SEA THE VALUE

MARINE BIODIVERSITY BENEFITS
FOR A SUSTAINABLE SOCIETY

Interlinkages between biodiversity & natural capital

WS2 for Coastal Partnership Network

Gordon Watson, Stefanie Broszeit, Joanne Preston and the STV team

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Natural Environment Research Council

Economic and Social Research Council

Where we start from in Sea The Value

Biodiversity is:

- sporadically integrated into public and private decision making

- remains peripheral to economic systems

Continuing biodiversity loss with negative implications for our society, economy, and wellbeing.

i. nascent understanding of how biodiversity provides benefits resulting in a lack of decision-grade data;
ii. hesitance to apply values due to low confidence, poor understanding, negligible beneficiary definition;
iii. uncertainty regarding green investment routes

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The Team

PML | Plymouth Marine Laboratory




Nicola Beaumont, Olivia Rendon, Stefanie Broszeit, Stephen Watson

1495 UNIVERSITY OF ABERDEEN

Tavis Potts, Jeremy Anbleyth-Evans


Gordon Watson, Jo Preston

UNIVERSITY OF PORTSMOUTH

MORAY FIRTH COASTAL PARTNERSHIP

SOLENT FORUM Est. 1992

Coastal Partnerships Network

eftec economics for the environment



Ian Dickie, Rob Tinch, Mark Collar

DB Daryl Burdon Ltd. Marine Research, Teaching & Consultancy

Daryl Burdon

Programme Steering Group. *Academic:* Prof Dasgupta, Prof Bateman (SWEEP), Prof Barbier, Prof Macreadie (Blue Carbon Lab), Prof Austin (Scottish Blue Carbon and Nat Cap Forum), Prof Paterson (SMMR), Burdon (CEH saltmarsh code); Prof Fletcher *Government and ALB:* Hinchen (Defra), Lannin (MMO), Morgan (JNCC), Armstrong (DAERA), Lindenbaum (NRW), Mellan (Environment Agency), Taylor (Natural England); NGO: Tudor (Blue Marine Foundation), Walmsley (WWF); Collin (Scottish Wildlife Trust, Marine Natural Capital Forum Scotland) *Industry and commerce:* Tinline (ABP), Rice (Southern Water), Goldie (Port of Cromty Firth).

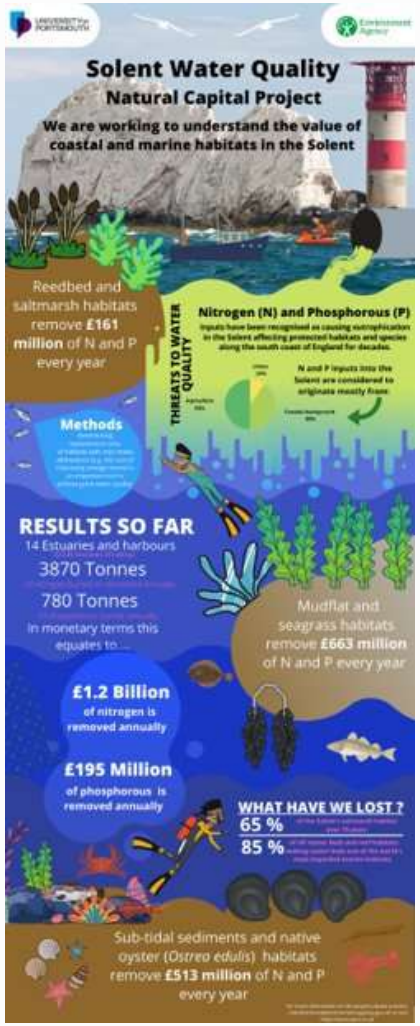
Our focus

Carbon sequestration and storage (CCS)

Bioremediation of waste/nutrients (BN)

- Moray Firth
- The Solent
- Scale to National

Image: Jenny Grant, copyright MFCP



Today: show and tell of biodiversity work in Sea The Value

Quantify the interlinkages between marine biodiversity, natural capital, and ecosystem services, taking quantity (extent), quality (condition), resilience and biodiversity into consideration.

Aim: to combine existing and novel natural science data to provide UK representations of how marine biodiversity provides carbon sequestration and storage and bioremediation of nutrients

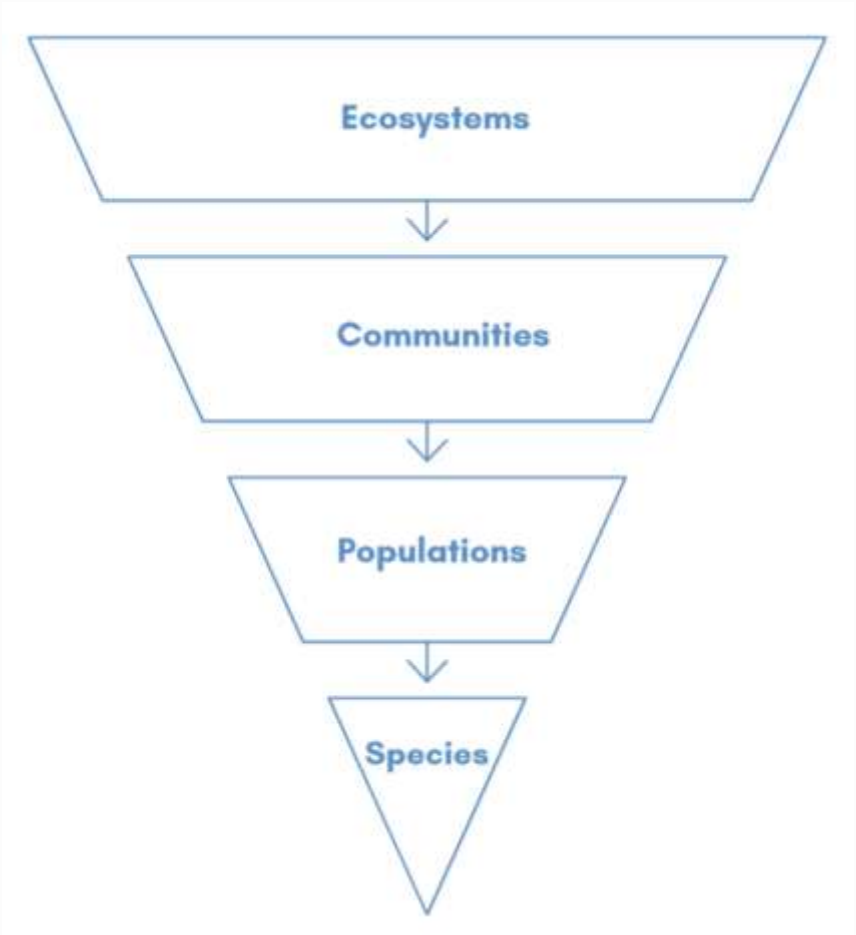
To speak the same language… some definitions

Image © A. vanderSchotteOlivier

Biological diversity (= Biodiversity)

Convention on Biological Diversity

Biological diversity means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems



Functions and interactions link these elements

- Predator-prey
- Competition
- Carbon sequestration
- Filter feeding
- Habitat provision

The non-living environment

Ecosystem, biotope or habitat?

Ecosystem: a dynamic complex of plant, animal and microorganism communities and their non-living environment, interacting as a functional unit

Biotope refers to the physical conditions in which a specific group of plant and animal species live, forming a distinct assemblage in a given geographic region

Habitat is where a species lives

Some habitats are created by other species (seagrass beds, oyster reefs….)

A landscape feature that provides habitat for species

Image © S. Broszeit

Quality and condition

Quality refers to the underlying condition of natural capital assets and their ability to maintain flows of services (NCC, 2019).

There is a wide range of possible condition indicators that can be used to measure habitat quality. A baseline or ”reference condition” provides a context against which changes can be assessed.

DEFRA uses quality as default term.

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Shoot density as indicator of Seagrass habitat quality

Definition from:
Natural Capital Committee Terminology 2019
https://assets.publishing.service.gov.uk/media/5f352ebbe90e0732e2d7ca58/ncc-terminology.pdf

Resilience

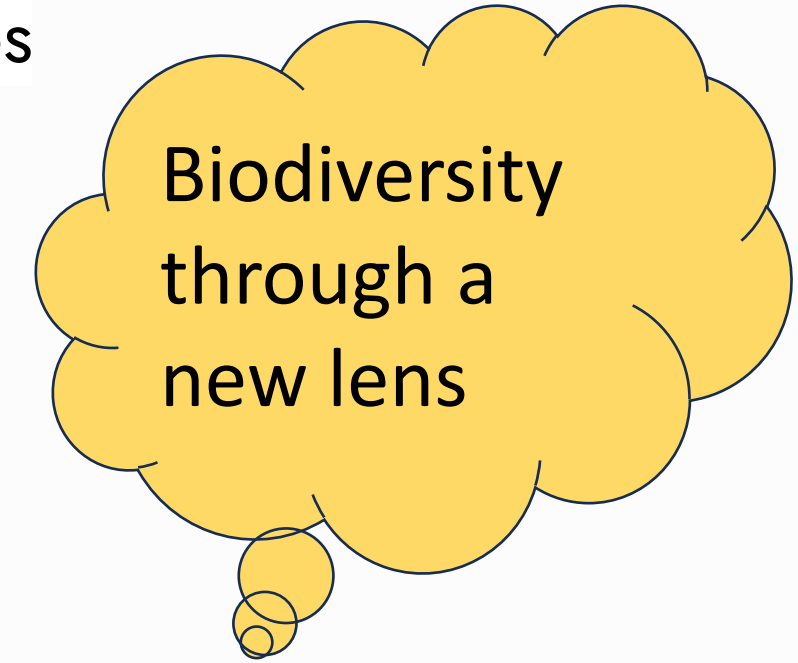
Ecological resilience is “the capacity of an ecosystem to absorb repeated disturbances or shocks and adapt to change without fundamentally switching to an alternative stable state" (Holling 1973).

Resilience relates to how an ecosystem resists stressors and how it recovers from loss or degradation (resilience = resistance and recovery) (Unsworth, et al. 2015).

Holling CS. 1973 Resilience and stability of ecological systems, Annual review of Ecology and Systematics
Unsworth RK, Collier CJ, Waycott M, Mckenzie LJ, Cullen-Unsworth LC. 2015 A framework for the resilience of seagrass ecosystems. Marine pollution bulletin;100:34-46.

Biodiversity is inherently valuable

- Net gain
- Conservation and restoration
- Trading schemes
- Biodiversity (index of quality): impacts services



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How to assess biodiversity (looking at biodiversity through a new lens)

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SEAGRASS: Summary of assessing biodiversity for key habitats

REGION:	TEMPERATE								
HABITAT	SEAGRASS								
BIODIVERSITY (QUALITY)									
TYPE	SERVICE PROVIDED	COMPONENTS	COMPONENTS	METHODS	METHODS	METHODS	METHODS	METHODS	METHODS
MICROBIAL	CSS, BN			eDNA water	agar plating	eDNA sediment			
MEIOFAUNA	CSS, BN			eDNA	elutriation	bubble and blo	swirl and decar	sieving	anesthetic
MACROFAUNA	CSS, BN			eDNA	core	quadrat	box core	drop down vid	grab
FISH				eDNA	netting	BRUVs	drop down vid	tagging	
BIRDS				eDNA	counting	video	netting	drone	
MAMMALS				eDNA	counting	video	tagging	drone	satellite
HABITAT	CSS, BN	SPECIES		quadrat	core	photo	grab		
HABITAT	CSS, BN	PLANTS	shoot density	quadrat	photo				
HABITAT	CSS, BN	PLANTS	leaf area	quadrat	photo				
HABITAT	CSS, BN	PLANTS	fragmentation	quadrat	photo				
HABITAT	CSS, BN	PLANTS	epiphyte cover	quadrat	photo				
HABITAT	CSS, BN	SEDIMENT	Particle size	core	box core				
HABITAT	CSS, BN	SEDIMENT	organic content	core	box core				
HABITAT	CSS, BN	SEDIMENT	physiochemical	core	direct sampling	pore water			

KEY

CSS: carbon sequestration and storage

BN: Bioremediation of nutrients

SALTMARSH: Summary of assessing biodiversity for key habitats

REGION:	TEMPERATE								
HABITAT	SALTMARSH								
BIODIVERSITY (QUALITY)									
TYPE	SERVICE PROVIDED	COMPONENTS	COMPONENTS	METHODS	METHODS	METHODS	METHODS	METHODS	METHODS
MICROBIAL	CSS, BN			eDNA water	plating	eDNA sed			
MEIOFAUNA	CSS, BN			eDNA	elutriation	bubble and blo	swirl and decar	sieving	anesthetic
MACROFAUNA	CSS, BN			eDNA	core	quadrat	box core	drop down vid	grab
FISH				eDNA	netting	BRUVs	drop down vid	tagging	
BIRDS				eDNA	counting	video	netting	drone	
MAMMALS				eDNA	counting	video	tagging	drone	satellite
HABITAT	CSS, BN	SPECIES		quadrat	core	photo	grab		
HABITAT	CSS, BN	PLANTS	plant height	quadrat	photo				
HABITAT	CSS, BN	PLANTS	erosion	quadrat	photo				
HABITAT	CSS, BN	PLANTS	biomass above/b	quadrat	core	photo			
HABITAT	CSS, BN	SEDIMENT	Particle size	core	box core				
HABITAT	CSS, BN	SEDIMENT	organic content	core	box core				
HABITAT	CSS, BN	SEDIMENT	physiochemical	core	direct sampling	pore water			

MUDFLAT: Summary of assessing biodiversity for key habitats

REGION:	TEMPERATE								
HABITAT	MUDFLAT								
BIODIVERSITY (QUALITY)									
TYPE	SERVICE PROVIDED	COMPONENTS	COMPONENTS	METHODS	METHODS	METHODS	METHODS	METHODS	METHODS
MICROBIAL	CSS, BN			eDNA water	plating	eDNA sed			
MEIOFAUNA	CSS, BN			eDNA	elutriation	bubble and blo	swirl and decar	sieving	anesthetic
MACROFAUNA	CSS, BN			eDNA	core	quadrat	box core	drop down vid	grab
FISH				eDNA	netting	BRUVs	drop down vid	tagging	
BIRDS				eDNA	counting	video	netting	drone	
MAMMALS				eDNA	counting	video	tagging	drone	satellite
HABITAT	CSS, BN	MACROFAUNA	bioturbation/fun	quadrat	core	photo			
HABITAT	CSS, BN	ALGAL MAT	% coverage	quadrat	photo				
HABITAT	CSS, BN	ALGAL MAT	biomass	quadrat	photo				
HABITAT	CSS, BN	SEDIMENT	Particle size	core	box core				
HABITAT	CSS, BN	SEDIMENT	organic content	core	box core				
HABITAT	CSS, BN	SEDIMENT	physiochemical	core	direct sampling	pore water			

NATIVE OYSTERS: Summary of assessing biodiversity for key habitats

REGION:	TEMPERATE								
HABITAT	NATIVE OYSTERS								
BIODIVERSITY (QUALITY)									
TYPE	SERVICE PROVIDED	COMPONENTS	COMPONENTS	METHODS	METHODS	METHODS	METHODS	METHODS	METHODS
MICROBIAL	CSS, BN			eDNA water	plating	eDNA sed			
MEIOFAUNA	CSS, BN			eDNA	elutriation	bubble and blo	swirl and decar	sieving	anesthetic
MACROFAUNA	CSS, BN			eDNA	core	quadrat	box core	drop down vid	grab
FISH				eDNA	netting	BRUVs	drop down vid	tagging	
BIRDS				eDNA	counting	video	netting	drone	
MAMMALS				eDNA	counting	video	tagging	drone	satellite
HABITAT	CSS, BN	REEF TYPE	oyster density	quadrat	direct sampling	photo			
HABITAT	CSS, BN	OYSTER	Morphometrics	quadrat	direct sampling	photo			
HABITAT	CSS, BN	OYSTER (PACIFI	Morphometrics	quadrat	direct sampling	photo			
HABITAT	CSS, BN	SEDIMENT	Particle size	core	box core				
HABITAT	CSS, BN	SEDIMENT	organic content	core	box core				
HABITAT	CSS, BN	SEDIMENT	physiochemical	core	direct sampling	pore water			

KELP: Summary of assessing biodiversity for key habitats

REGION:	TEMPERATE								
HABITAT	KELP								
BIODIVERSITY (QUALITY)									
TYPE	SERVICE PROVIDED	COMPONENTS	COMPONENTS	METHODS	METHODS	METHODS	METHODS	METHODS	METHODS
MICROBIAL	CSS, BN			eDNA water	plating	eDNA sed			
EPIFAUNA ON KELP	CSS, BN			eDNA	Photo	Direct sampling			
FISH				eDNA	netting	BRUVs	drop down vid	tagging	
BIRDS				eDNA	counting	video	netting	drone	
MAMMALS				eDNA	counting	video	tagging	drone	satellite
HABITAT	CSS, BN	SPECIES		quadrat	direct sampling	photo			
HABITAT	CSS, BN	KELP	Plant height	quadrat	direct sampling	photo			
HABITAT	CSS, BN	KELP	Morphometrics	quadrat	direct sampling	photo			
HABITAT	CSS, BN	SUBSTRATE	Rock type	Photo	sample				
HABITAT	CSS, BN	SUBSTRATE	Rugosity	Photo	sample				

MAERL: Summary of assessing biodiversity for key habitats

REGION:	TEMPERATE								
HABITAT	MAERL BEDS								
BIODIVERSITY (QUALITY)									
TYPE	SERVICE PROVIDED	COMPONENTS	COMPONENTS	METHODS	METHODS	METHODS	METHODS	METHODS	METHODS
MICROBIAL	CSS, BN			eDNA water	plating	eDNA sed			
MEIOFAUNA	CSS, BN			eDNA	elutriation	bubble and blo	swirl and decar	sieving	anesthetic
MACROFAUNA	CSS, BN			eDNA	core	quadrat	box core	drop down vid	grab
FISH				eDNA	netting	BRUVs	drop down vid	tagging	
BIRDS				eDNA	counting	video	netting	drone	
MAMMALS				eDNA	counting	video	tagging	drone	satellite
HABITAT	CSS, BN	REEF TYPE	maerl density	quadrat	direct sampling	photo			
HABITAT	CSS, BN	MAERL	Morphometrics	quadrat	direct sampling	photo			
HABITAT	CSS, BN	SEDIMENT	Particle size	core	box core				
HABITAT	CSS, BN	SEDIMENT	organic content	core	box core				
HABITAT	CSS, BN	SEDIMENT	physiochemical	core	direct sampling	pore water			

HORSE MUSSEL: Summary of assessing biodiversity for key habitats

REGION:	TEMPERATE								
HABITAT	HORSE MUSSELS								
BIODIVERSITY (QUALITY)									
TYPE	SERVICE PROVIDED	COMPONENTS	COMPONENTS	METHODS	METHODS	METHODS	METHODS	METHODS	METHODS
MICROBIAL	CSS, BN			eDNA water	plating	eDNA sed			
MEIOFAUNA	CSS, BN			eDNA	elutriation	bubble and blo	swirl and decar	sieving	anesthetic
MACROFAUNA	CSS, BN			eDNA	core	quadrat	box core	drop down vid	grab
FISH				eDNA	netting	BRUVs	drop down vid	tagging	
BIRDS				eDNA	counting	video	netting	drone	
MAMMALS				eDNA	counting	video	tagging	drone	satellite
HABITAT	CSS, BN	REEF TYPE	mussel density	quadrat	direct sampling	photo			
HABITAT	CSS, BN	MUSSEL	Morphometrics	quadrat	direct sampling	photo			
HABITAT	CSS, BN	MUSSEL	Morphometrics	quadrat	direct sampling	photo			
HABITAT	CSS, BN	SUBSTRATE	Rock type	quadrat	direct sampling	photo			
HABITAT	CSS, BN	SUBSTRATE	Rugosity	quadrat	direct sampling	photo			
HABITAT	CSS, BN	SEDIMENT	Particle size	core	box core				
HABITAT	CSS, BN	SEDIMENT	organic content	core	box core				
HABITAT	CSS, BN	SEDIMENT	physiochemical	core	direct sampling	pore water			

Method explanations/details (example for mudflat)

TASK 1: Biodiversity sampling Methods

Technique/metho	Biodiveristy	Details
eDNA water/sedim	All	Generates species lists of habitat . Those detected depend on the primers used (invertebrates, eukaryotes etc). Also cannot quantify organsims and issues of was the DNA from a dead organism/just passing through
Elutriation	Meiofauna	Quantitative. Known volume of sediment is continually suspended in a flow through system and then meiofauna (organisms >63 um, <1000 um) are caught on the sieve.
Bubble and blot	Meiofauna	Extracts meiofauna from sediment using the hydrophobicity of the cuticle. Good for some groups: harpacticoid copepods
Swirl and decant	Meiofauna	Extracts meiofauna from sediment using differences in density between meiofauna and sediment. Good for some groups: nematides, but not high density: foraminiferans, gastropods
Anesthetic with sw	Meiofauna	Extracts meiofauna from sediment using differences in density between meiofauna and sediment. Good for halicarid mites and harpacticoid copepods as release grip on sediment foraminiferans, gastropods
Sieving	Meiofauna	Extracts meiofauna from sediment using differences in size. Good for halicarid mites and harpacticoid copepods as release grip on sediment foraminiferans, gastropods
Quadrat	Various	Can count or do % coverage of organisms. Take a photo of them and also measure many morphometrics of species within
Core	Macrofauna and mei	Usually a drain pipe (10cm diamter) pushed into sediment. Then macrofauna have to sieved and picked out. Also use for carbon
Box core	Macrofauna and mei	Bigger volume removed, for macrofauna of lower density
Grab	Macrofauna and mei	Usually from a boat (subtidal) various sizes
Drop down video	Various	Towed behind boat. Good for habitat (e.g. seagrass, mussel beds). Can also be used for epifauna
BRUV	Fish and crustaceans	Baited underwtaer video. Attracts mobile species (fish and crustaceans). Challenging in murky waters and some fish not attracted by bait and others are scared off by other species
Netting	Fish and crustaceans	Fyke (a long tube) can be used in saltmarsh creeks as fish swim up/down). Seine netting deployed at low tide by hand
Tagging	Fish and crustaceans	Acoustic tags: will ping (record an event) when fish passes a listening station. Other tags can use GPS to track individuals and also record depth, temperature etc. Streamer/microtags are mark recapture.
Drone	habitats	Can detect human footprints-sized detail on surface, but flight restrictions and challenging to autiomatically separate some habitats: algal mat and seagrass. Coverage limited by drone type : fixed wing/ octocopter
Satellite	habitats	Broadscale for free satellites (e.g. ESA Sentinel) but up to 50-100cm resolution for commerical ones: Planet and Worldview. Same issues as drone
Pore water	Environmental	Use porewater extractors or take a core to remove water between sediment. Then measure concentrations of nutrients, contaminants etc.

Example of sampling method considerations (using mudflat)

TASK 2: Considerations for sampling

Components	Examples
TIME OF YEAR	Macrofauna best to sample seasonally, especially due to wading birds eating them, algal mat changes over time. Some species (oysters) have high post spawning mortality
LOW/HIGH TIDE	Cores will be used at lowtide, but can use larger grab to sample at high
REPLICATION	Minimal 3 to generate for statistics, but may need more as some habitats have high heterogenity at different spatial/temporal scales (e.g. mudflats)
FIELD/LAB	Some samples will have to be returned from the field e.g. detailed macrofauna ID cannot be done without keys and guides. Fix the samples
EQUIPMENT	Do you need access to get to habitat. Maerl beds/horse mussels subtidal, therefore need boat. Measuring nutrients and carbon complicated
TRAINING	Some biodiversity can be collected by volunteers, but identification can be challenging. E.g. 12 species of Ulva recorded in harbour: all look the same.
PEOPLE	Intertidal habitats need buddy system due to H&S and some much more challenging will need people who are fit/mobile.
COST	Equipment can be bought or hired. Some water quality probes can be hired. Some sampling can be expensive: about 250 per core to ID macrofauna
REGULATIONS	Need permission to sample protected habitat (SPA, SAC, SSSI). Even for smallest amount. Take weeks to get permission. Might not be granted permission to fly drone during breeding season or when waders back.

Key
H&S: health and safety regulations
ID: Identification
Macrofauna: animal species in mud that are retained on a sieve with 0.5 cm holes
Meiofauna: all fauna that falls through a sieve with 0.5 cm size

Task 3: To share data source knowledge

Please use the link to access data source table

The Coastal Partnership Network workshops

WS1: Wednesday 05/06/2024: Natural Capital and different ways of understanding value - Done

WS2: Wednesday 12/06/2024: Interlinkages between biodiversity and natural capital

WS3: Wednesday 19/06/2024: Participatory mapping

WS4: Wednesday 26/06/2024: Funding nature's needs

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Thank you

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