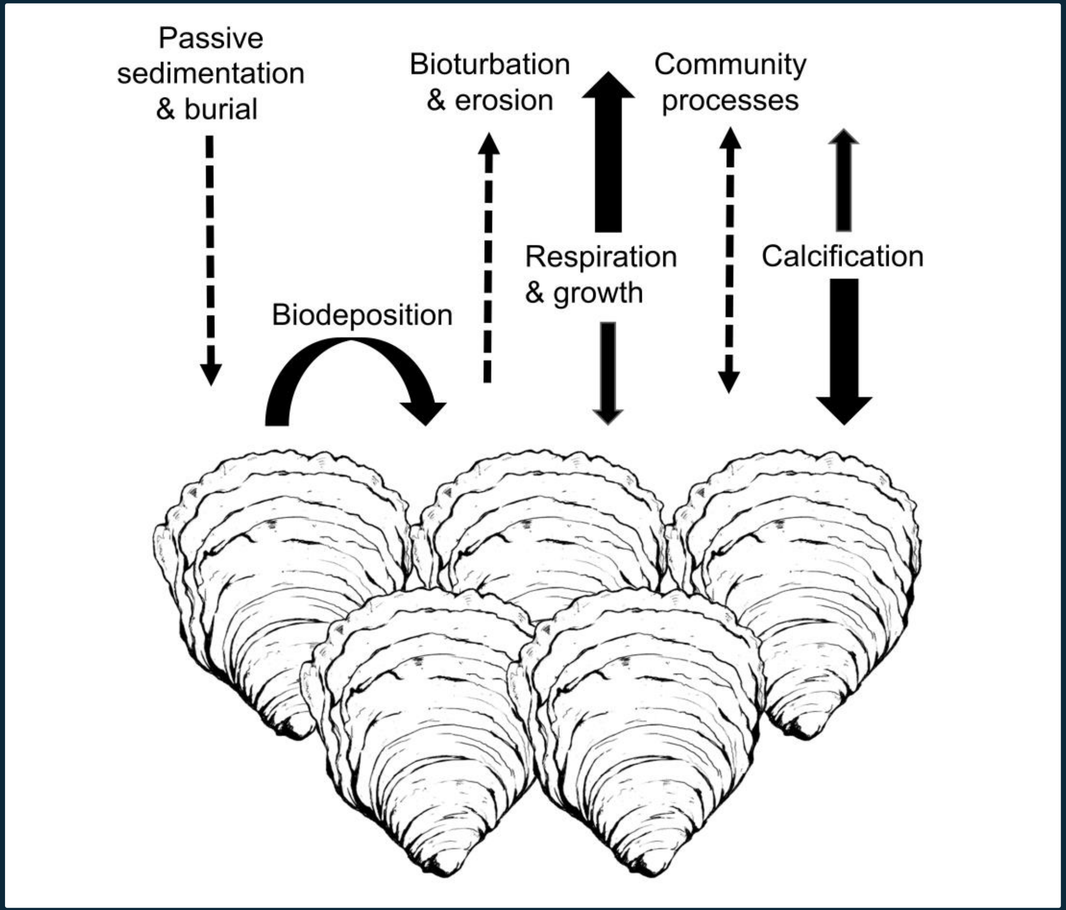
We do not yet value Ecosystem Services

- And yet the bioremediation value of habitats in Solent is equivalent to £billions

- Valuation of N, P and C removal in coastal systems

Watson, S.C., Preston, J., Beaumont, N.J. and Watson, G.J., 2020. Assessing the natural capital value of water quality and climate regulation in temperate marine systems using a EUNIS biotope classification approach. Science of the total Environment, 744, p.140688.
BBC 2022c Solent Seascape Project launched to restore marine habitats https://www.bbc.co.uk/news/uk-england-hampshire-63930408

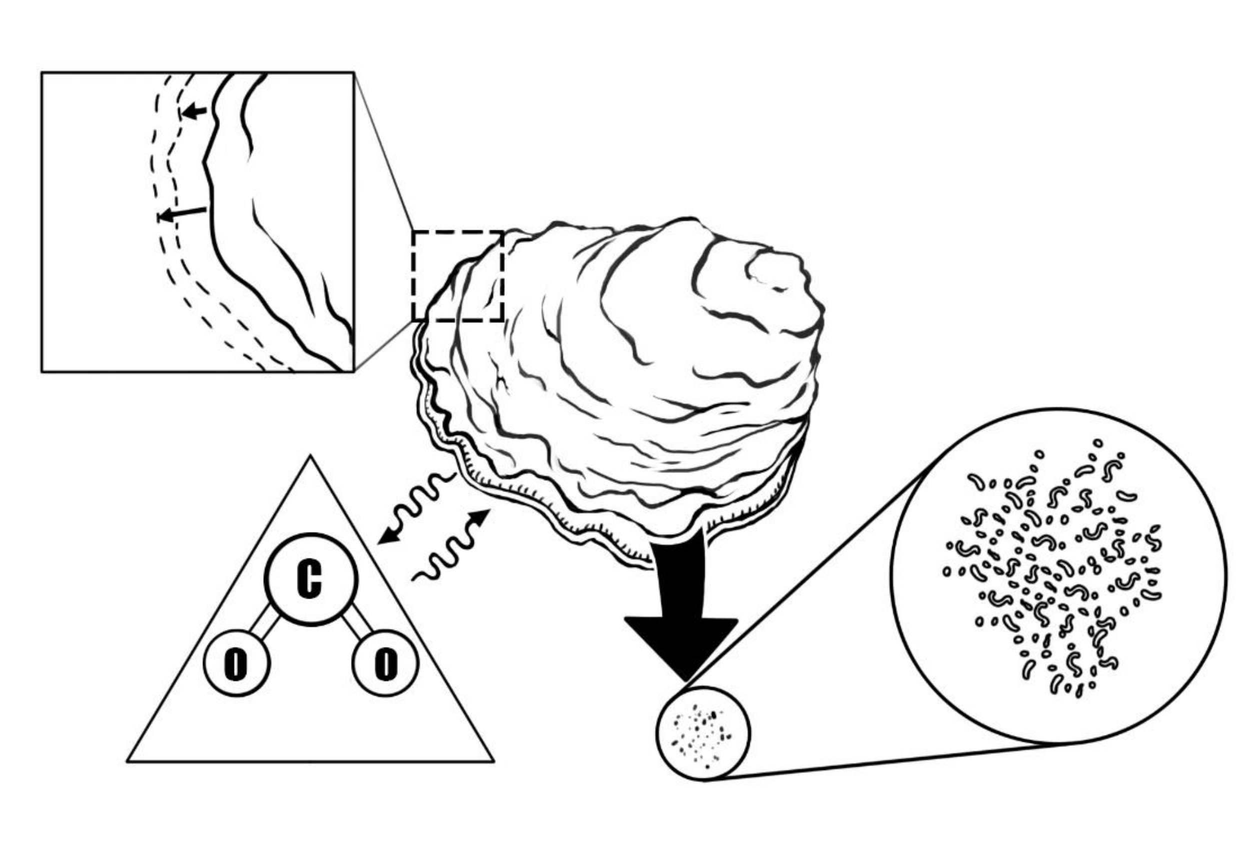
WQ and carbon?



- Carbon to seabed x3

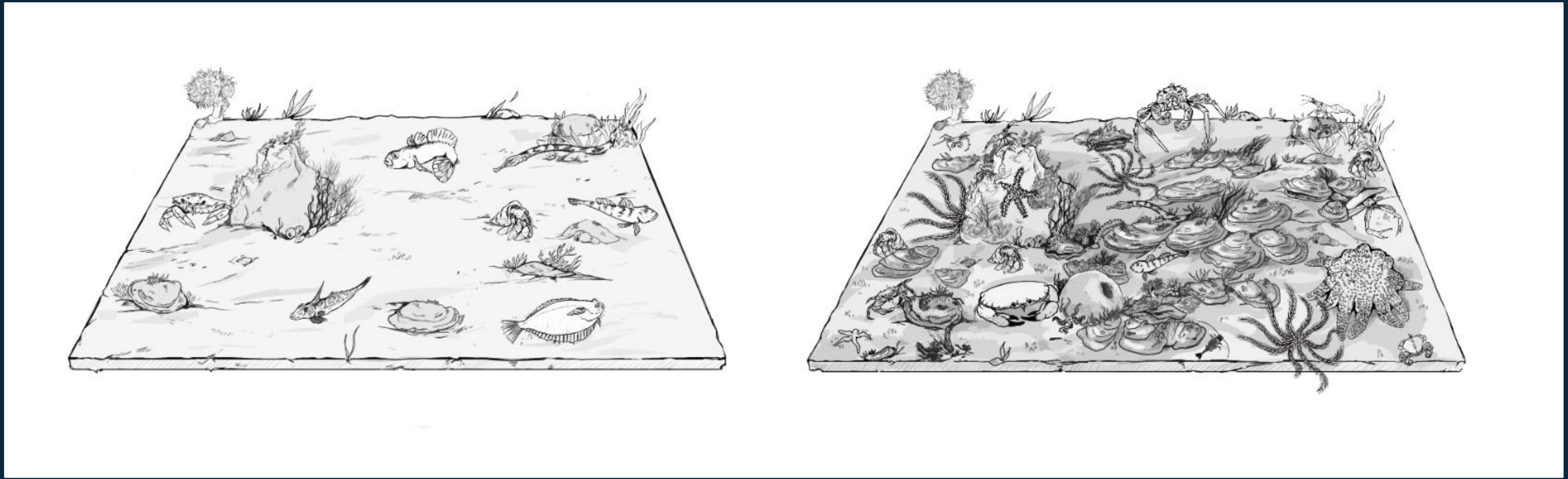
Lee, Davies, Baxter, Diele & Sanderson 2020. Missing the full story: First estimates of carbon deposition rates for the European flat oyster, *Ostrea edulis*. Aquatic Conservation: Marine and Freshwater Ecosystems; 30(11): 2076-86.

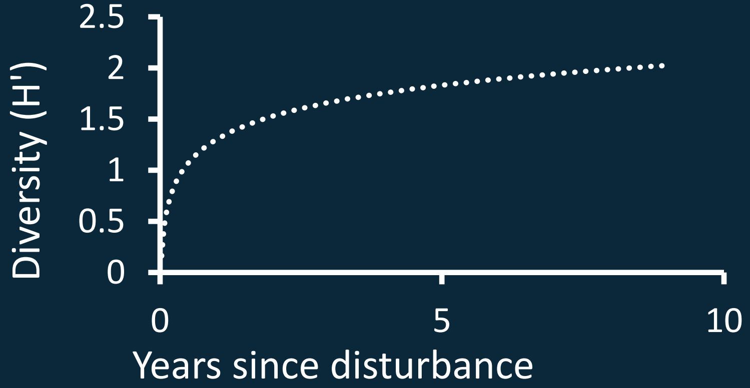
Oysters release almost as much carbon as they fix



Lee, H.Z., Davies, I.M., Baxter, J.M., Diele, K. and Sanderson, W.G., 2024. A blue carbon model for the European flat oyster (*Ostrea edulis*) and its application in environmental restoration. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *34*(1), p.e4030.

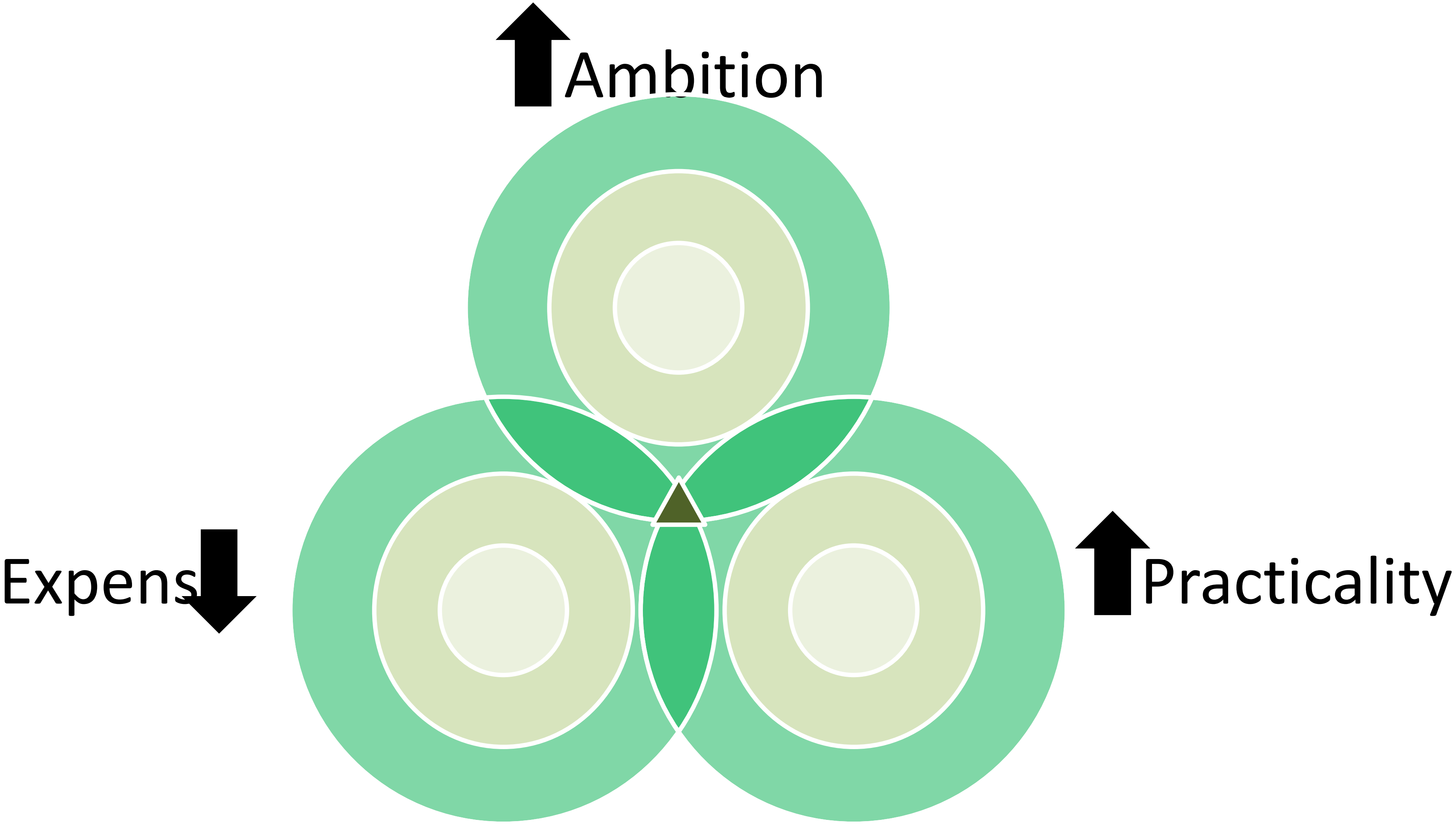
Oysters could double diversity in a decade



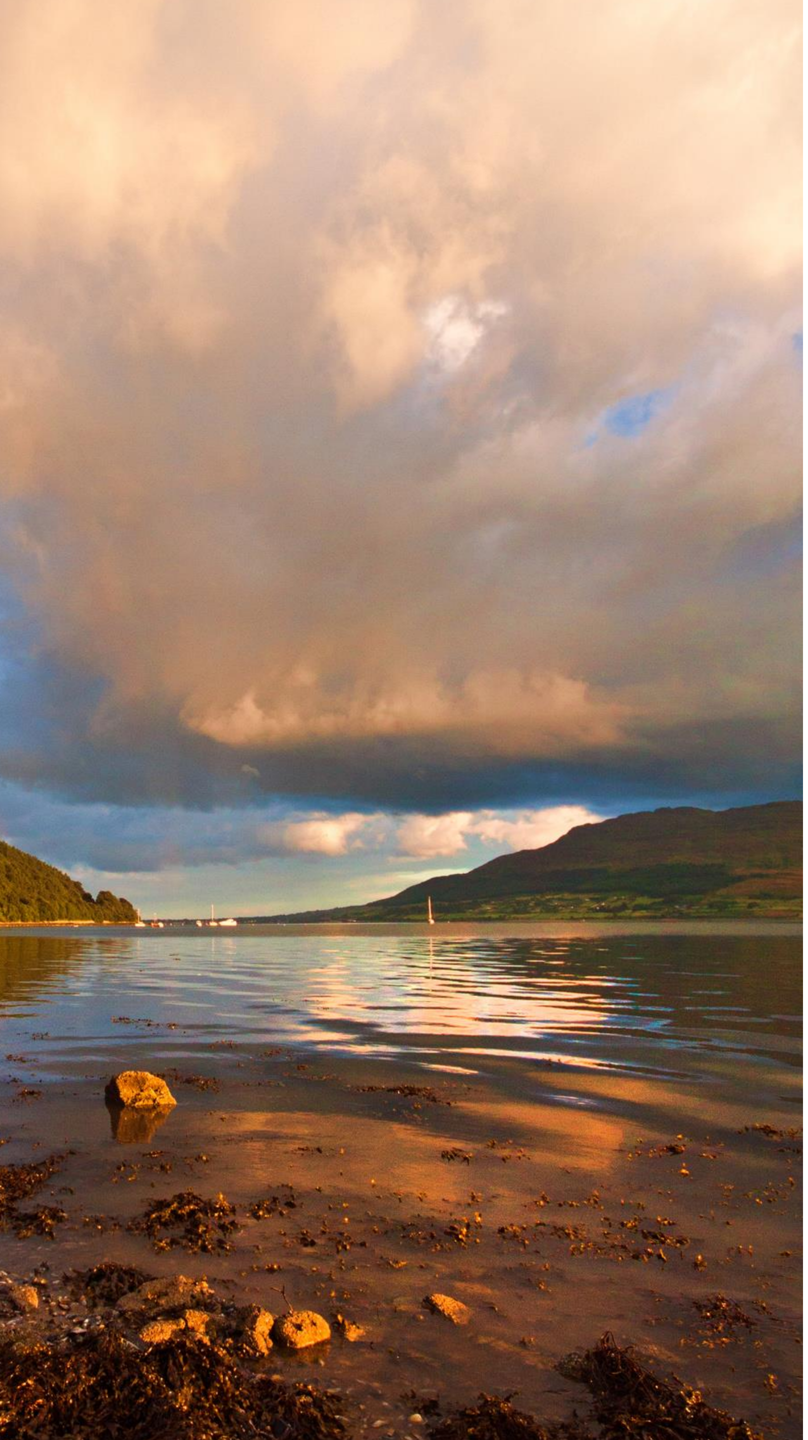


Kennon, N.A., Robertson-Jones, A., Jemmett, S., Hugh-Jones, T., Bell, M.C. and Sanderson, W.G., 2023. Rotational fishing enables biodiversity recovery and provides a model for oyster (*Ostrea edulis*) habitat restoration. PloS one, 18(3), p.e0283345.

Summary: Everything everywhere, all at once?



Thank you!



ReMeMaRe Conference 2024

Science Session

Pippa Moore, Newcastle University

Ecosystem service provision of wild, restored & farmed kelp

Environment Agency

OCEAN & COASTAL FUTURES

Ecosystem service provision of wild, restored & farmed kelp

Pippa Moore, Hannah Earp, Ethan Clarke, Maxine Canvin, Robyn Mastin-Wynne & Dan Smale

Dove Marine Laboratory, School of Natural and Environmental Sciences

Pip.Moore@ncl.ac.uk

Newcastle University

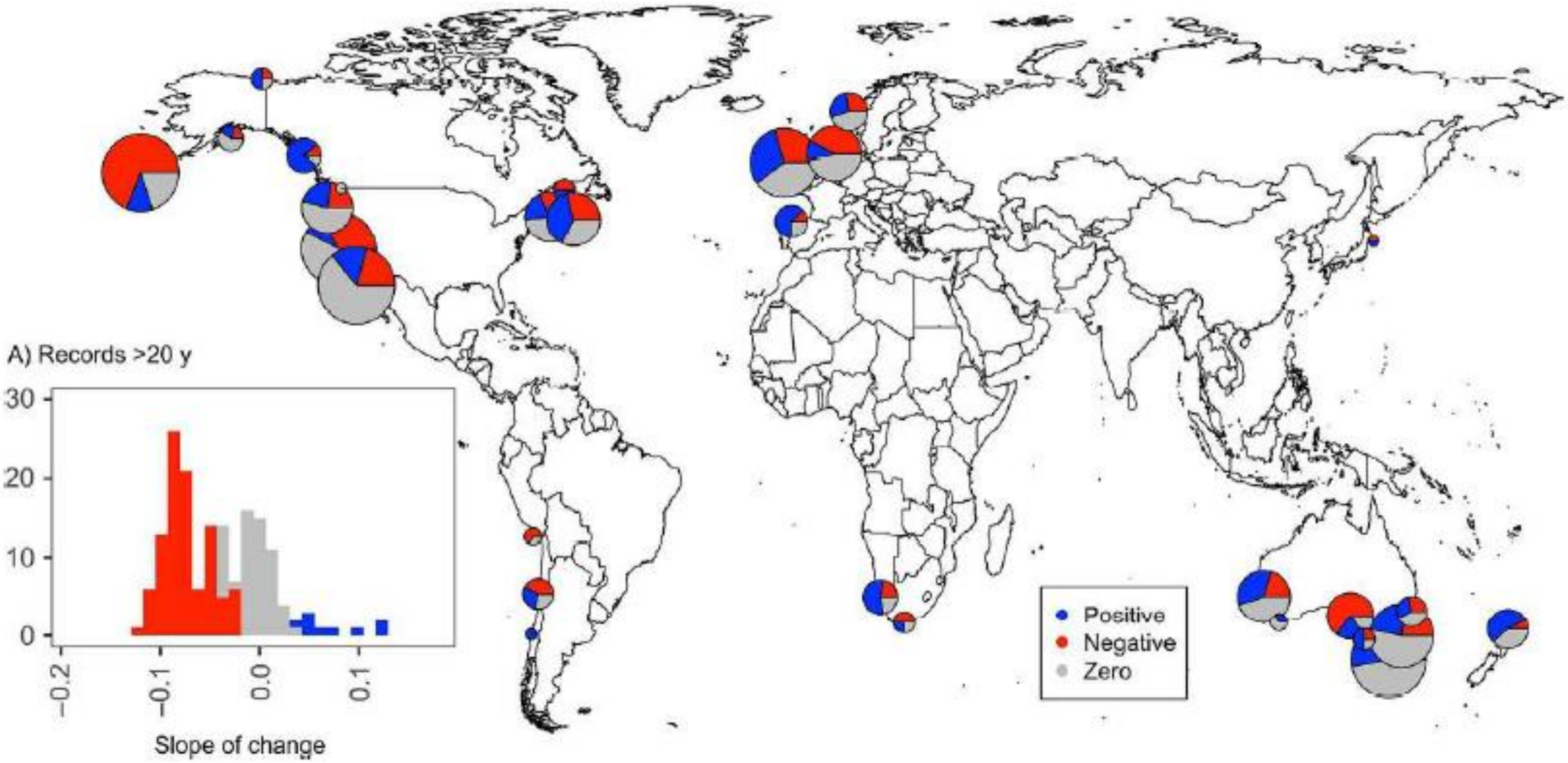
@Pippa_J_Moore






30x

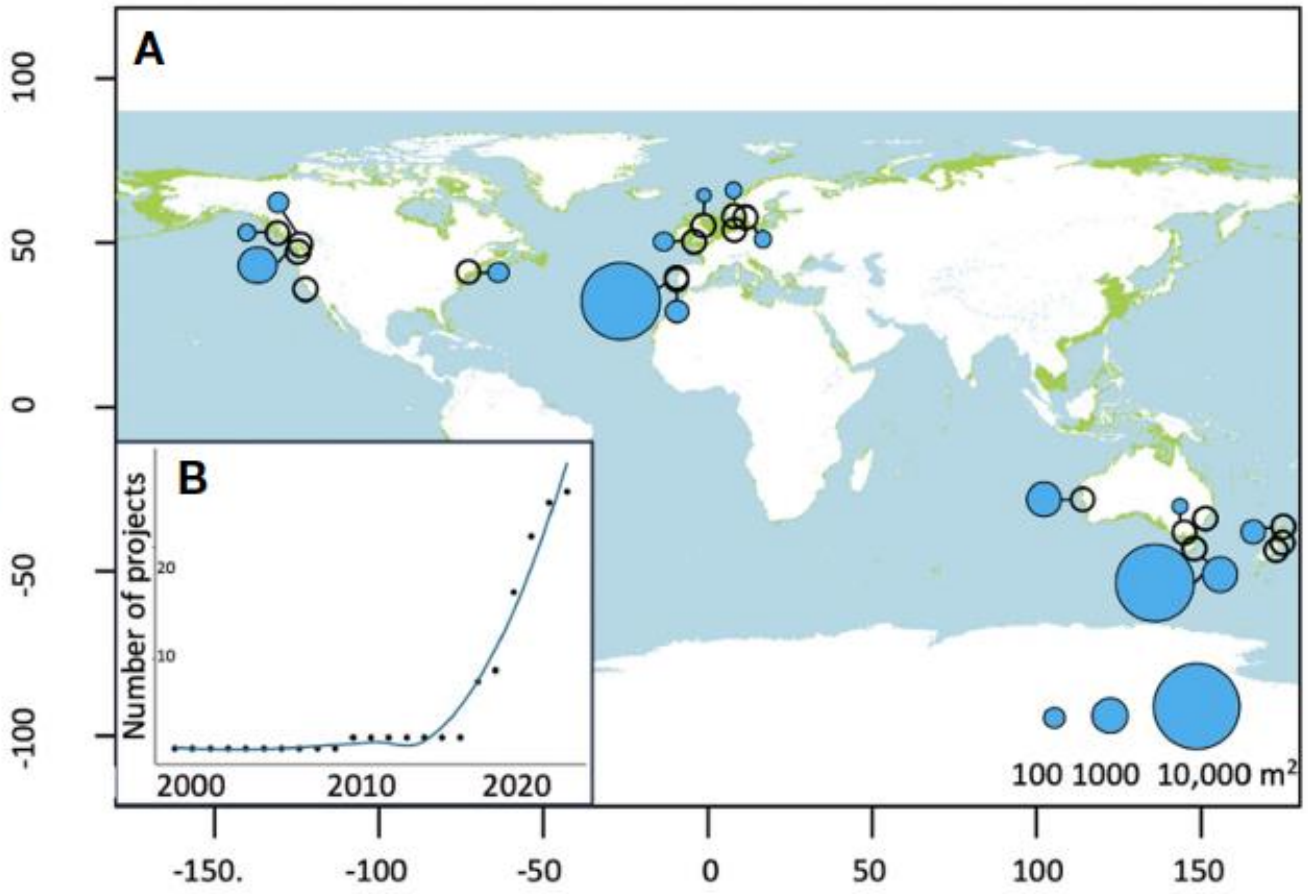
Kelp forests in decline: Global



Filbee-Dexter & Wernberg 2018 Bioscience 68: 64-76; Wernberg et al 2018 in World Seas: An environmental evaluation doi: 10.1016/B978-0-12-805052-1.00003-6

Kelp forests in decline: UK context

Kelp forest restoration



Wood et al 2024 Front Mar Sci doi: 10.3389/fmars.2024.1364263

GREEN GRAVEL ACTION GROUP

1. Supporting services e.g. Biodiversity, habitat provision, nutrient cycling (nitrogen, carbon)

- A single kelp holdfast may support >50 species
- A single kelp plant may support >80,000 individuals
- Kelp support:
  - Rich understory algal assemblages which support diverse faunal assemblages
  - Habitat for fish & crustaceans, including nursery habitat for commercially important species
  - Attracts higher order predators including otters, seals, seabirds
- Nitrogen cycling valued at ~£74,000 $Ha^{-1}yr^{-1}$ globally
  - *Laminaria* and *Saccharina* ~£113,000 $Ha^{-1}yr^{-1}$
- Seaweed aquaculture support higher abundance, but lower diversity

Teagle et al 2017 JEMBE doi 10.1016/j/jembe.2017.01.017; Eger et al 2023 Nat Comms doi: 10.1038/s41467-023-37385-0; Corrigan et al 2024 J App Phycol doi: 10.1007/s10811-023-03055-3

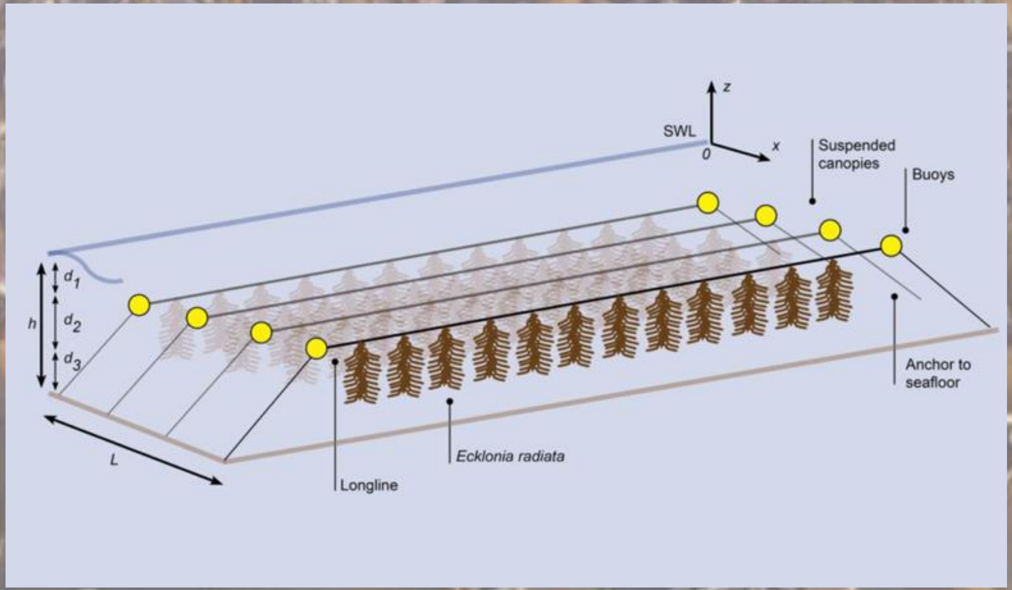
2. Provisioning services e.g. fisheries

- Natural kelp forests estimated to contribute ~£30,000 $Ha^{-1}yr^{-1}$ globally
    - *Laminaria* and *Saccharina* forests ~£33,000 $Ha^{-1}yr^{-1}$
- Early work suggests that seaweed aquaculture supports commercially important species - seasonally

Eger et al 2023 Nat Comms doi: 10.1038/s41467-023-37385-0; Corrigan et al 2024 Aqua Env Inter doi: doi.org/10.3354/aei00478

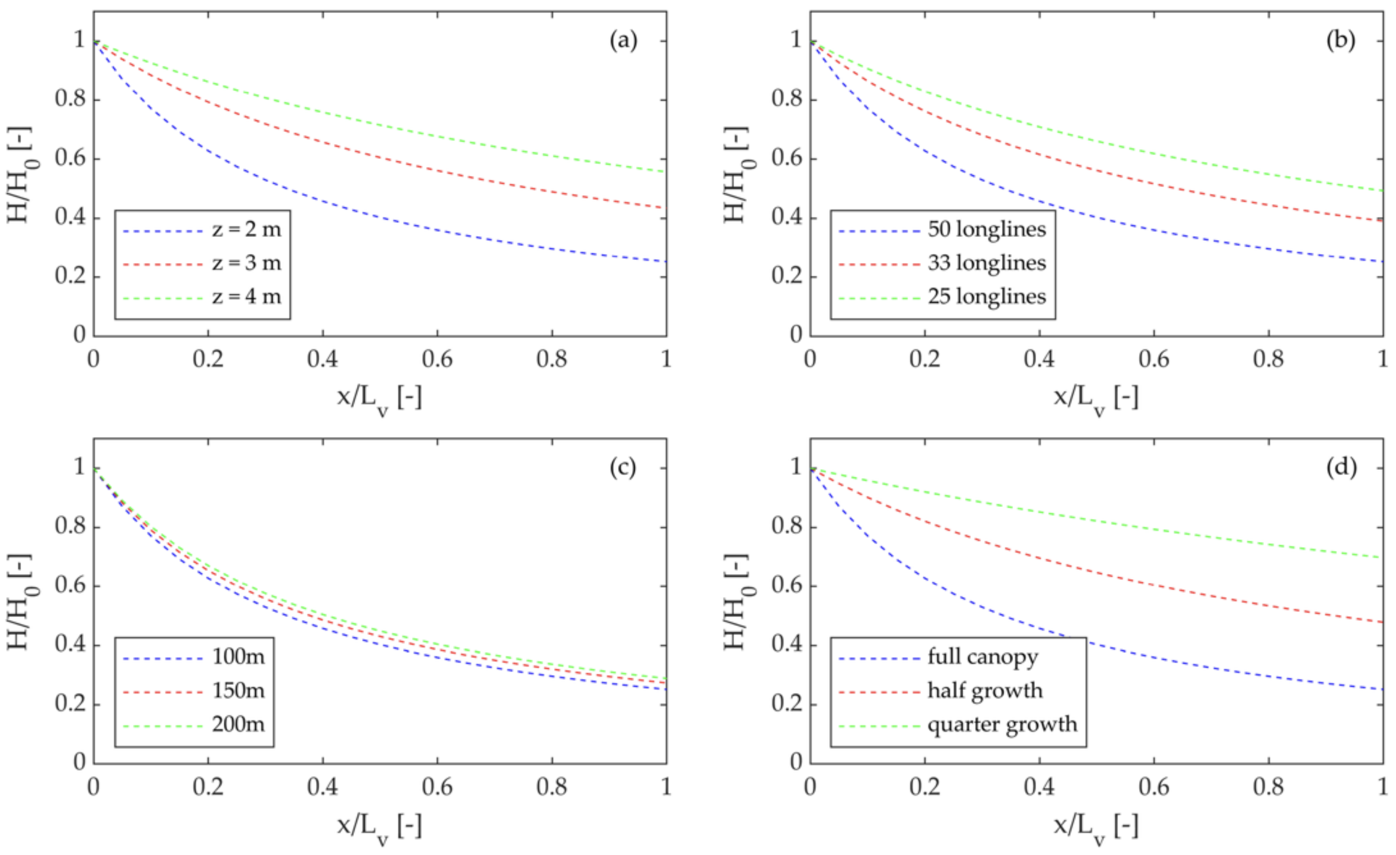
3. Regulating services e.g. flood/coastal defence

Karen Daglish
Delivery Manager
Session 4



Water depth

Plant density line^{-1}



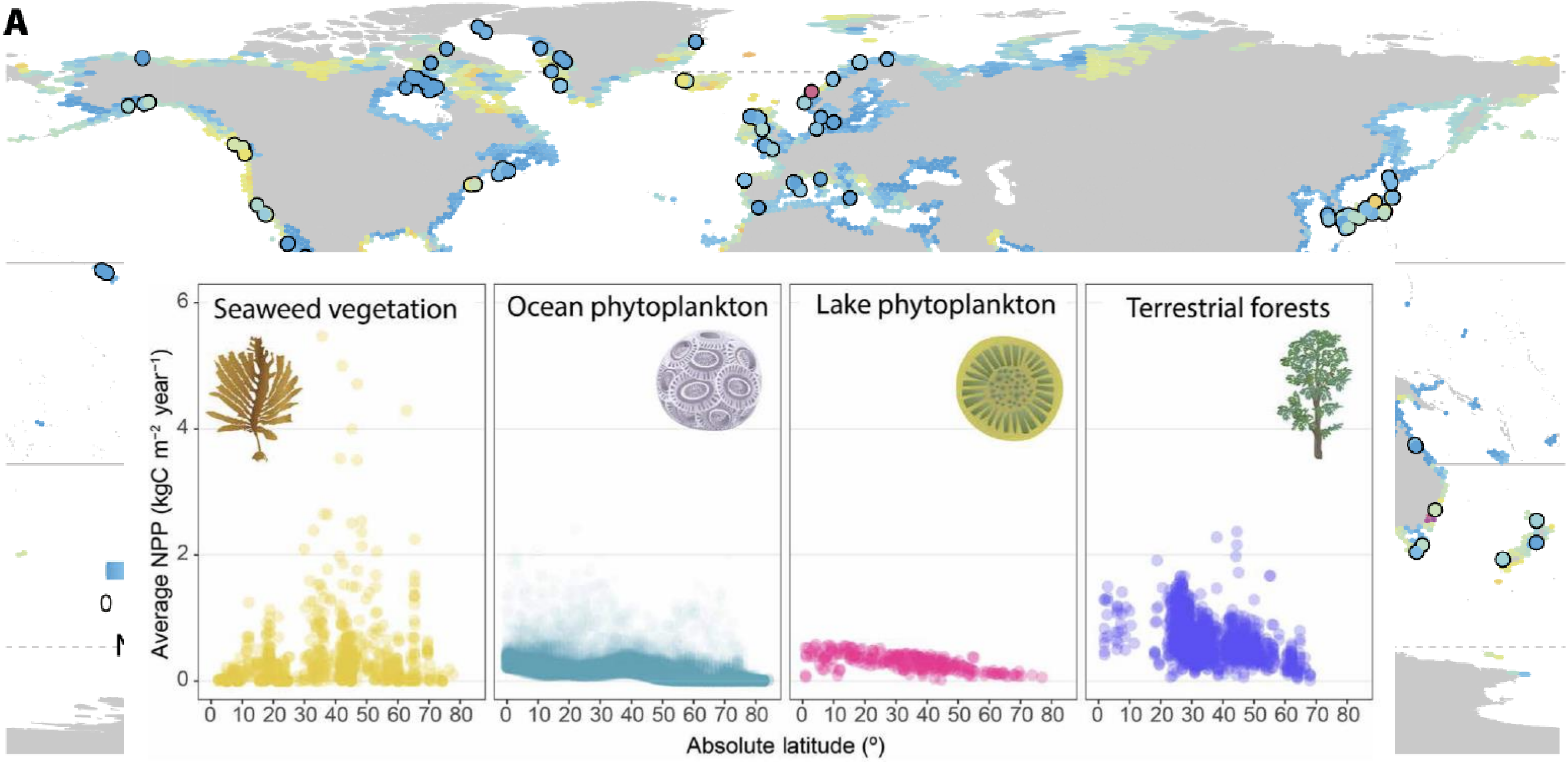
Farm area

Plant growth stage

Bodycomb et al 2023 J Mar Sci Eng doi: 10.3390/jmse11091822

3. Cultural services e.g. recreation, education

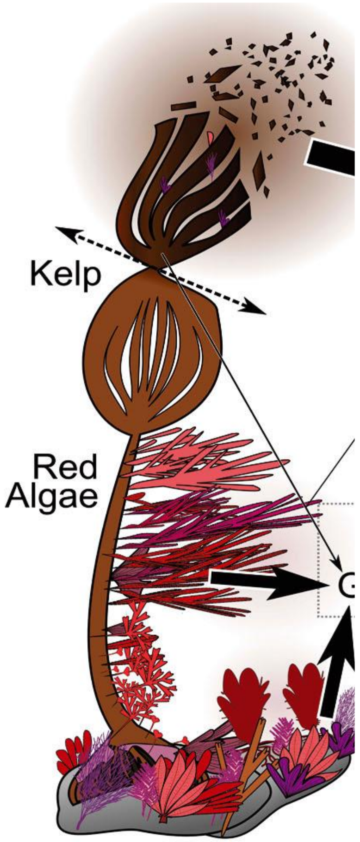
Kelp productivity: carbon

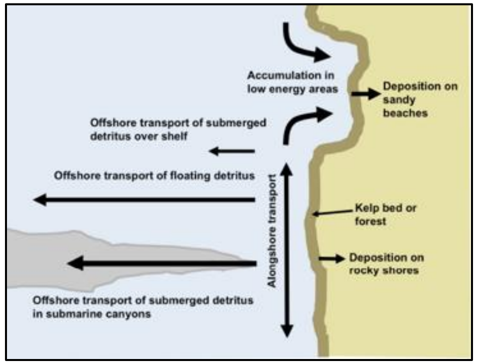


Pessarrodona et al 2022 Sci Adv doi 10.1126/sciadv.abn2465

Kelp productivity: Carbon cycling

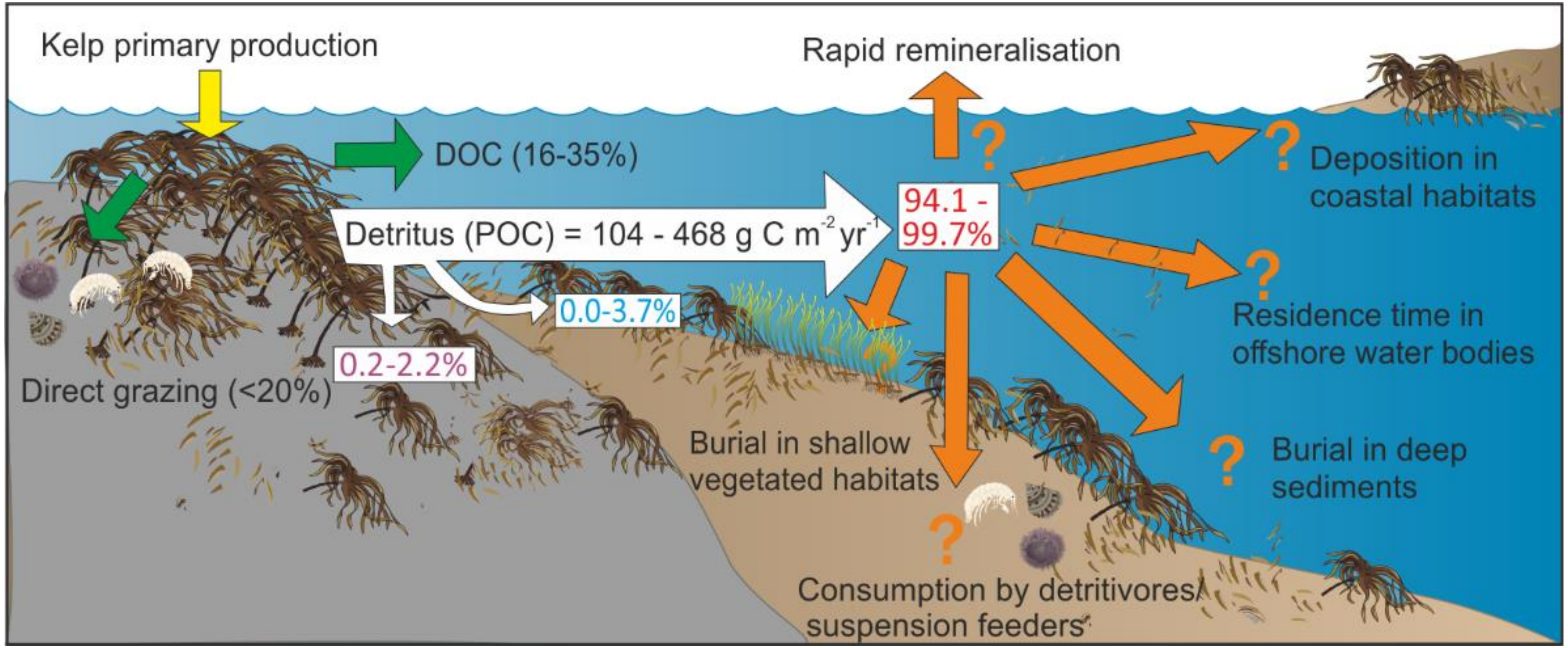
- Kelp lose biomass two main means:
  - Distal (older) ends eroding releasing dissolved and particulate organic matter
  - Whole plant loss
  - In *L. hyperborea* also loss of old growth collar (May cast)





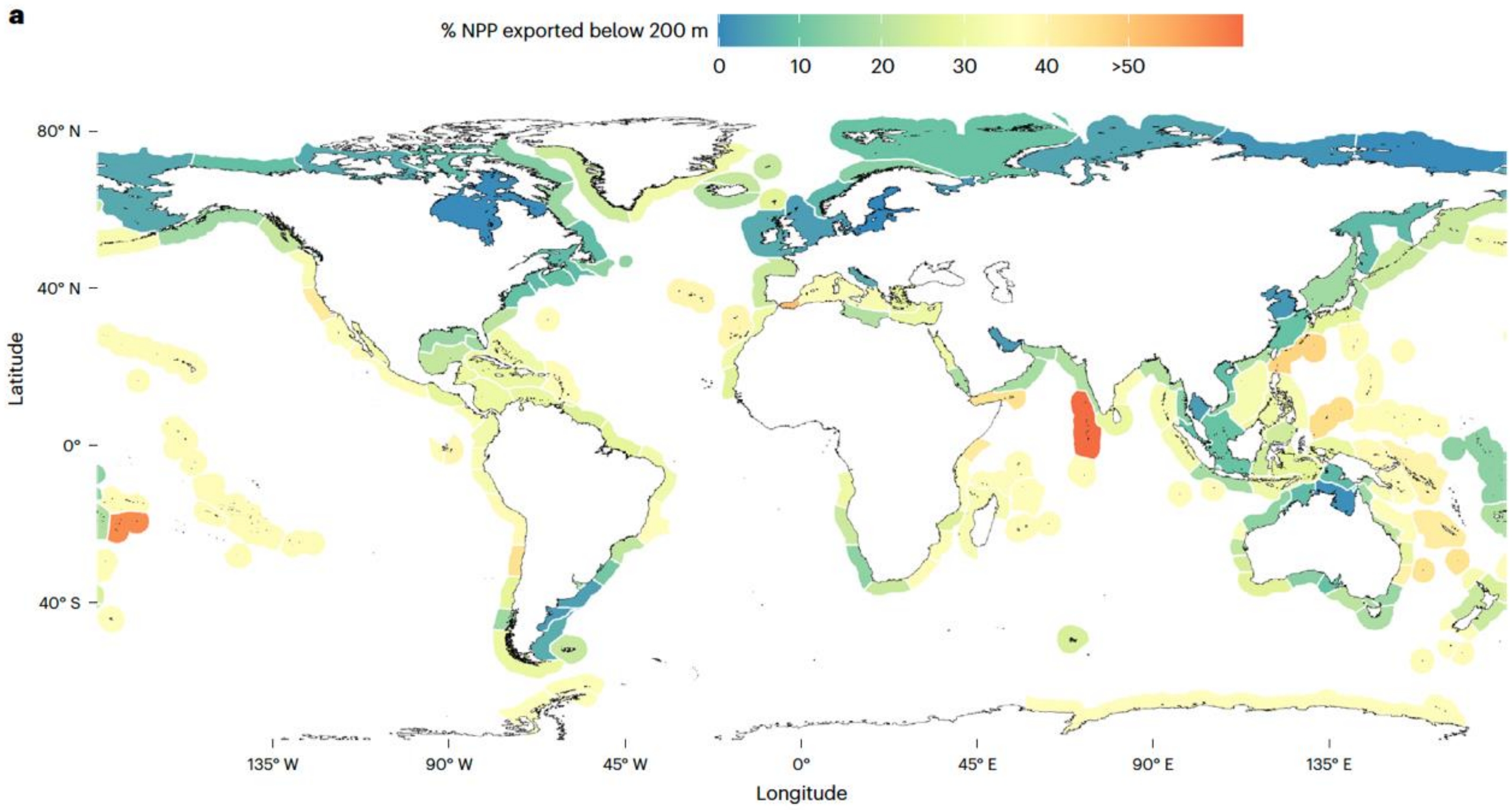
Kelp productivity: Carbon cycling

- Based on UK estimate >90% of particulate organic matter is exported out of the kelp forest
- Estimates suggest 15% of POC could be sequested



Smale et al 2021 Limnol Oceanogr doi: 10.1002/lno.11970

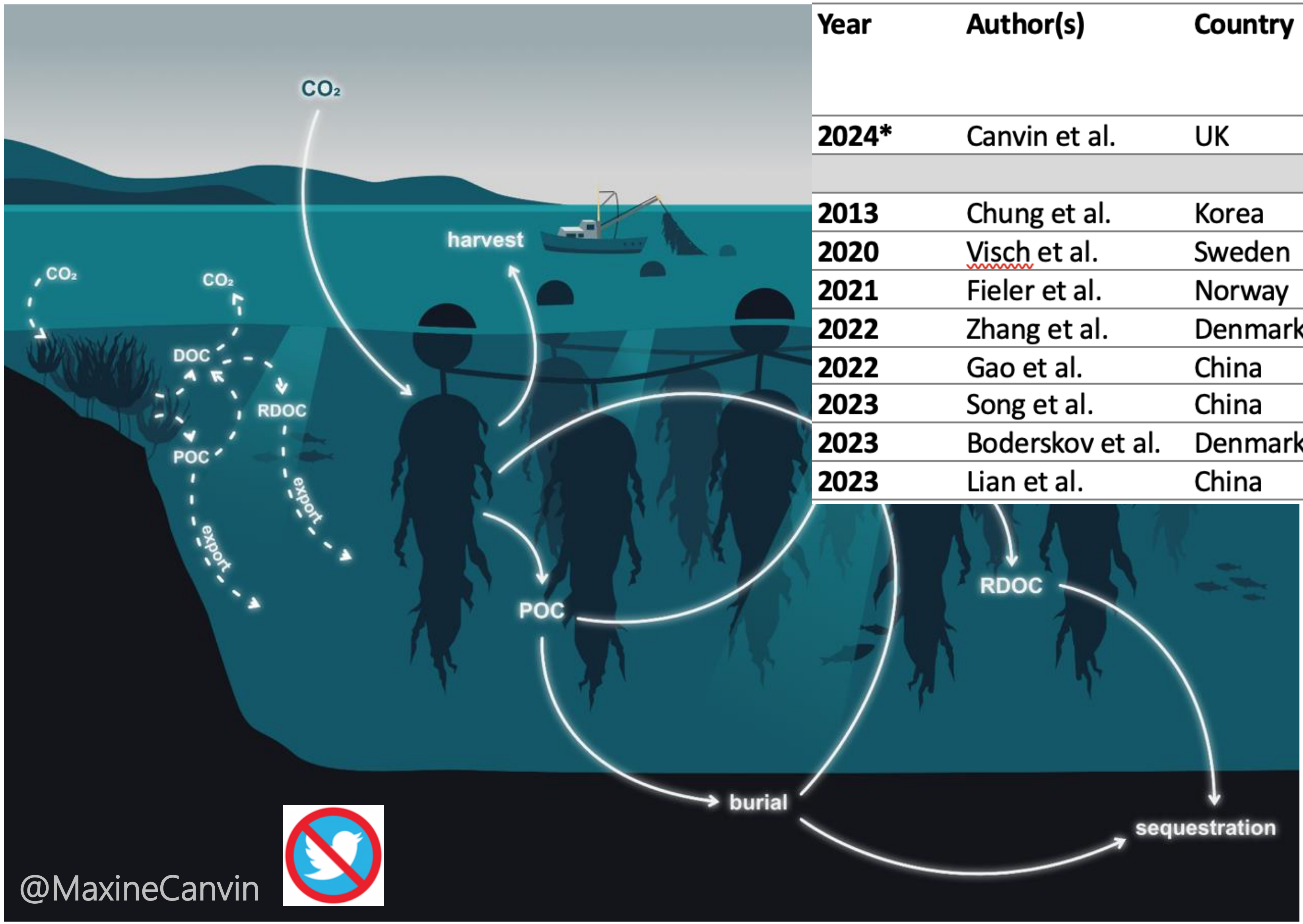
Seaweed transport: carbon sequestration



- Used models of seaweed forest extent, production, decomposition & transport rates
  - 4-44 Tg C yr^{-1} can be sequested beyond continental shelf as POC for >100 years
  - Similar values to previous studies (Krause-Jensen & Duarte 2016)
- UK 0.66 (0-3.00) Tg C yr^{-1} – only 5.4% of productivity

Filbee-Dexter et al 2024 Nat Geoscience doi: 10.1038/s41561-024-01449-7

Carbon sequestration from aquaculture



Year	Author(s)	Country	Carbon Captured (t C ha^{-1} yr^{-1})	Carbon Loss (t C ha^{-1} yr^{-1})	Carbon Sequestered (t C ha^{-1} yr^{-1})
2024*	Canvin et al.	UK	0.14	0.09	0.014 **
2013	Chung et al.	Korea	2.72		
2020	Visch et al.	Sweden	0.05-1.08		
2021	Fieler et al.	Norway		0.68-0.88	0.10-0.13 **
2022	Zhang et al.	Denmark	0.06-0.65		
2022	Gao et al.	China	7.53-9.17		4.28-5.21
2023	Song et al.	China			3.10
2023	Boderskov et al.	Denmark	≤ 3.40		
2023	Lian et al.	China	9.83		0.98

Canvin et al (in review) J. App Phycol

- Amounts of carbon sequested relatively small – not optimised for C capture
- Considered as passive co-benefit & focus on low carbon services
  - Food security
  - Biofuel production
  - Replacement of high C products

Conclusions

- Kelp forests are the UKs most extensive marine vegetated habitat

- Natural kelp forests and seaweed aquaculture provide a wealth of ecosystem services

- Need to be careful of greenwashing
    - UK natural kelp forests and seaweed aquaculture do sequest carbon, but relatively small amounts - distance from continental shelf, seasonality of seaweed aquaculture
    - Seaweed aquaculture support fish and macroinvertebrate assemblages, but less diverse (and less even) than natural kelp forests, also only seasonal based on current aquaculture practices
    - Co-location of seaweed aquaculture possible, but some arguments for this include biodiversity NetGain????

- UK kelp forests generally in a healthy state, but pre-emptive conservation and management required to protect these critically important habitats

- Seaweed aquaculture has huge potential, but need to focus on direct uses rather while accounting for the passive benefits for biodiversity and carbon sequestration.

Thank you for listening

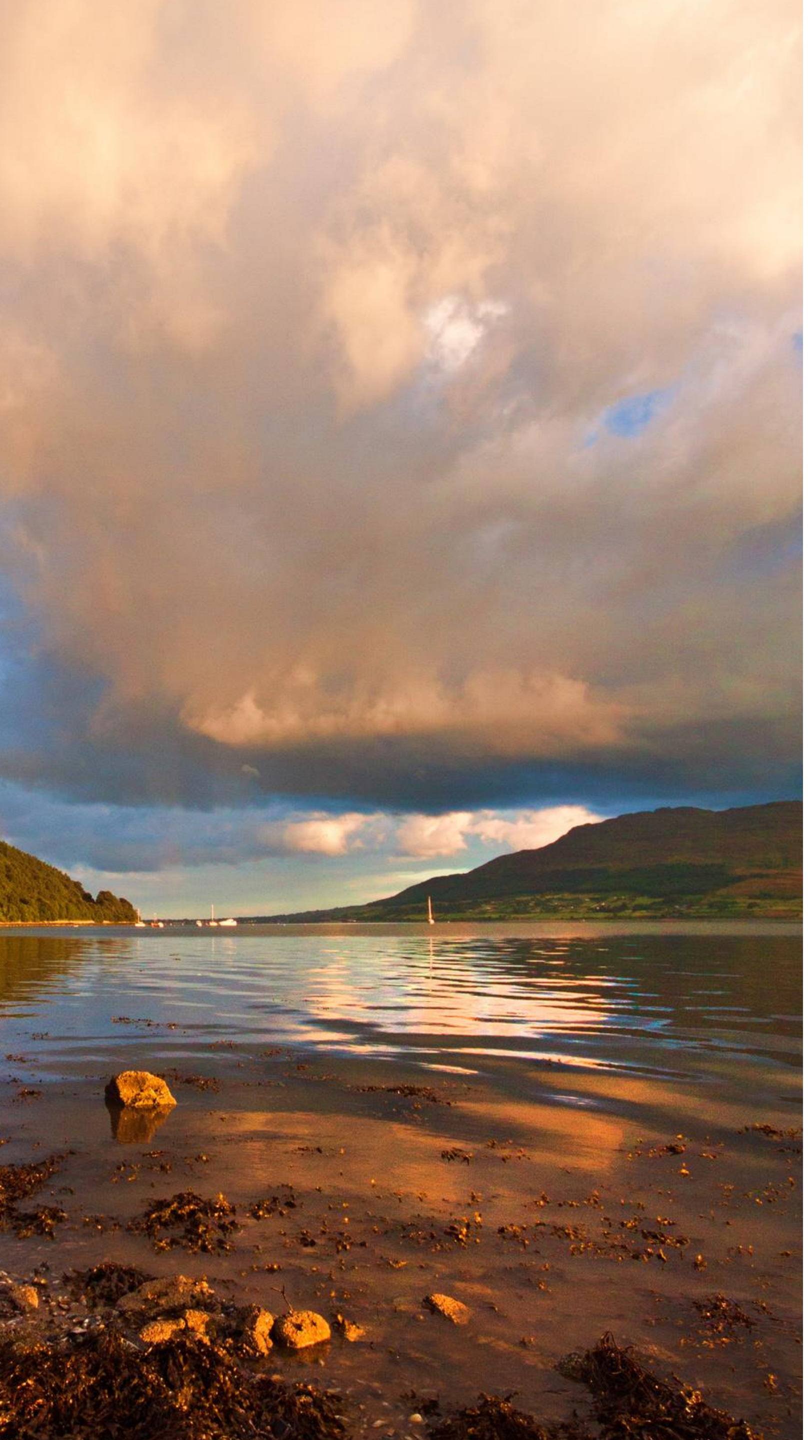
aura Doctoral Training

Heritage Coast Sunderland-Durham-Hartlepool

Stronger Shores

WWF

UKRI Natural Environment Research Council



ReMeMaRe Conference 2024

Science Session

Jo Preston, University of Portsmouth

Evidence for ecological connectivity across temperate coastal seascapes and implications for coastal ecosystem restoration practice and policy

Environment Agency

OCEAN & COASTAL FUTURES

Seascape connectivity: evidence, knowledge gaps and implications for coastal ecosystem restoration practice and policy .

ReMeMaRe

10th – 11th July 2024

Photo: Shaun Roster

Preston, J., Debney, A, Gamble, C, Hardy, M. J., Underwood, G. J. C., Garbutt A., Harley, J., Baker, R, Dunk, R. M., Grigg, M.,Hancock, B.T., Hendy I, W., La Marca, E.C., McGarrigle, A., Millington-Drake, M., Murray, J. Pettorelli N., Pittman, S. J., Reeves, S.E., Robertson, M., Sturrock, A.M., Thurstan, R. H. Unsworth R,K,F, Ward, E. A., Ward, S.L., Watson, G.J., Watson, S.C.L , Wedding, L.M., Worthington, T.A., Wright R.A, Yesson, C., and zu Ermgassen, P.S.E.

Joanne.preston@port.ac.uk
University of Portsmouth / Native Oyster Network
Twitter/X @jprestondiggles

Title:
Seascape connectivity: evidence, knowledge gaps and implications for coastal ecosystem restoration practice and policy.

Short title:
Restoring seascape connectivity for delivery of planetary health.

Authors: Preston, J[1].Debney, A[2], Gamble, C[2], Hardy, M. J[3]., Underwood, G. J. C.[3], Garbutt A.[4], Harley, J.[4], Baker, R[5], Dunk, R. M.[6], Grigg, M.[2],Hancock, B.T[7]., Hendy I, W[1]., La Marca, E.C.,[8] Murray, J[9]. Pettorelli N.[2], Pittman, S. J.[10, 11], Reeves, S.E.[12], Robertson, M.[13], Sturrock, A.M.[3], Thurstan, R. H.[14] Unsworth R,K,F[15, 16], Ward, E. A.[1], Ward, S.L.[17], Watson, G.J.[1], Watson, S.C.L[18] , Wedding, L.M.[10], Worthington, T.A.[19], Wright R.A[11], Yesson, C.[2], and zu Ermgassen, P.S.E.[20]

Journal: Nature Ocean Sustainability Submission.

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SUBMITTED

Seascape connectivity: evidence, knowledge gaps and implications for coastal ecosystem restoration practice and policy.

- Presents the consensus **definitions** and **statements** for a seascape approach to restoration
- Defines the **concept of ecological connectivity** when applied to the temperate coastal environment
- Provides a **metareview** of existing evidence of **ecological connectivity** across the seascape
- Identify **priority** areas of **research** to meet **knowledge gaps**
- Presents evidence for **uplift** of **ecosystem service** delivery due to **connectivity** across the seascape
- Applies this knowledge present a ***roadmap to achieve seascape restoration of coastal habitats***
- Recommends **policy pathways to achieve seascape recovery**

SUSTAINABLE DEVELOPMENT GOALS

2020 UN BIODIVERSITY CONFERENCE
COP 15 - CP/MOP10-NP/MOP4
KUNMING – MONTREAL

United Nations Framework Convention on Climate Change

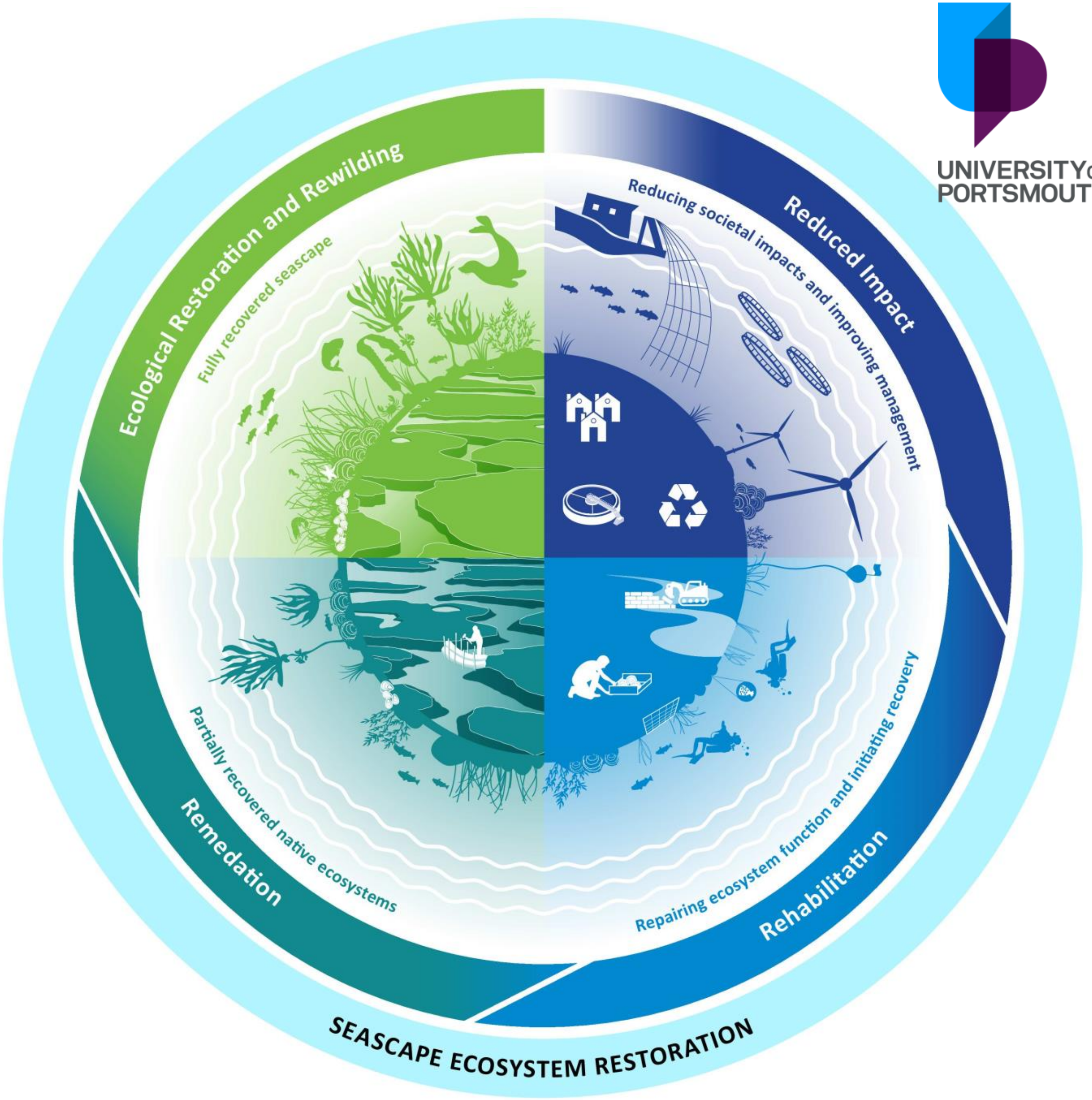
UNIVERSITY OF PORTSMOUTH

NATIVE OYSTER NETWORK UK & IRELAND

Seascape Restoration

Restoration of multiple habitats concurrently or sequentially to restore functionality and connectivity across the mosaic of habitats in a marine ecosystem.

UNITED NATIONS DECADE ON
ECOSYSTEM RESTORATION
2021-2030



THE SEASCAPE ECOSYSTEM RESTORATION SPECTRUM

UNIVERSITY OF PORTSMOUTH

Preston, J., Debney, A, Gamble, C, Hardy, M. J., Underwood, G. J. C., Garbutt A., Harley, J., Baker, R, Dunk, R. M., Grigg, M.,Hancock, B.T., Hendy I, W., La Marca, E.C., Murray, J. Pettorelli N., Pittman, S. J., Reeves, S.E., Robertson, M., Sturrock, A.M., Thurstan, R. H. Unsworth R,K,F, Ward, E. A., Ward, S.L., Watson, G.J., Watson, S.C.L , Wedding, L.M., Worthington, T.A., Wright R.A, Yesson, C., and zu Ermgassen, P.S.E. (*in review*). Seascape connectivity: evidence, knowledge gaps and implications for coastal ecosystem restoration practice and policy. Invited submission for the Special Collection: Bridging Land and Seascape Restoration for Ecoscape Recovery. *Ocean Sustainability*.

Seascape Restoration Statement

A seascape approach to restoration is rooted in the understanding that coastal ecosystems are dynamic and heterogeneous mosaics of habitats interconnected by a body of water through which living things, nutrients, matter and energy flow. A seascape approach to restoration recognises the importance of the spatial and historical context of a site, habitat configuration and interconnectivity between neighbouring habitat types in shaping the outcomes of marine restoration projects.

To restore complete trophic webs, enhance biodiversity and deliver ecological functions and services requires the existence of a healthy mosaic of coastal habitats, maintained by the flows that occur between them. Acknowledging the interconnected nature of these systems allows for more effective and holistic management, conservation, and restoration strategies. *A seascape approach that enhances connectivity and hence restores optimal structure-function relationships is crucial for successful ecosystem restoration.*

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Ecological Connectivity

*The unimpeded movement of **species** and the flow of **natural processes** that sustain life on earth. (IUCN CMS 2020).*

Structural connectivity describes only the physical characteristics of a landscape or seascape, such as geographical or spatial proximity between habitats or the configuration of habitat patches that confers functional connectivity, such as habitat stepping stones or mosaics that enables movement through the seascape.

Functional connectivity describes the responses of organisms to this seascape structure and the movements and exchanges that entail. This phenomenon occurs through various types of connectivity, such as larval and seed dispersal, migratory movements of individuals, populations or species, and the transfer of non-living matter such as nutrients and energy from one location to another.

*The underlying **mechanism** is the process that facilitates this connectivity, such as water flow, swimming, drifting or active filtration.*

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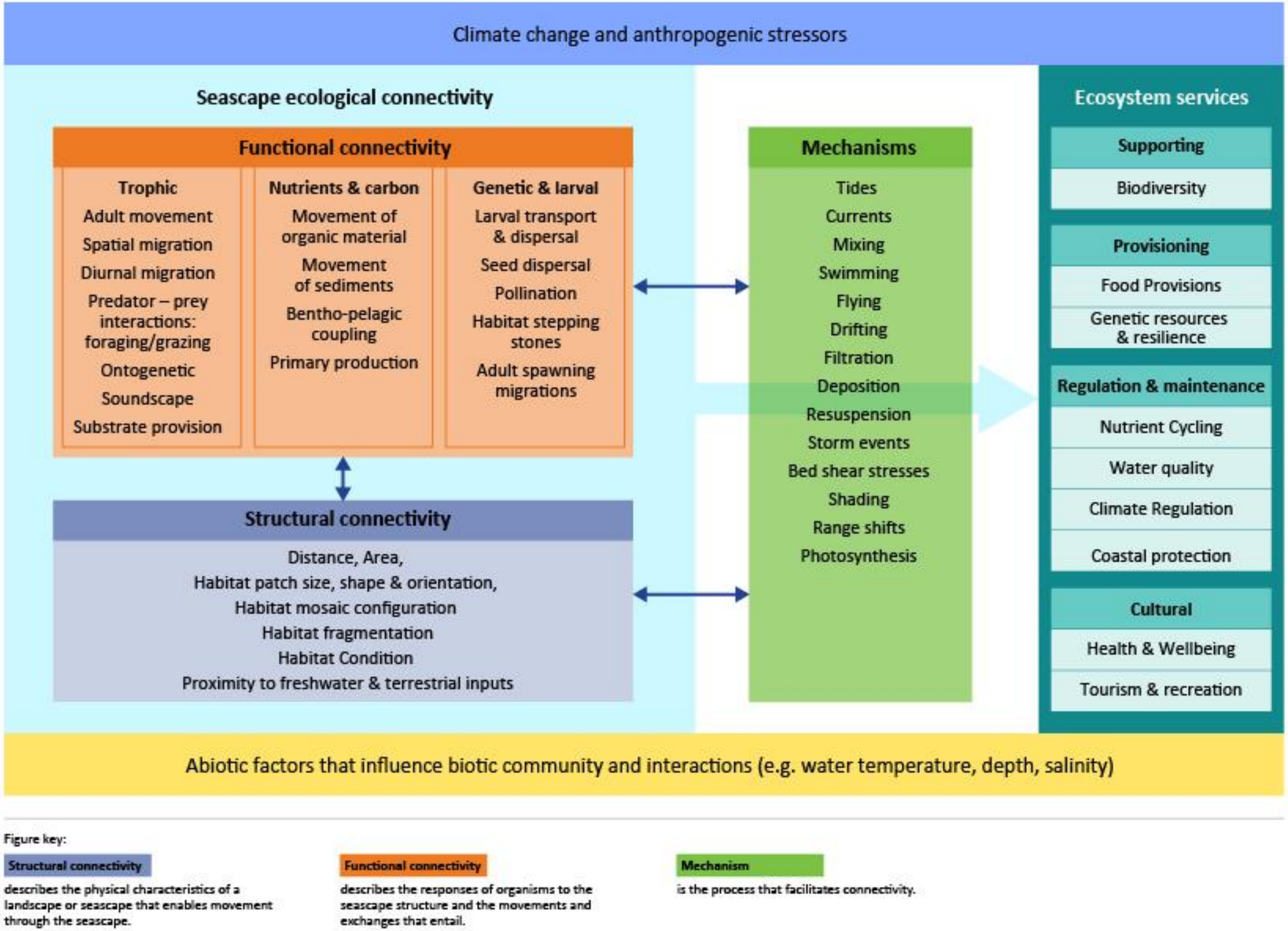
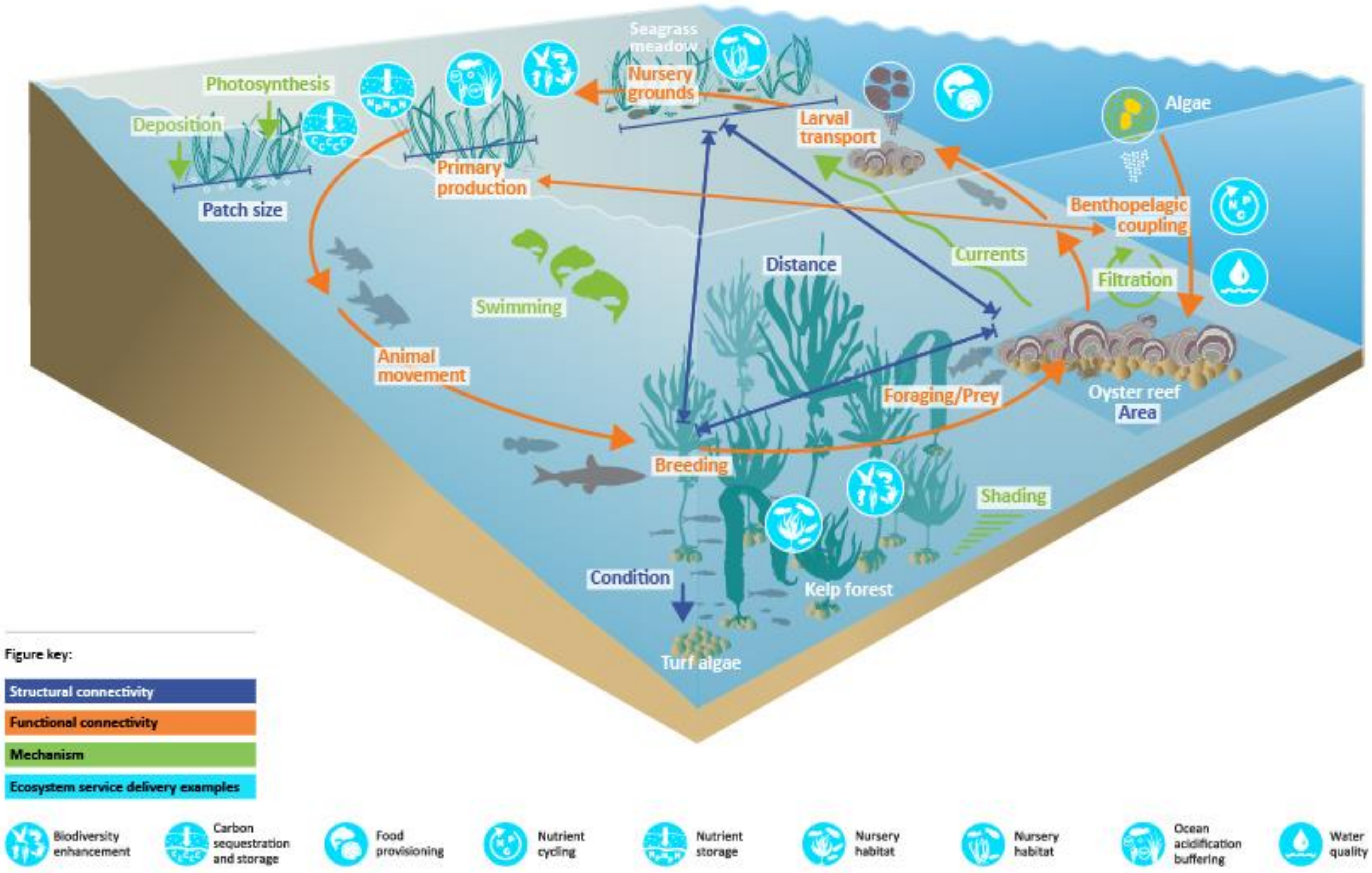
Conceptual framework of seascape ecological connectivity: Types of structural and functional connectivity, the mechanism that facilitate them, and the ES they underpin



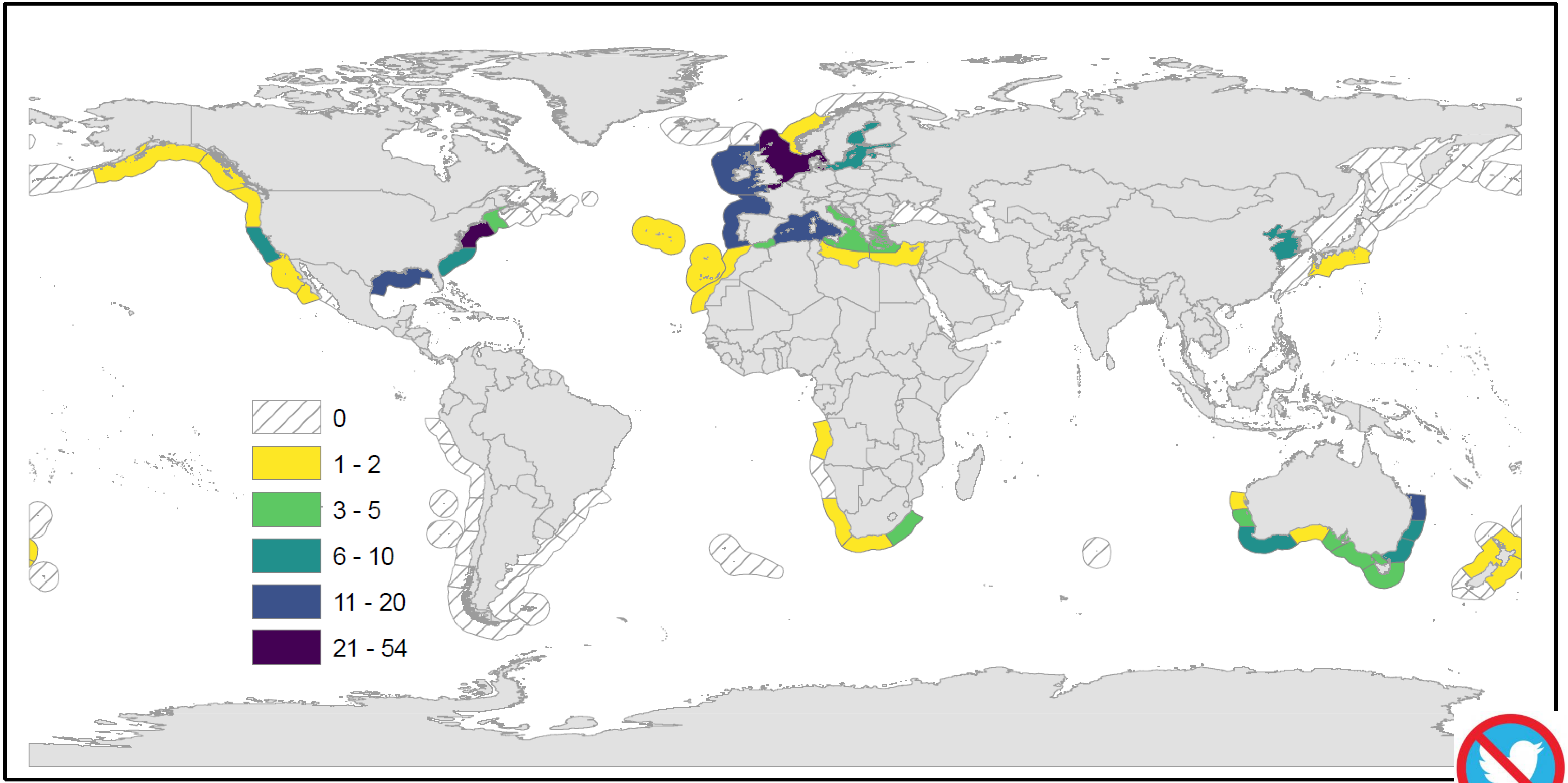
Preston, J., et al (*in review) Ocean Sustainability npj Special Collection: Bridging Land and Seascape Restoration for Ecoscape Recovery*

Schematic figure illustrating how structural and functional connectivity, mechanisms and ecosystem service delivery relate.



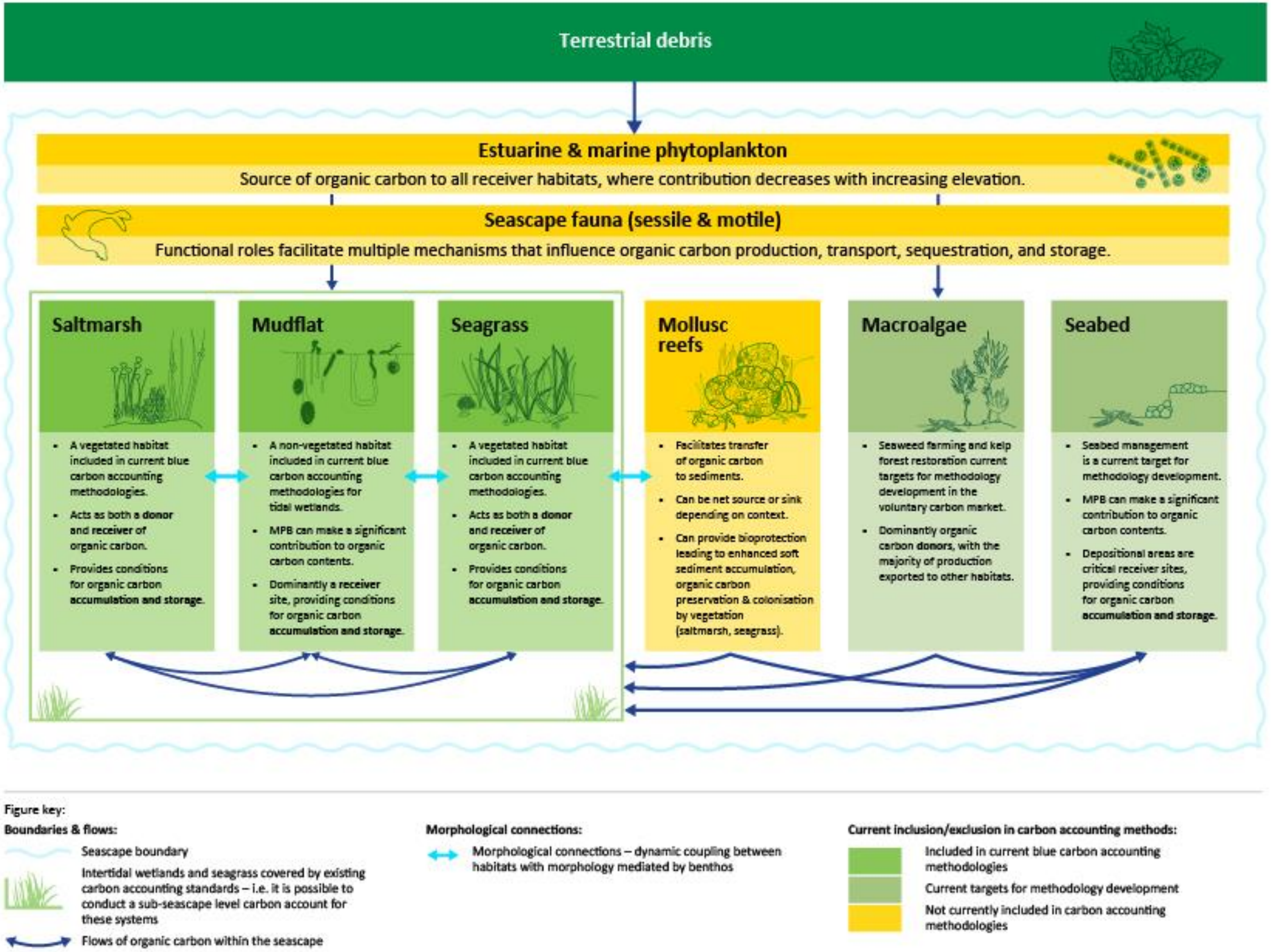
Preston, J., et al (*in review) Ocean Sustainability npj Special Collection: Bridging Land and Seascape Restoration for Ecoscape Recovery*

Biogeographic distribution and number of sources of evidence for ecological connectivity across temperate habitats:



Preston, J., et al (*in review*) *Ocean Sustainability npj Special Collection: Bridging Land and Seascape Restoration for Ecoscape Recovery*

Conceptual framework for organic carbon contributions, accumulation and storage with a temperate seascape boundary:



Preston, J., et al (*in review) Ocean Sustainability npj Special Collection: Bridging Land and Seascape Restoration for Ecoscape Recovery*

Evidence for ecosystem services delivery across priority coastal habitats with SDGs and specific targets they support:

ESS Category	Ecosystem Service	Examples/subcategories	Seagrass	Saltmarsh	Oysters	Marcroalgae	Mudflat	Maerl	Mussels	SDGs - symbols	Specific Targets
Supporting (ecosystem processes and functions)	Biodiversity	Food webs	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Expert opinion/inferred	11, 12, 14	11.4, 12.2, 12.A, 14.2, 14.4, 14.5, 14.9
		Larval/gamete supply	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Expert opinion/inferred	Peer-reviewed literature	2, 8, 12, 14	2.1, 12.2, 14.4, 14.5
		Habitat for species/nursery grounds	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Expert opinion/inferred	2, 6, 11, 14	2.1, 6.6, 11.4, 12.2, 12.A, 14.2, 14.4 14.5
	Nutrient cycling	Biogeochemical cycling	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Expert opinion/inferred	Expert opinion/inferred	6, 12, 13, 14	6.6, 12.4, 12.8, 13.1, 14.1
Regulation & Maintenance	Carbon sequestration and storage	Carbon Sequestration and Carbon storage (vegetation & shell & soils)	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Grey literature	7, 12, 13, 14	12.2, 12.8, 12.9, 13.1, 13.4, 14.3
	Ocean acidification buffering	Ocean acidification buffering	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	13, 14	13.1, 14.3
	Waste breakdown & detoxification	N burial/storage	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	No data	Peer-reviewed literature	6, 11, 14	11.6, 6.3, 6.5, 6.6, 14.1
		P burial/storage	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	No data	Peer-reviewed literature	6, 11, 14	6.3, 6.5, 6.6, 11.6, 14.1
		Denitrification	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	No data	Peer-reviewed literature	6, 11, 14	6.3, 6.5, 6.6, 11.6, 14.1
		Viral/bacterial control	Expert opinion/inferred	Expert opinion/inferred	Peer-reviewed literature	Expert opinion/inferred	No data	No data	Grey literature	3, 6, 11, 14	3.3, 6.3, 6.5, 6.6, 11.6, 14.1
	Coastal protection	Sediment stabilisation	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Expert opinion/inferred	Peer-reviewed literature	No data	Peer-reviewed literature	6, 11, 14	6.3, 6.6, 11.5, 14.1, 14.2, 14.5
		Wave attenuation	Grey literature	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	No data	Grey literature	11, 13, 14	11.5, 13.1, 14.5
Provisioning	Food provisioning	Finfish yield/biomass	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	No data	No data	2, 8, 12, 14	2.1, 8.4, 12.2, 14.4
		Shellfish yield/biomass	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Peer-reviewed literature	Expert opinion/inferred	Peer-reviewed literature	Peer-reviewed literature	2, 8, 12, 14	2.1, 8.4, 12.2, 14.1, 14.7, 14.9
		Other harvestable goods – seaweed and bait	Expert opinion/inferred	Expert opinion/inferred	Expert opinion/inferred	Peer-reviewed literature	Peer-reviewed literature	No data	No data	2, 8, 12	2.1, 8.4, 12.8, 12.9
	Genetic Resources	Genetic resources	Peer-reviewed literature	Expert opinion/inferred	No data	No data	No data	No data	Expert opinion/inferred	3, 14	3.B, 14.8
Cultural	Tourism & Recreation	Boating, diving, tourism, beach, bird watching	Grey literature	Peer-reviewed literature	Expert opinion/inferred	Peer-reviewed literature	Expert opinion/inferred	Expert opinion/inferred	Expert opinion/inferred	3, 8, 11, 12	3.4, 8.9, 11.4, 12.9, 12.A
	Health and Wellbeing	Aesthetic appreciation of nature scenery (seascapes)	Grey literature	Peer-reviewed literature	Expert opinion/inferred	Expert opinion/inferred	Expert opinion/inferred	Expert opinion/inferred	Expert opinion/inferred	3, 11, 12	3.4, 11.4, 12.A
		Physical and mental health benefits	No data	No data	Grey literature	No data	No data	No data	No data	3	3.4
		Spiritual and artistic inspiration	Expert opinion/inferred	Expert opinion/inferred	Peer-reviewed literature	Expert opinion/inferred	Expert opinion/inferred	No data	Expert opinion/inferred	3	3.4
	Education	Science and educational services	Expert opinion/inferred	Expert opinion/inferred	Grey literature	Peer-reviewed literature	Expert opinion/inferred	Expert opinion/inferred	Expert opinion/inferred	3, 4, 13, 14	3.B, 4.7, 13.3, 14.8

(dark blue)	Peer- reviewed literature
(medium blue)	Grey literature
(light blue)	Expert opinion/inferred
(white)	No data

Matrix of ecological connectivity across seascape temperate habitats and its effect on ecosystem service delivery

Strength of evidence for the role of connectivity in positively or negatively impacting, or having no impact (neutral) on the degree of each ecosystem service delivered by habitats:

A. Mudflat,
B. Seagrass,
C. Salt marsh,
D. Oyster,
E. Macroalgae.

The size of each segment indicates the strength of evidence (see methods).

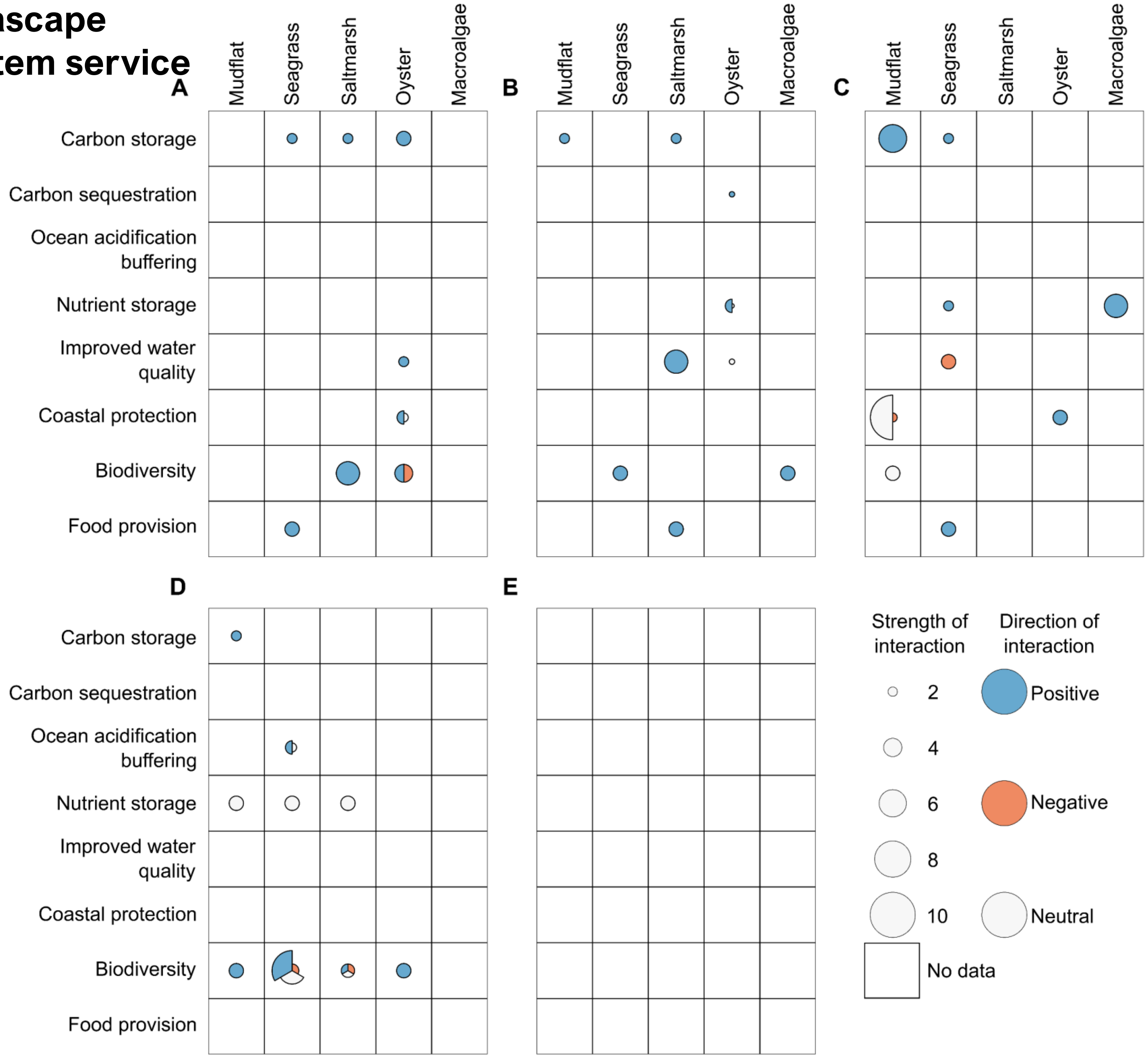
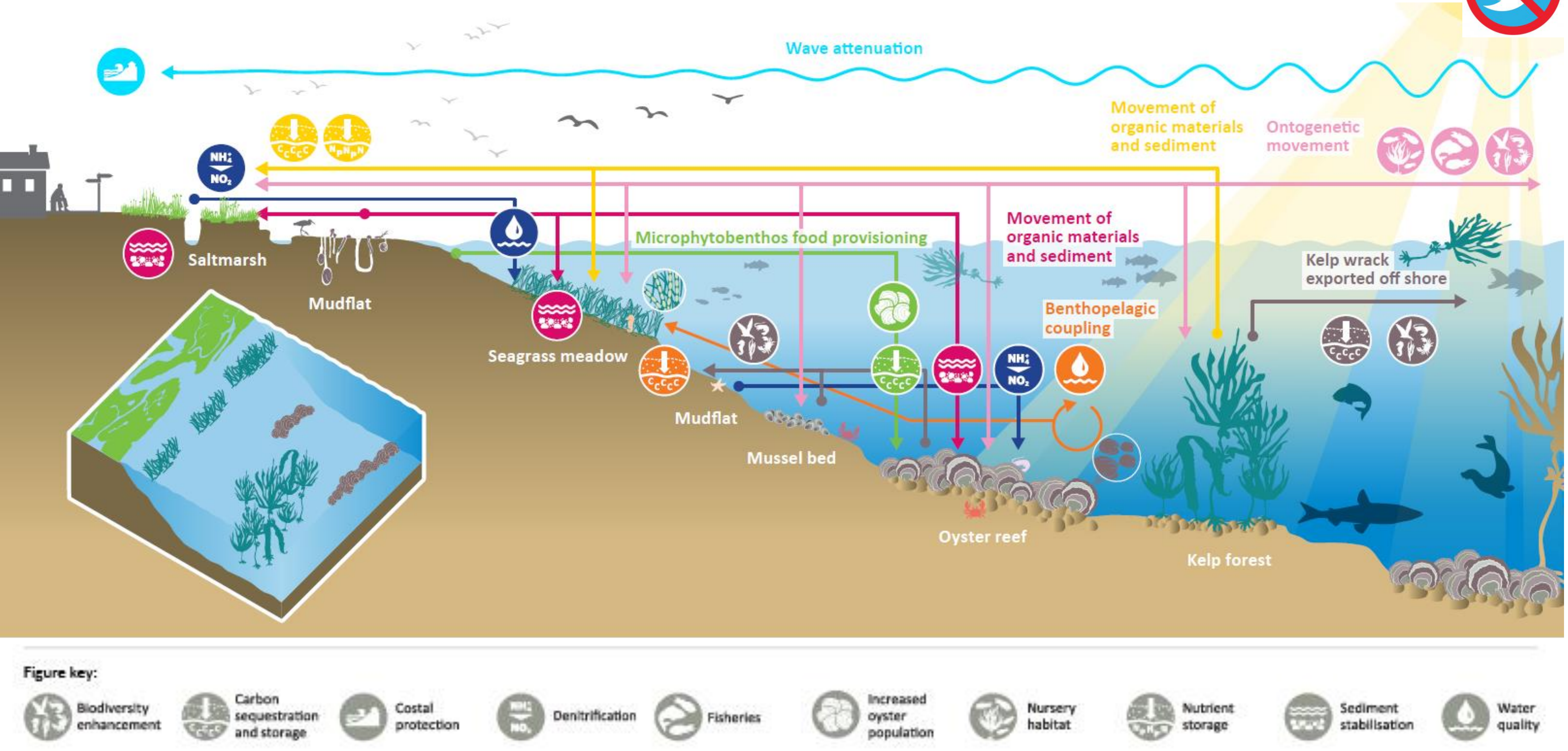


Illustration of ecological connectivity across the temperate coastal seascape



Preston, J., et al (*in review) Ocean Sustainability npj Special Collection: Bridging Land and Seascape Restoration for Ecoscape Recovery*

A roadmap to achieve seascape restoration of coastal habitats

1. A **seascape approach** to restoration is **timely** and **urgent**;
2. **Connectivity** needs to be fully **integrated** into the **restoration planning** stages of multi-habitat seascape restoration projects.
3. **Site suitability** is an essential and fundamental consideration in restoration planning
4. Consider the **order** of **habitat restoration** efforts when planning seascape restoration, to allow for the causal chains that can occur in seascape restoration;
5. **Restoration planning** needs to be a component of integrated and climate-smart **marine spatial planning**.
6. Marine restoration needs to **mature** to deliver projects at scale; *to achieve this **restoration practice** and **innovation** needs to develop in parallel with **enabling regulation and licencing** environments.*
7. We need to **learn whilst restoring**: monitoring frameworks should be aligned with **research agendas** to increase confidence in outcomes and support **nature positive financial markets**.

Policy pathways to achieve seascape recovery
Policy opportunities and actions to deliver benefits from seascape restoration:

1. Transition from **feature-based** to **spatial assessments**, for protection and management, which account for **connectivity** and the delivery of **ecosystem services**.
   - Recognise the potential impact of **degraded baselines** on nature protection targets
   - Nature targets to aim to restore **functionality** & **resilience** for future climates
   - **Management** practices to encompass **entire protected area**

2. Incorporate seascape **connectivity** into climate-smart **marine spatial planning** (MSP) to ensure that areas critical for ecosystem services and biodiversity are effectively protected and restored.
   - Adopt a **multi-habitat approach** that considers spatial **patterns** and **connectivity** across land-sea interface
   - Build on **terrestrial** knowledge to develop suite of **metrics** to assess **seascape connectivity**

3. **Seascape connectivity** offers an opportunity to **integrate policy frameworks** across **climate** and **biodiversity** agendas.
   - **Monitoring & reporting** be streamlined across **global policies** linked to ecosystem restoration → provide **consistent data** that facilitates efforts towards effective global restoration;
   - Identify **priority seascape connectivity metrics** to be integrated into global and national monitoring frameworks, such as for GBF target 2.

"In nature, nothing exists alone."

Rachel Carson

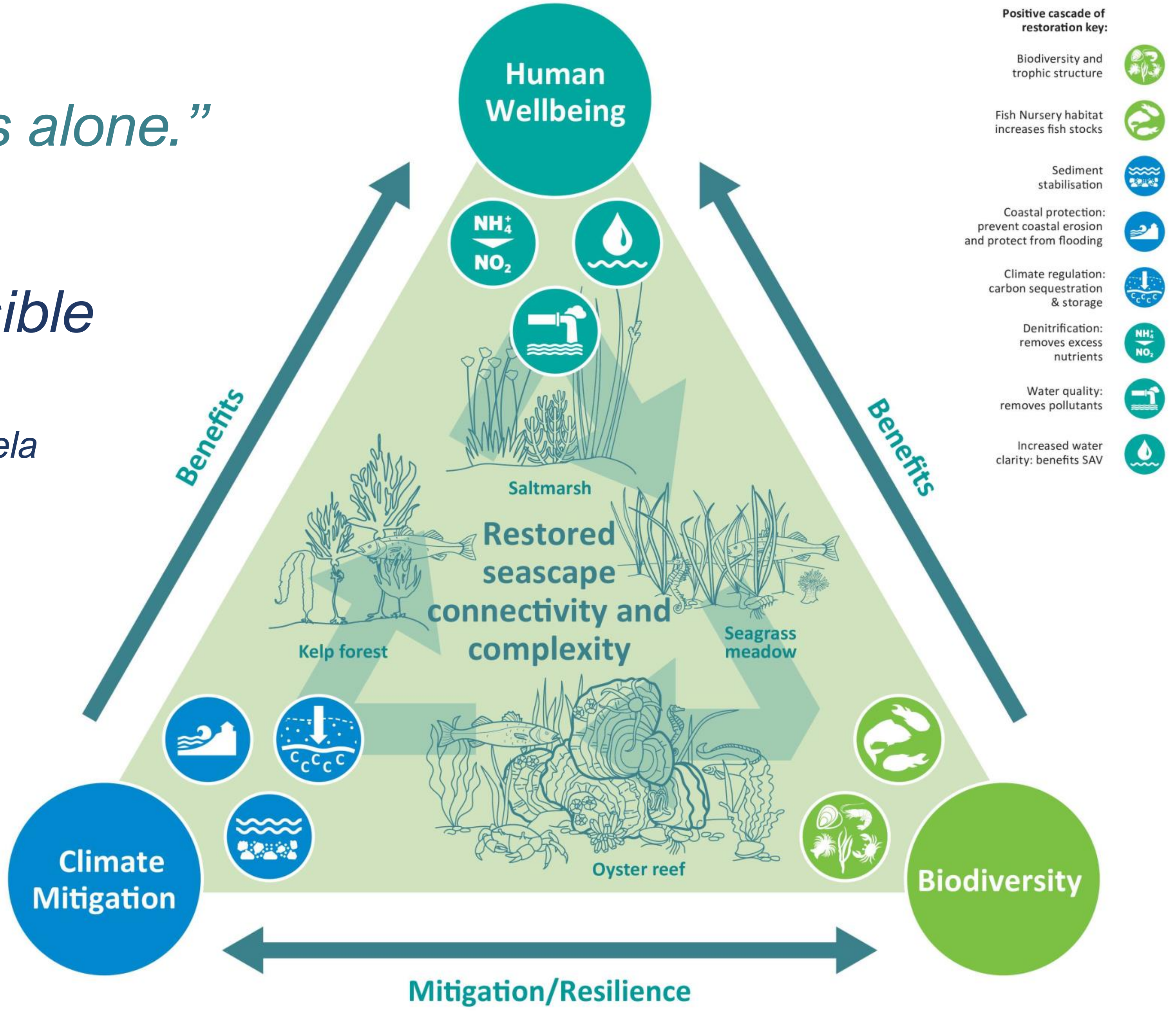
"It always seems impossible until it's done"

Nelson Mandela

Hold the Date – Seascape Symposium II

Reconnecting the Seascape
ZSL, London
4th & 5th June 2025

UNITED NATIONS DECADE ON ECOSYSTEM RESTORATION 2021-2030



Conceptual diagram of ecosystem services arising from a healthy and connected seascape, which supports climate mitigation, biodiversity and underpins human wellbeing.

UNITED NATIONS DECADE ON ECOSYSTEM RESTORATION 2021-2030

Thank you!
Any questions?

Let's bend the curve back for future generations

Joanne.preston@port.ac.uk

@solentseascapeproject

UNIVERSITY OF PORTSMOUTH

ReMeMaRe Conference 2024

Science Session, Chair: Graham Underwood, University of Essex

- **Mark Parry**, Ocean Conservation Trust
- **Bill Sanderson**, Heriot Watt University
- **Angus Garbutt**, Centre for Ecology & Hydrology
- **Pippa Moore**, Newcastle University
- **Jo Preston**, University of Portsmouth

Slido for questions
QR code or www.slido.com
Code: **4741966**

ReMeMaRe

Conference 2024

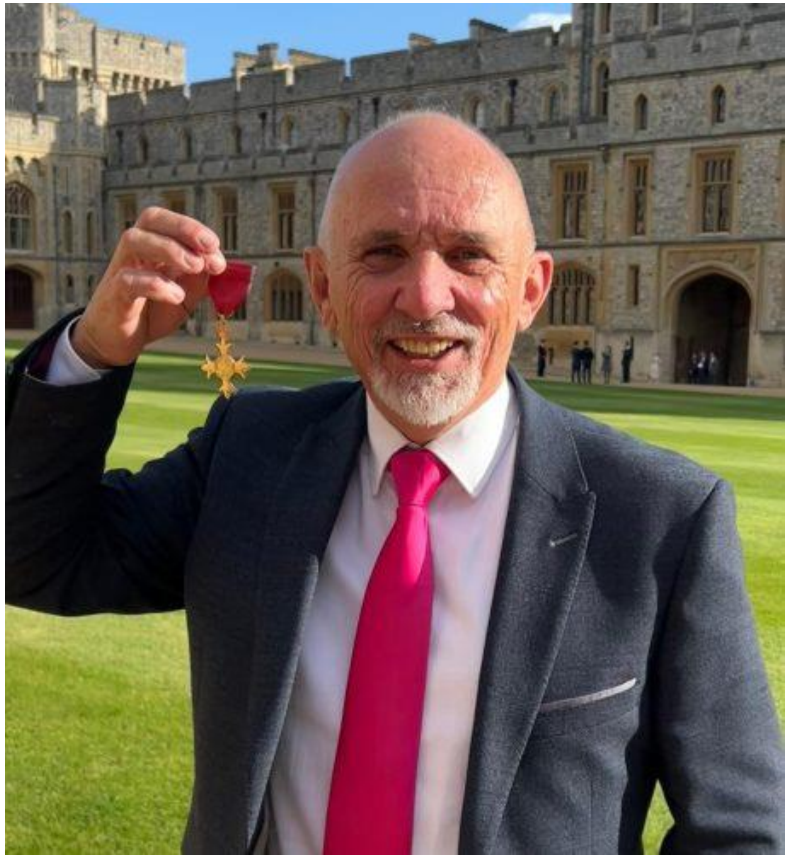
POSTER FLASH PRESENTATIONS

Joe Breen OBE

1961-2024

Marine Conservation Biologist, Diver, Skipper, Innovator,

Educator, Volunteer Life Saver, Colleague and Friend



ReMeMaRe Conference 2024

POSTER FLASH PRESENTATIONS

With Dedication To Joe Breen