Bournemouth University

Ecological Enhancement for Marine Infrastructure Workshop

11th – 12th October 2022 – Day 2

Cumberland Hotel, Bournemouth

Websites and social media

Website	Website	Website	Website
Facebook	Facebook	No social media but search "3DPARE" on Twitter and YouTube for posts by project partners and staff	Twitter
Twitter	Twitter		LinkedIn
LinkedIn	Instagram		YouTube
YouTube	LinkedIn		
	YouTube		

Programme

- 09.00 – 09.30 Arrival, refreshments
- 09.30 – 10.45 Presentations from each project
  - SARCC
  - Marineff
  - Ecostructure
  - 3DPARE
  - Questions
- 10.45 – 11.00 Refreshment break
- 11.00 – 12.00 Activity 3 – Future collaborations and projects
- 12.00 – 13.00 Lunch and close

Bournemouth University

SARCC Project

Bert Van Severen, Flemish Government for SARCC project

bert.vanseveren@vlaanderen.be

Interreg

EUROPEAN UNION

2 Seas Mers Zeeën

SARCC

European Regional Development Fund

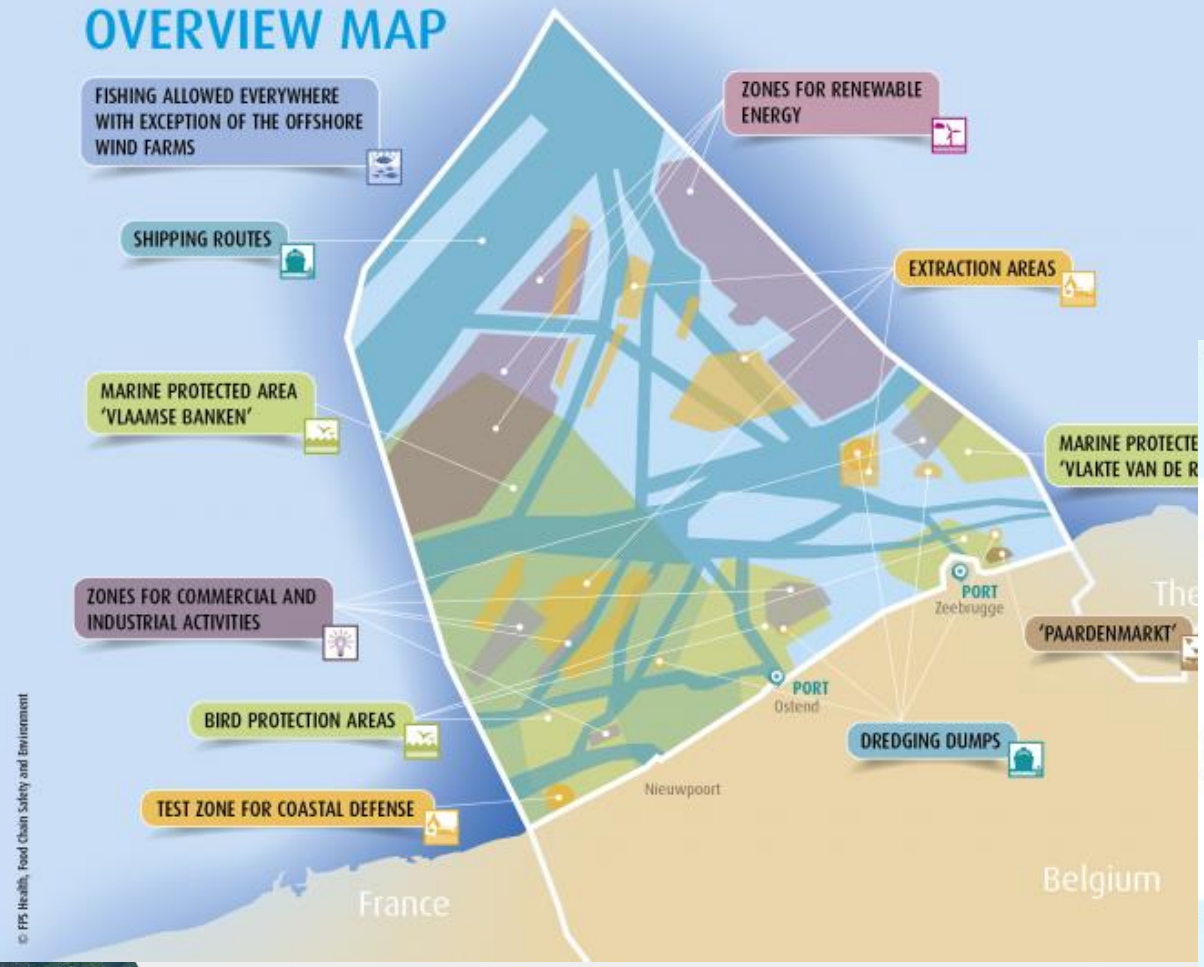
SARCC Lessons Learned

Bert Van Severen

Flemish Government – Department of Environment and Spatial Development

bert.vanseveren@vlaanderen.be

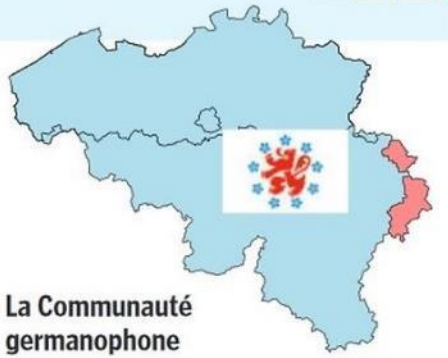
OVERVIEW MAP



Trois Communautés

La Communauté flamande

La Communauté française



La Communauté germanophone

Trois Régions

La Région flamande

La Région de Bruxelles-Capitale

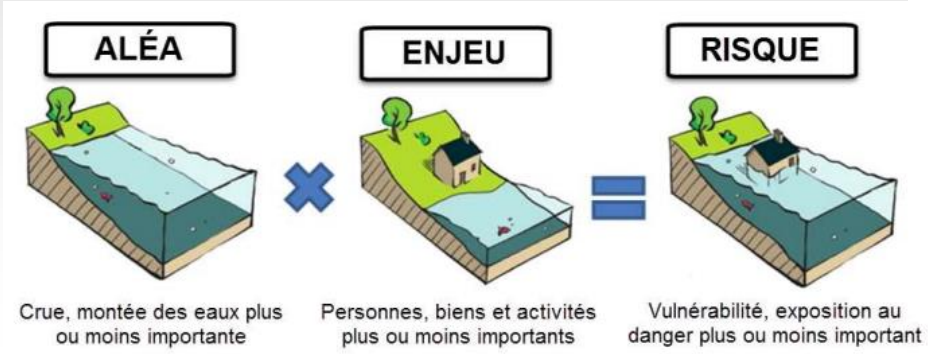
La Région wallonne

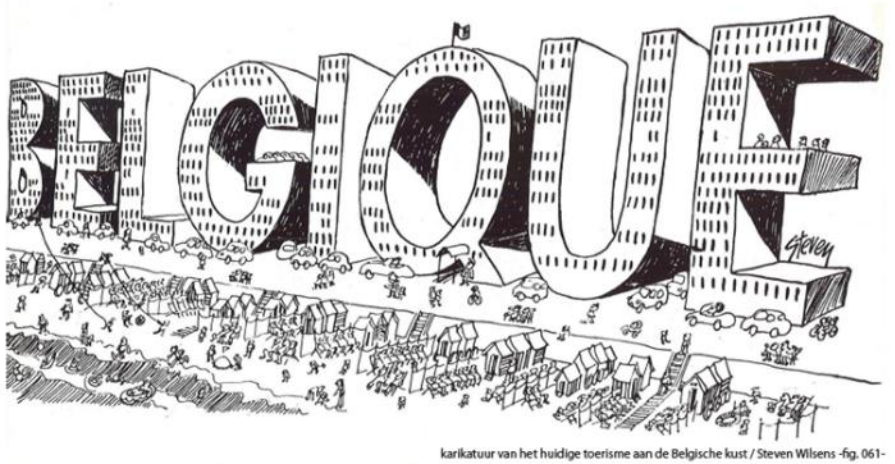
Source: www.lavenir.net

SARCC: Améliorer la compréhension des solutions fondées sur la nature (NBS) dans les villes côtières

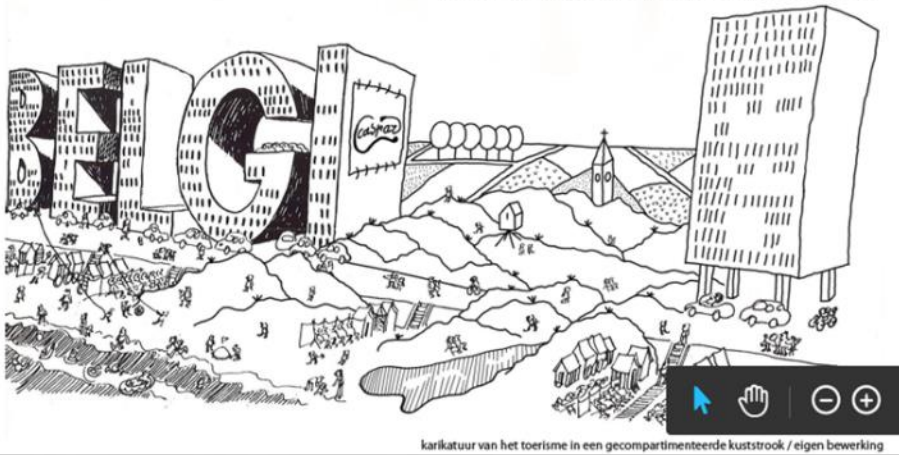
Pourquoi?

- NBS can help **reduce the chance** for flooding or economical damages
- NBS are often not know or taken into account by **Urban leaders/ decision makers**





karikatuur van het huidige toerisme aan de Belgische kust / Steven Wilsens -fig. 061-

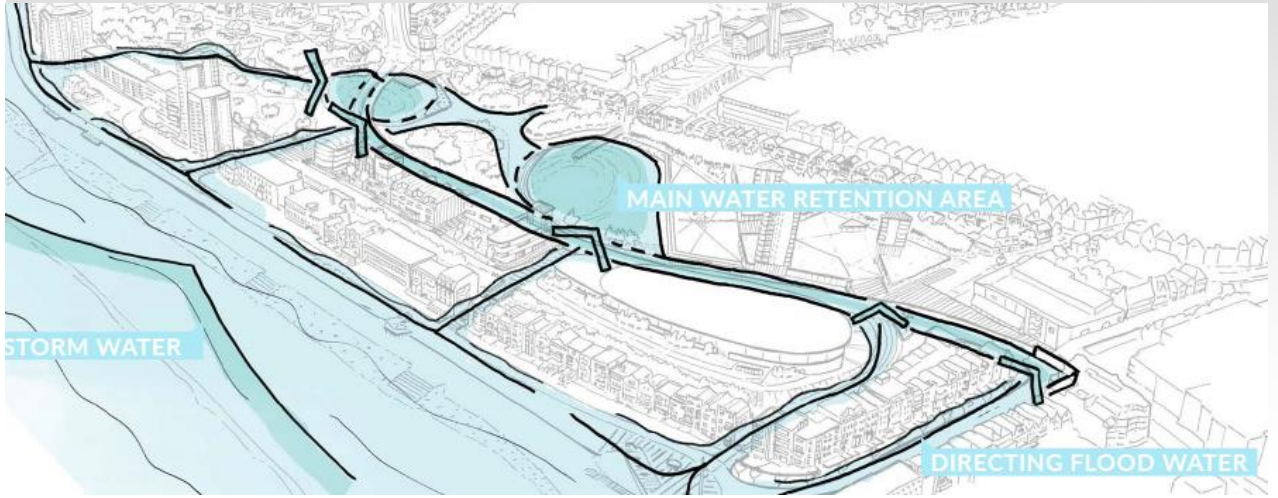

karikatuur van het toerisme in een gecompartimenteerde kuststrook / eigen bewerking

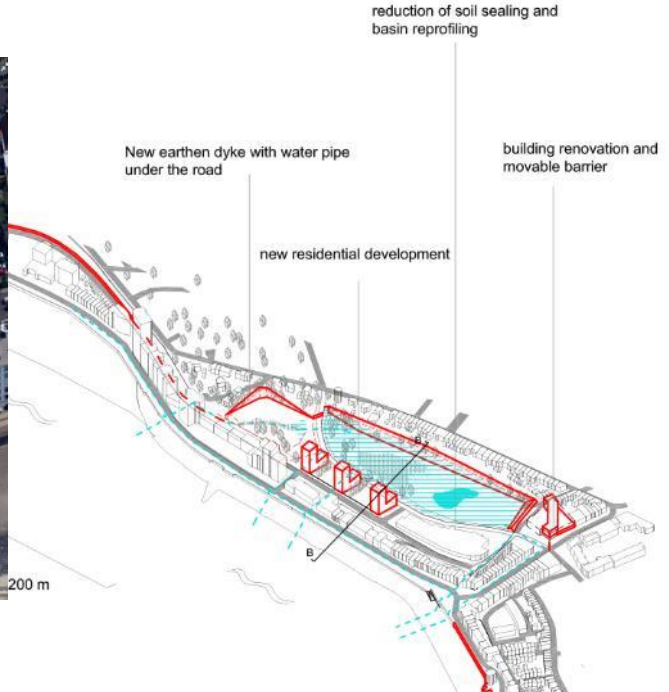
Pilot Vlissingen (NL)

Project Pilot
Boulevard Bankert, Vlissingen

Interreg 2 Seas Mers Zeeën

During heavy storms Vlissingen's urban area runs the risk of being flooded.

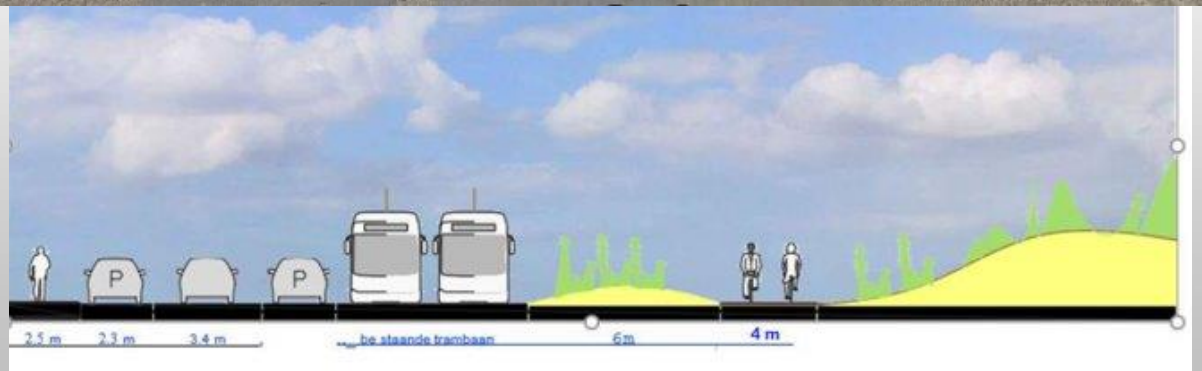




Pilote Gravelines (F)

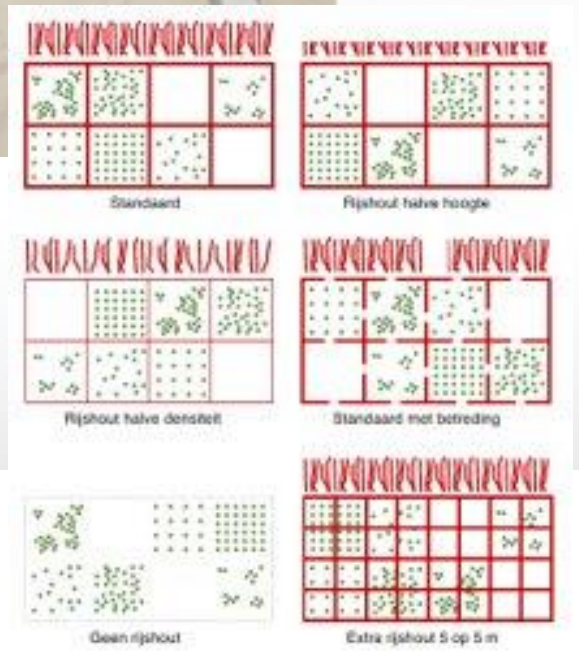
renforcer les défences naturelles

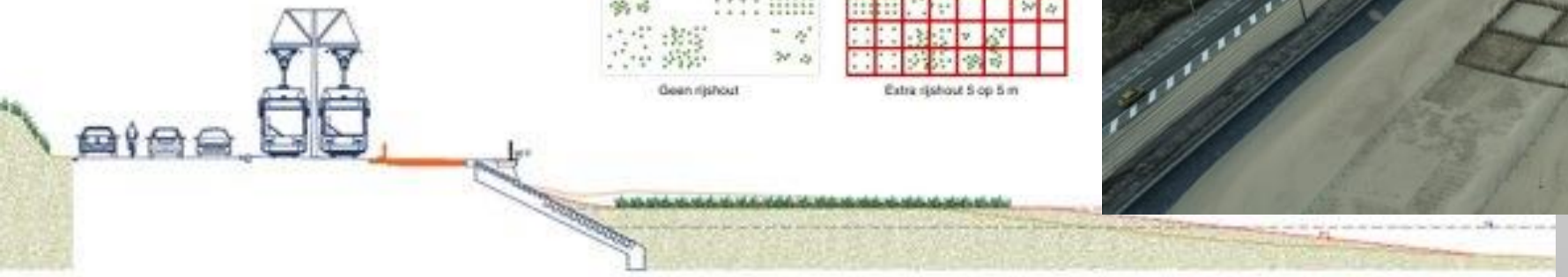

Kustlaan


P
P
2.5 m
2.3 m
3.4 m
6 m
4 m

Pilot Newlyn (Cornwall, UK)

Pilot Oostende (B)
combining challenges





Work Packages

WP1: Pilot Projects

WP2: Urban Leaders Capacity Building

WP3: Visualization & Community Engagement

WP4: Project Management

WP5: Communication & Dissemination

WP6: Monitoring & Evaluation

WP2: participation and awareness raising

- **The workshops will cover in the first part:**
  - **Scientific evidence of sea level rise & climate change & how it will impact urban coastlines**
  - **Historical trends of coastal flooding in the 2Seas region**
  - **Information about nature based solutions**

- **A second phase : developed by the partners to demonstrate how they can utilize the tools:**
  - **Technical solutions**
  - **Finance models**
  - **How to engage with local communities**

Connecting Urban Leaders with Specialists

Capacity building programme for Urban Leaders

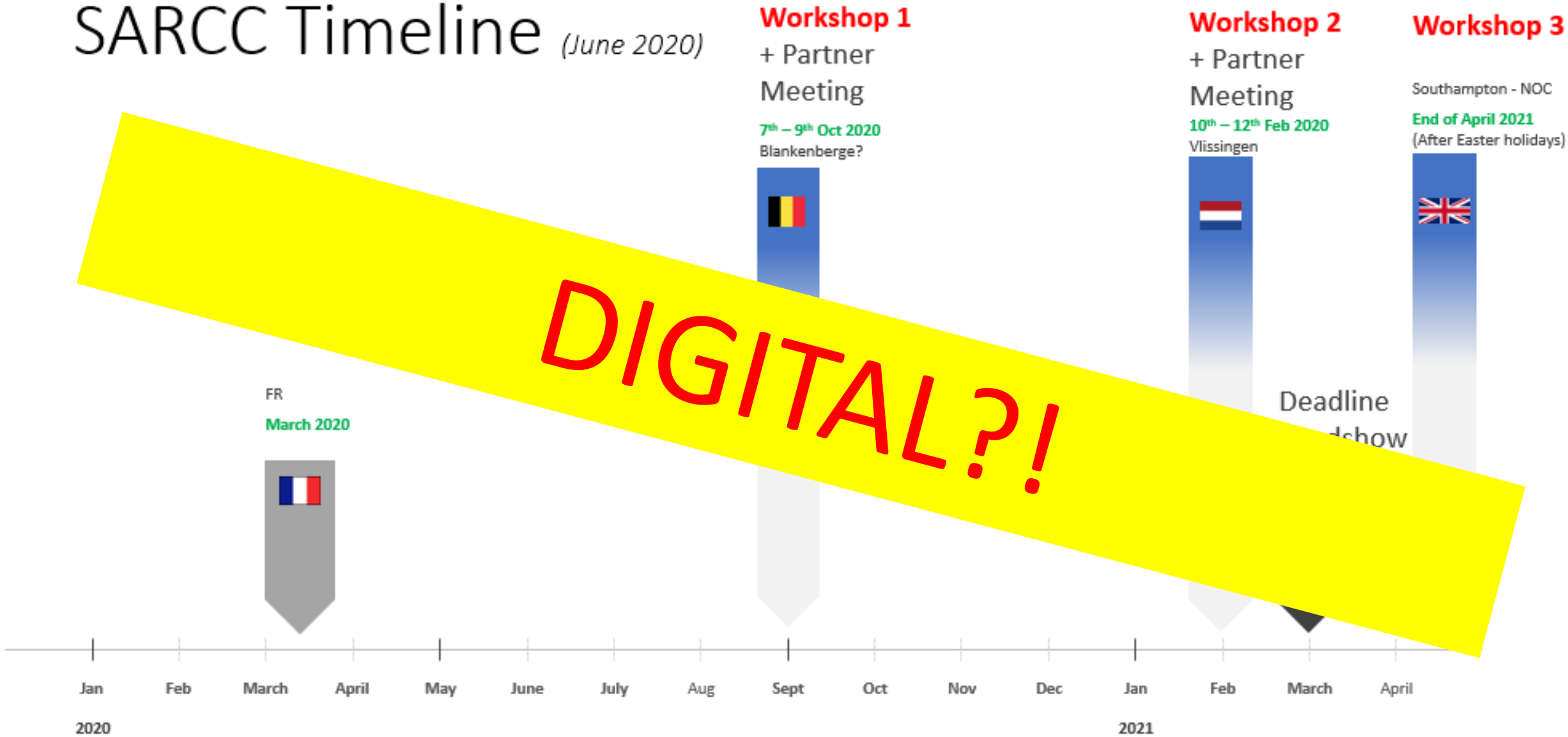
- Introductory programme
- Developing basic knowledge around CC, NBS and best practices
- Challenge existing ideas
- Sessions get more specialised over time

Academic Sector, Companies and Industries

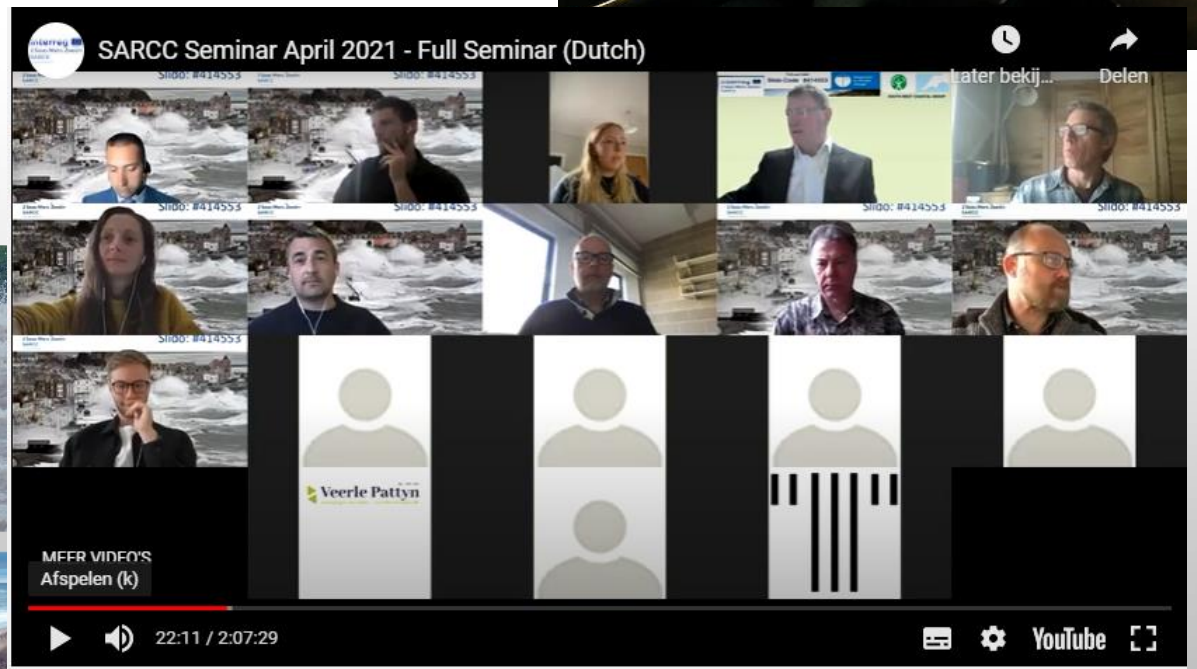
- More focused and specialised sessions
- Deepen knowledge
- Reassuring Urban Leaders why NBS is worth trying

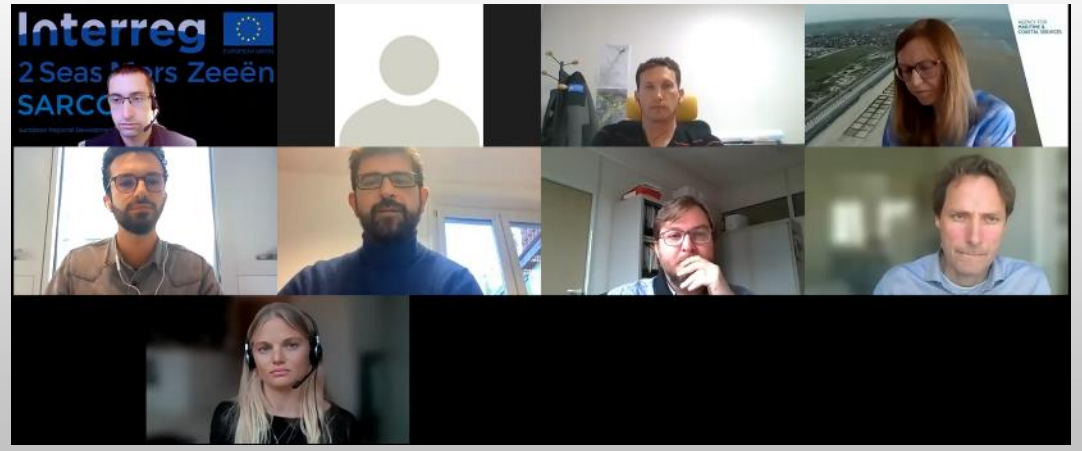
SARCC provides:
Neutral ground for encounters
No fears for prescience & inside information

SARCC Timeline *(June 2020)*




Klimaatsverandering & biodiversity


SARCC Seminar April 2021 - Full Seminar (Dutch)
Later bekij...
Delen
Veerle Pattyn
MEER VIDEO'S
Afspelen (k)
22:11 / 2:07:29
YouTube


Interreg
2 Seas
SARCC

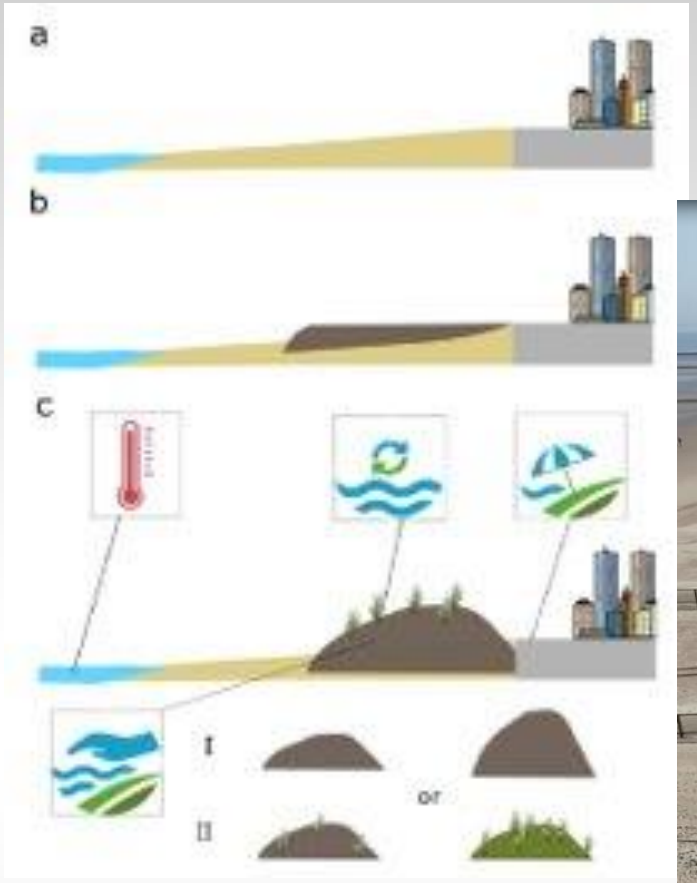
Lessons Learned

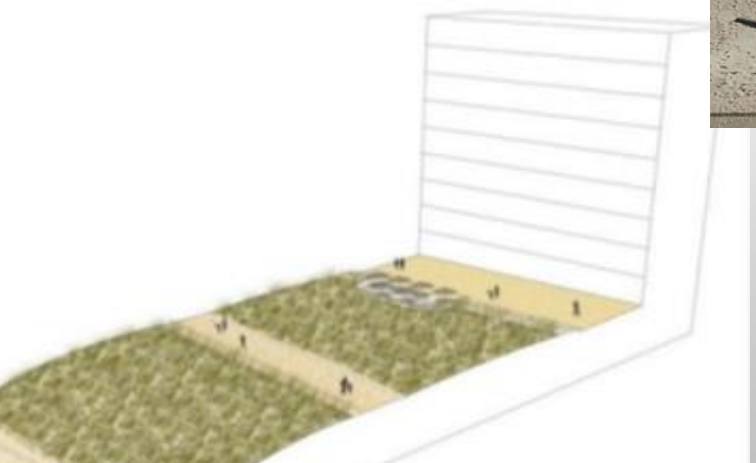
- **Conservative reflex (grey vs green)**
  - ⇒**way forward : showcase the Multiple Benefits; combine stakeholders' visions**
  - ⇒**difficulty of Ecosystem Services**
- **European ambition vs local capacity (FTE)**
- **Governance: dispersed in all regions**
- **European Nature Directive, how to tackle?**
- **Participation and positive communication**
- **Triple/quadruple helix: closer cooperation – engage urban leaders**

- **Need for pilots and 'agents of change' + knowledge sharing (open source modelling, …)**

Pilote Middelkerke (B)

communication and participation!



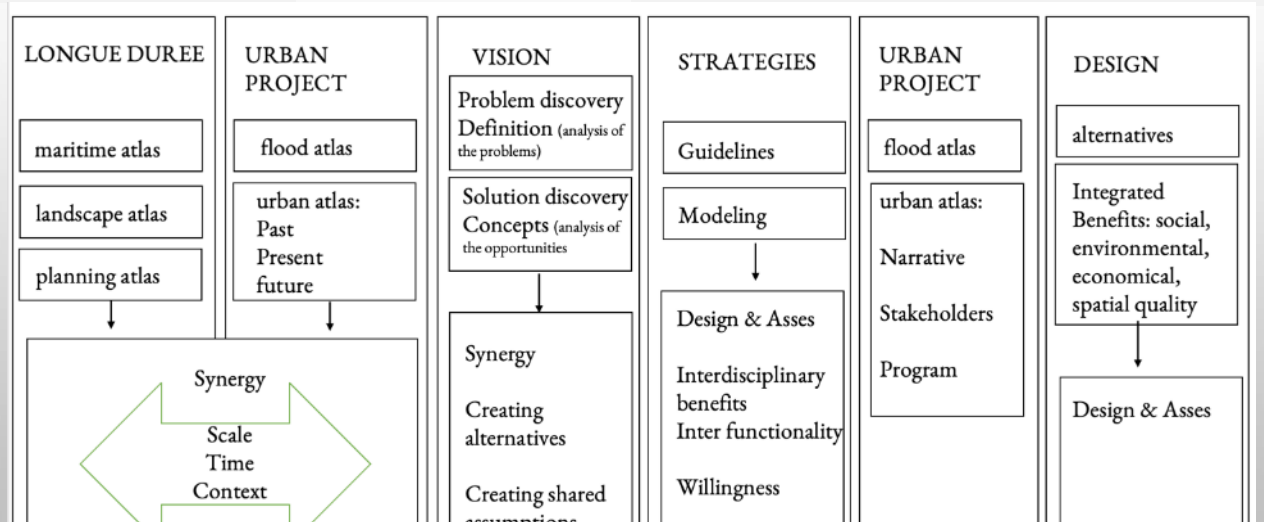


Pilote Southend-on-Sea (UK)

communication and participation?

Joint output WP1/WP2 / WP3

- Define 7 stratégies for deliverance of NBS (+ brochures)



Interreg 2 Seas Mers Zeeën SARCC

SARCC - Sustainable and Resilient Coastal Cities Interactive Visualisation Tool

Improving the understanding of Nature-Based Solutions in coastal cities

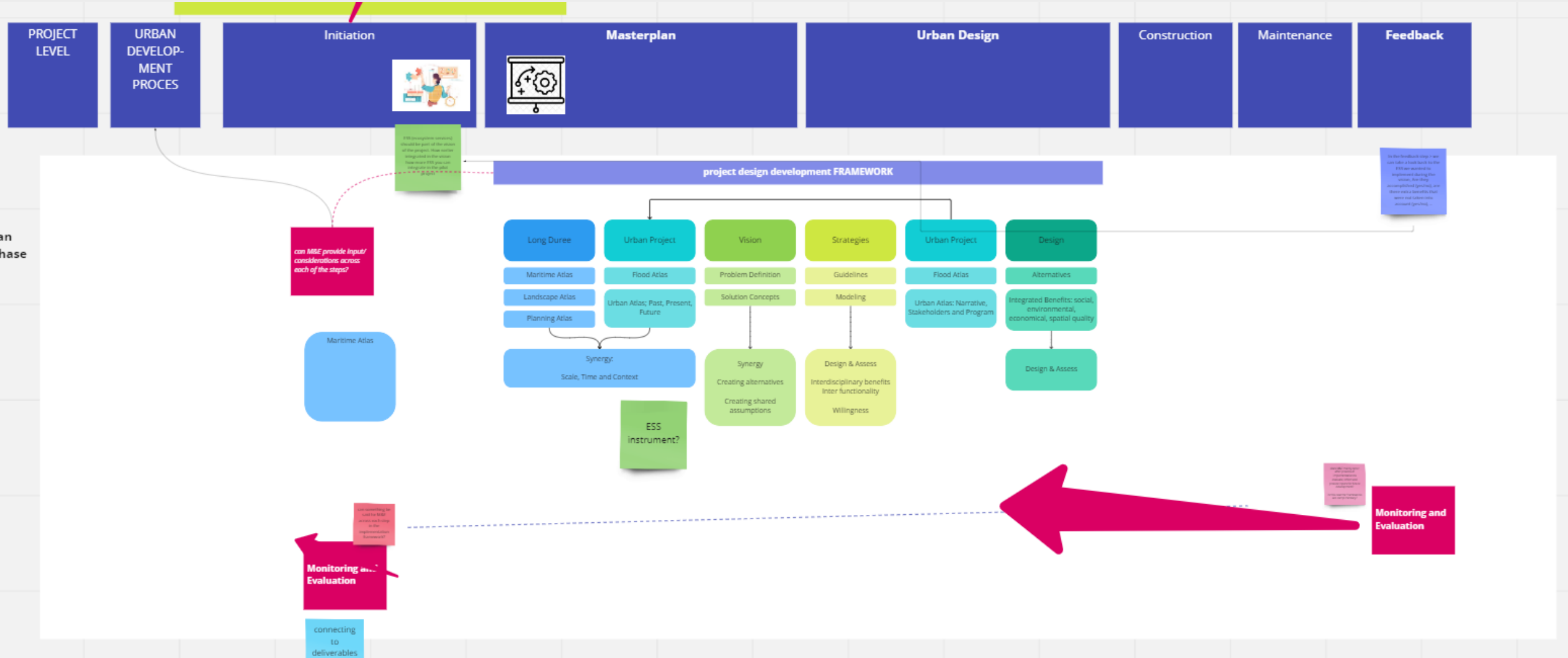
Why is this project required?

Mean sea level rise (SLR) could increase by **1.5m-2.5m by 2100**, which would see damage caused by coastal flooding in Europe increase from €1.25bn per annum currently to **€961bn** in just over 80 years (European Commission, 2018). Urban areas situated along the 2 Seas coastline are particularly vulnerable to extreme SLR (a combination of SLR, tide and storm surges). Coastal flood plans and policies focus predominantly on deploying traditional grey infrastructure/heavy engineering and ignore the use of **nature-based solutions (NBS)**, despite the overwhelming evidence of their potential to reduce flood risk and provide multiple benefits.

NBS are often not considered by policy-makers in detail due to the perceived risks around costs, potential for success, requirements for immediate protection / improvement and uncertainties regarding future change. A clear knowledge gap exists across coastal local authorities to deploy NBS as a means to reduce future coastal flood risk and economic damage.

Explore

Joint output WP1/WP2 / WP3



Bournemouth University

Marineff Project

Roger Herbert, Bournemouth University for Marineff

rherbert@bournemouth.ac.uk

More or Less: Scaling-up ecological enhancement trials on coastal infrastructure

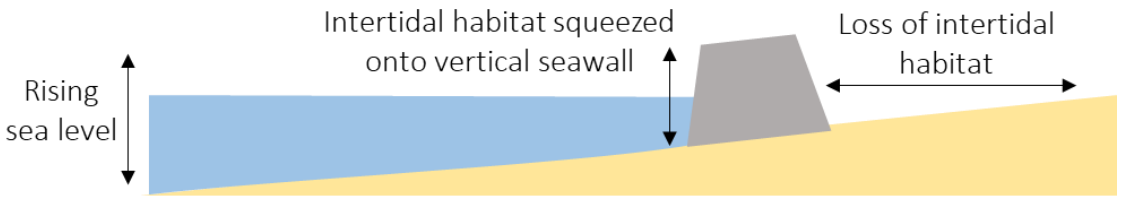
Roger J.H.Herbert[1], Jessica Bone[1], Alice.E. Hall[1,2], Rick Stafford[1], Stephen J. Hawkins[3], Ian Boyd[4], Nigel George[4]

[1]*Bournemouth University, Fern Barrow, Dorset, UK*
[2]*Plymouth University, Drake Circus, Devon, UK*
[3]*Southampton University, Drake Circus, Hampshire, UK*
[4] *Artecology, Sandown, Isle of Wight, UK*

Challenge on urban coasts

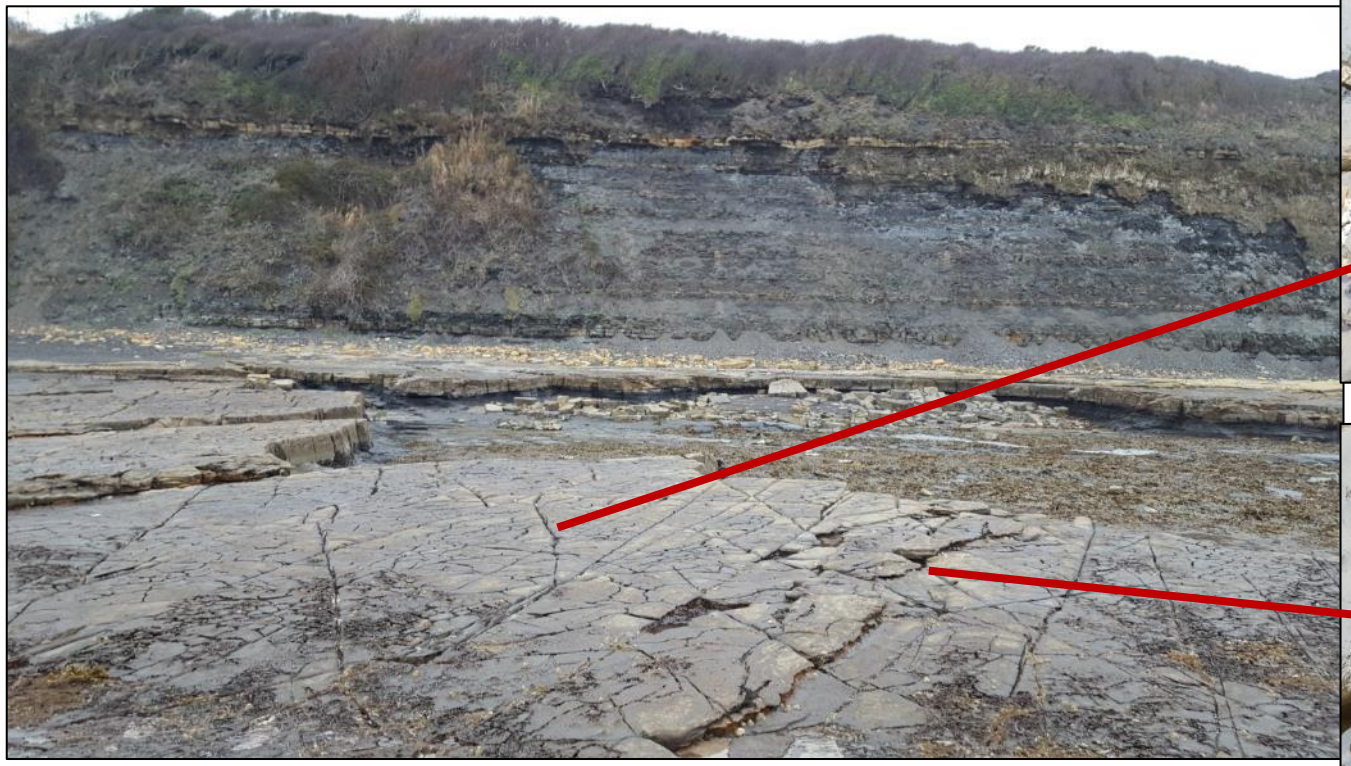
Ventnor, Isle of Wight

- Sea Level Rise and Coastal Squeeze

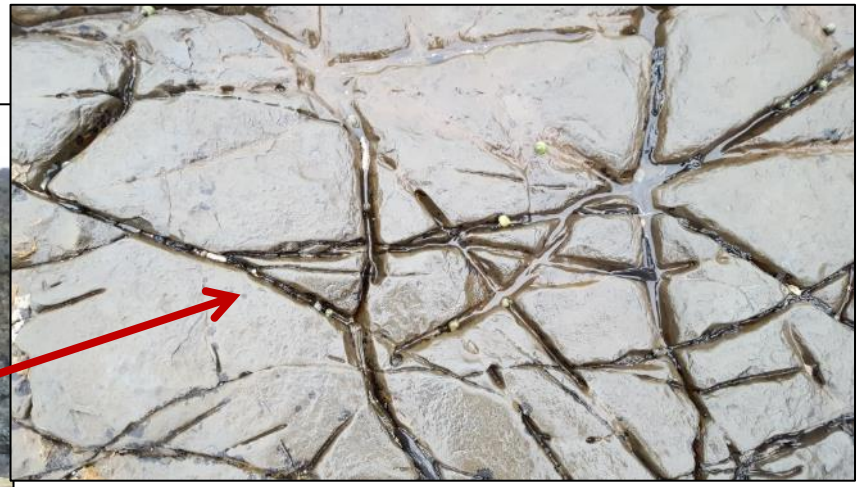


- Smooth structures
- Sheer surfaces
- Few cracks and crevices at appropriate scales for intertidal species

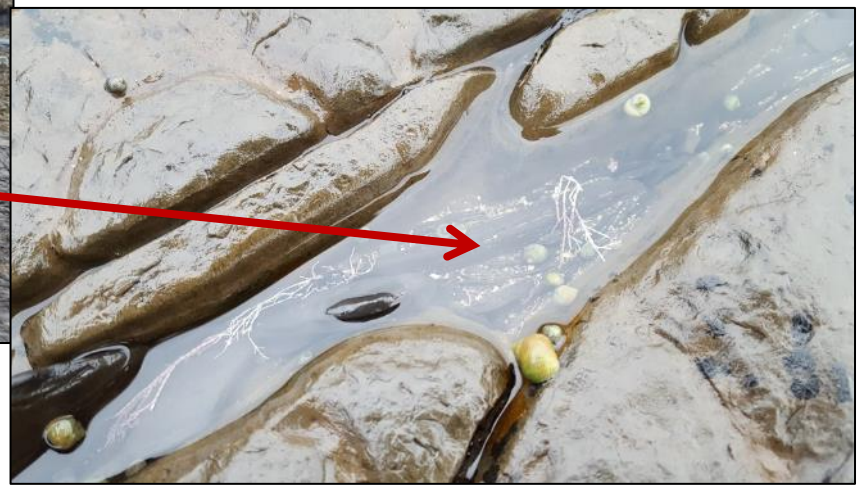
Rocky shores



Kimmeridge, Dorset. Purbeck Marine Wildlife Reserve



Refuges in cracks and crevices



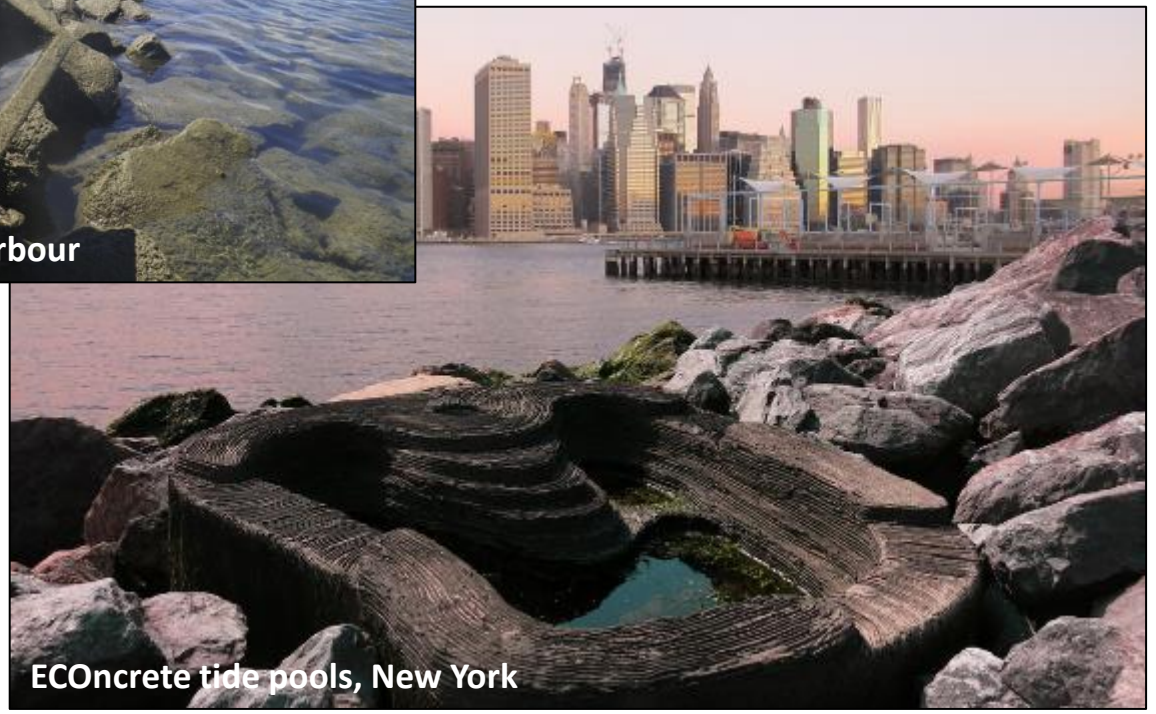
Rockpools

Rock pools

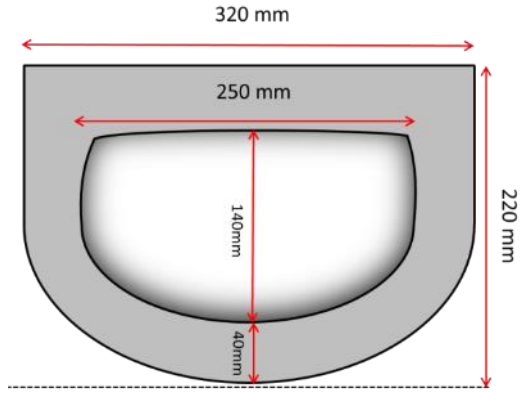
Freshwater Bay, Isle of Wight

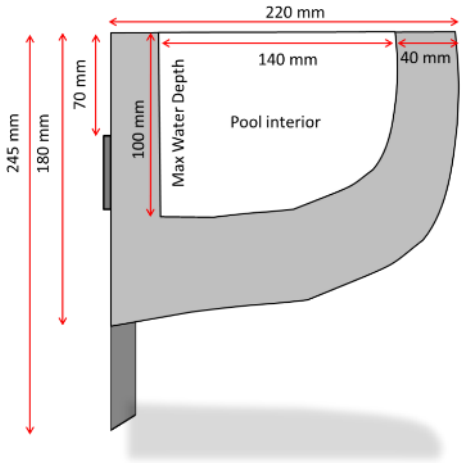
- Provide refugia from abiotic stress (e.g. high temperatures) and predators;
- Provide recruitment areas and nursery grounds for many important species including limpets (*Patella* spp.);
- Can extend upper vertical limits of organisms susceptible to desiccation.

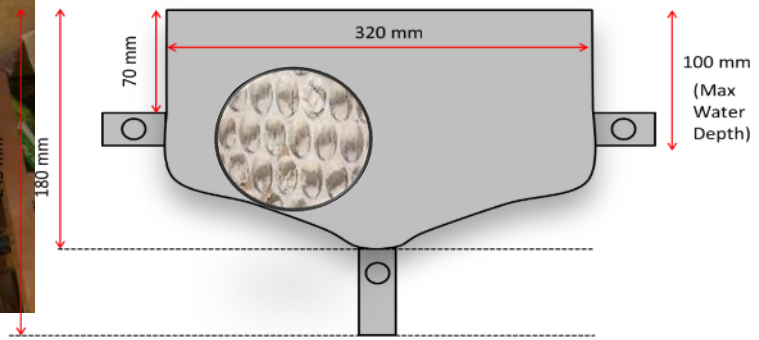
Examples of artificial rockpools



Marineff Rock pools







- Designed by BU
- Made by ARTECOLOGY on Isle of Wight
- VICAT Prompt Natural Cement
- Low Carbon

ARTECOLOGY
Ecological Engineering Specialists

Questions from Coastal Managers

1. How many rockpools are needed on a sea wall to significantly increase species diversity?

2. Where on a sea wall do we put the rockpools?

3. Will the creation of rockpools help mitigate loss in biodiversity due to sea level rise?

Marineff Experiment

Questions

1. Compared to the installation of single pools, does the creation of clusters of rockpools significantly increase species richness?
2. Does installation of clusters of rockpools modify species assemblages?
3. Do rockpools enable low wall/shore species to colonise higher tidal levels?

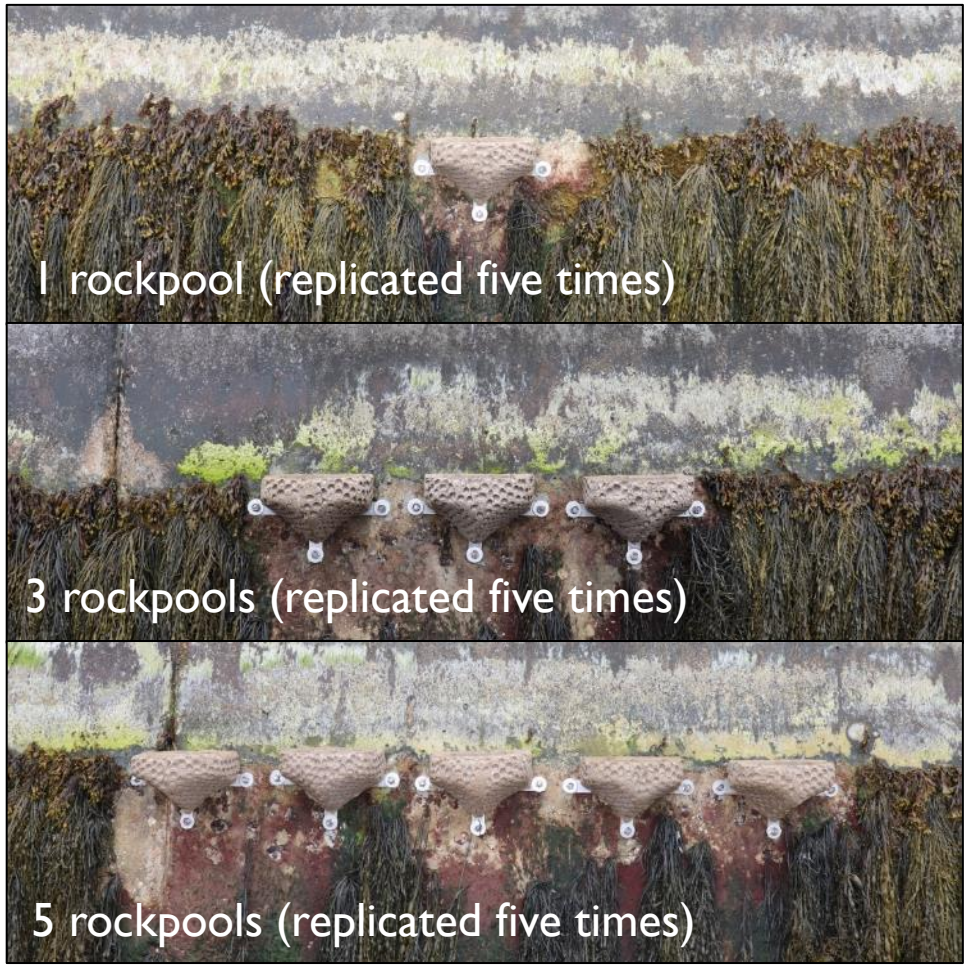
Scales investigated:

- Tidal zone (MHWN)
- Wall section (HWS-MTL)
- Wall type (Expt v Control)
- Location (n=2)

Experimental Design

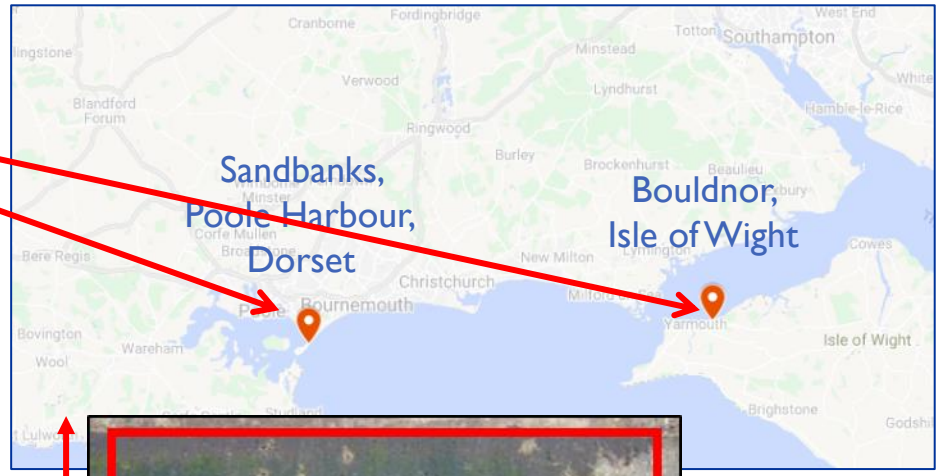
- Five treatments (all 2m length of sea wall)
- N=5 replicates of each treatment along 80m section of wall;
- Treatments (created July 2020)
  - All Rockpools installed at High Water Neap Level
  - **Single Rockpool**
  - **Cluster of 3 Rockpools**
  - **Cluster of 5 Rockpools**

  - **True control** – undisturbed section of sea wall
  - **Procedural control** – disturbed section to compare recolonisation with colonisation of artificial rockpools
- 2m gaps between each treatment to maintain independence



Spatial Scales

Two Locations



Wall Section

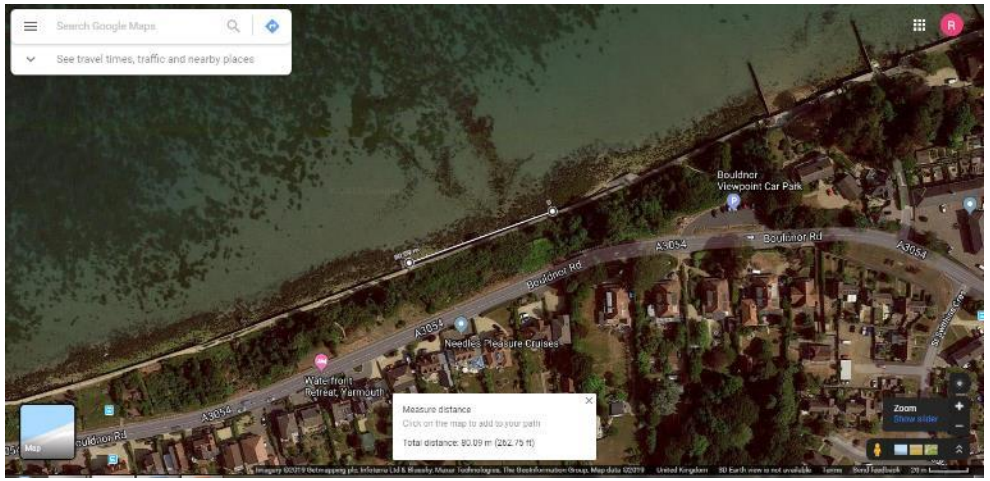
(2m length treatment and control sections on Experimental Wall between Mean Tide Level and Mean High Water)

Tidal Zone

(2m length treatment and control sections on Experimental Wall at the tidal level of the artificial rockpools (MHWN)

Wall Type - Bouldnor

Experimental

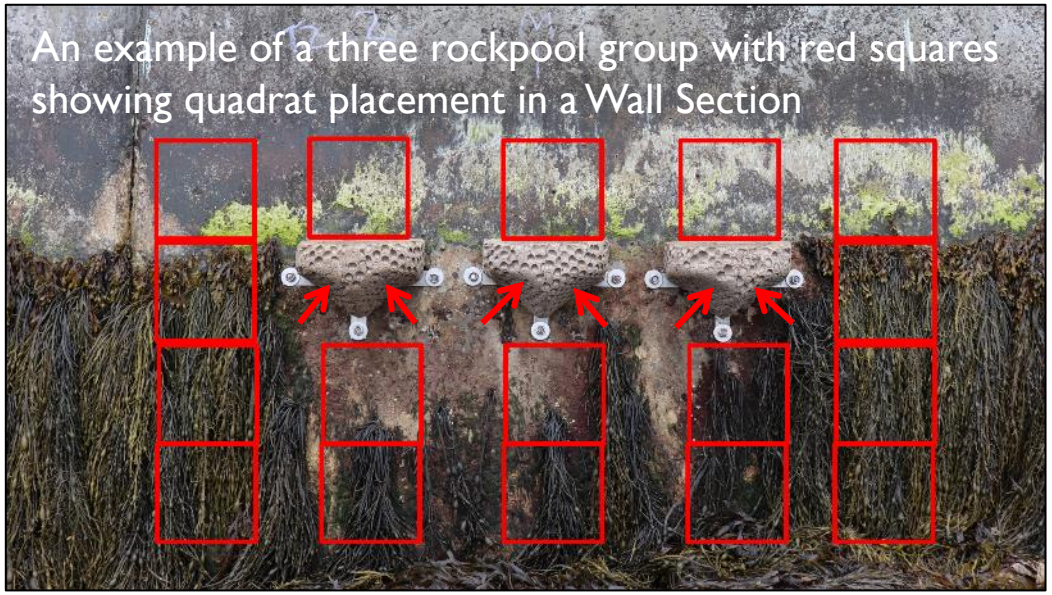


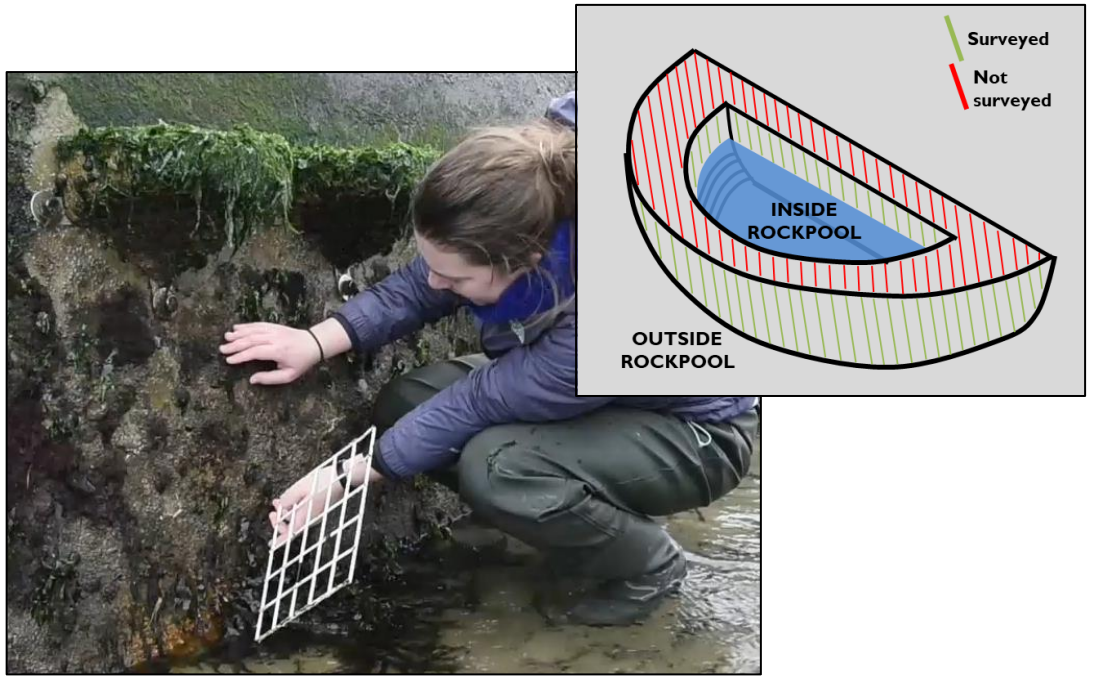
Control

Method

- Quadrats (25x25cm) to record percentage cover and counts of individuals on surrounding seawall
- Quadrat area is equivalent to surface area of rockpool interior and one half of exterior

- Percentage cover and counts of individuals recorded *inside the rockpool* and *on the outside* (below the rim)
- A small net is used to catch mobile fauna

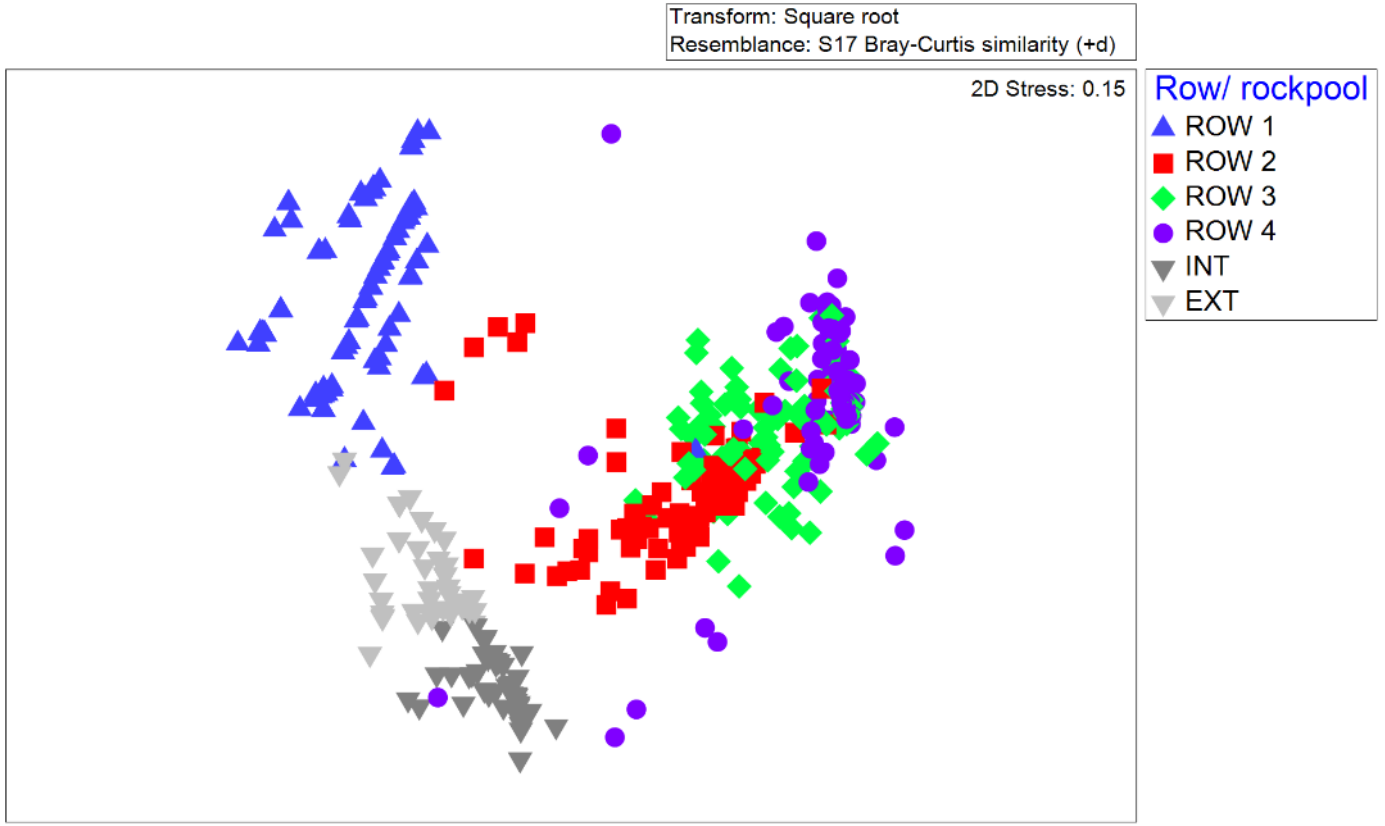




Results – Bouldnor, Isle of Wight (18 Months)

- Total no. of taxa identified in all rockpool interior: **20** (6 more than at 12 months)
  - Includes 9 species not found on the seawall so far (all seaweeds)
- Total no. of taxa identified on all rockpool exterior: **8** (4 more than at 12 months)
- Non-native species identified on/in rockpools **to date**
  - barnacle *Austrominius modestus* (already present on the seawall)

Results – Bouldnor, Isle of Wight (24 Months)



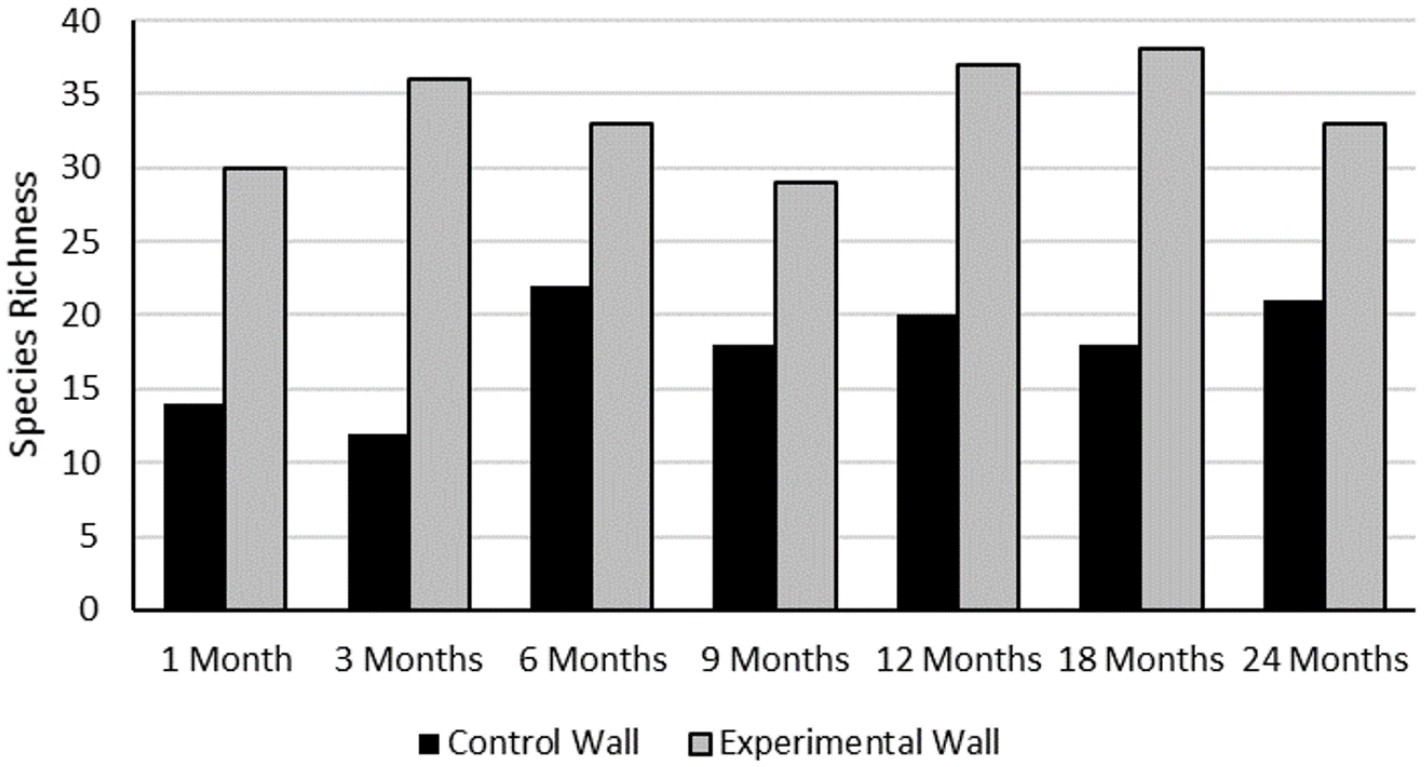
Wall Section

PERMANOVAs pairwise tests were conducted on species abundance data for assemblage comparison (number of unrestricted permutations 9999) – **all pairwise combinations were significant ($p<0.05$)**

Results

Bouldnor, Isle of Wight (UK)

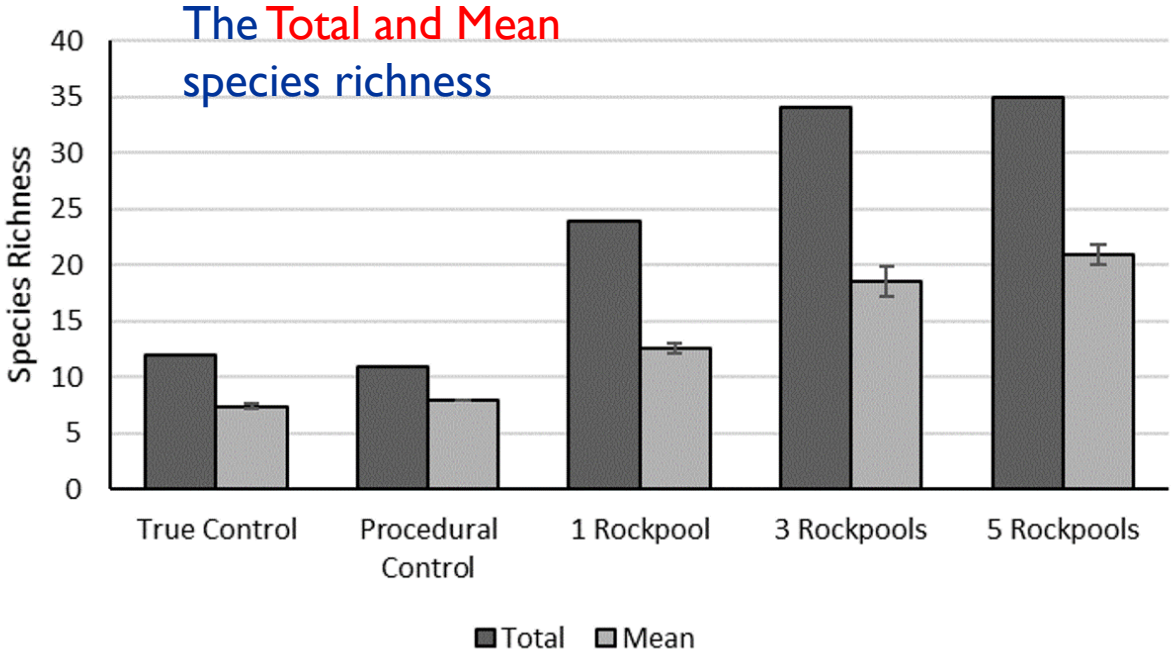
Scale: Wall Type



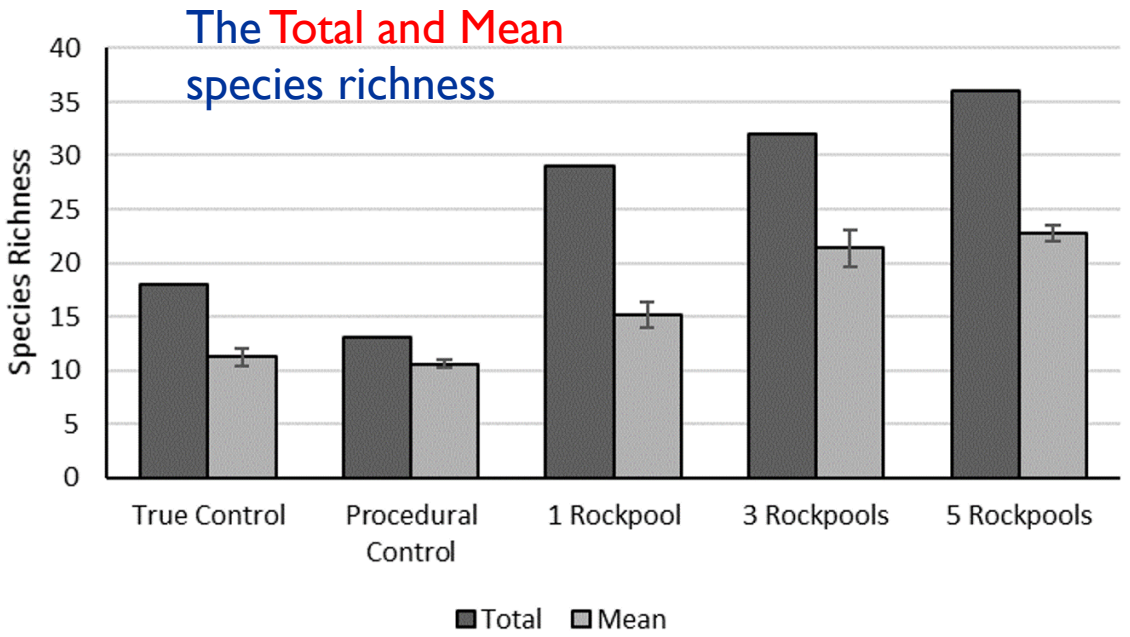
The total species richness of the control wall and the experimental wall over 24 months.

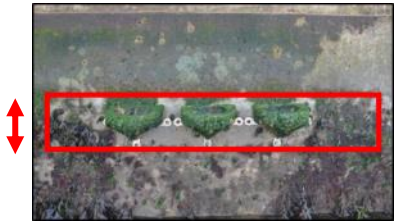
Results – 24 Months (July 2020-July 2022)
Sandbanks, Poole Harbour (UK)

Scale: Tidal Zone (HWN)



Scale: Wall Section (HWS-MTL)





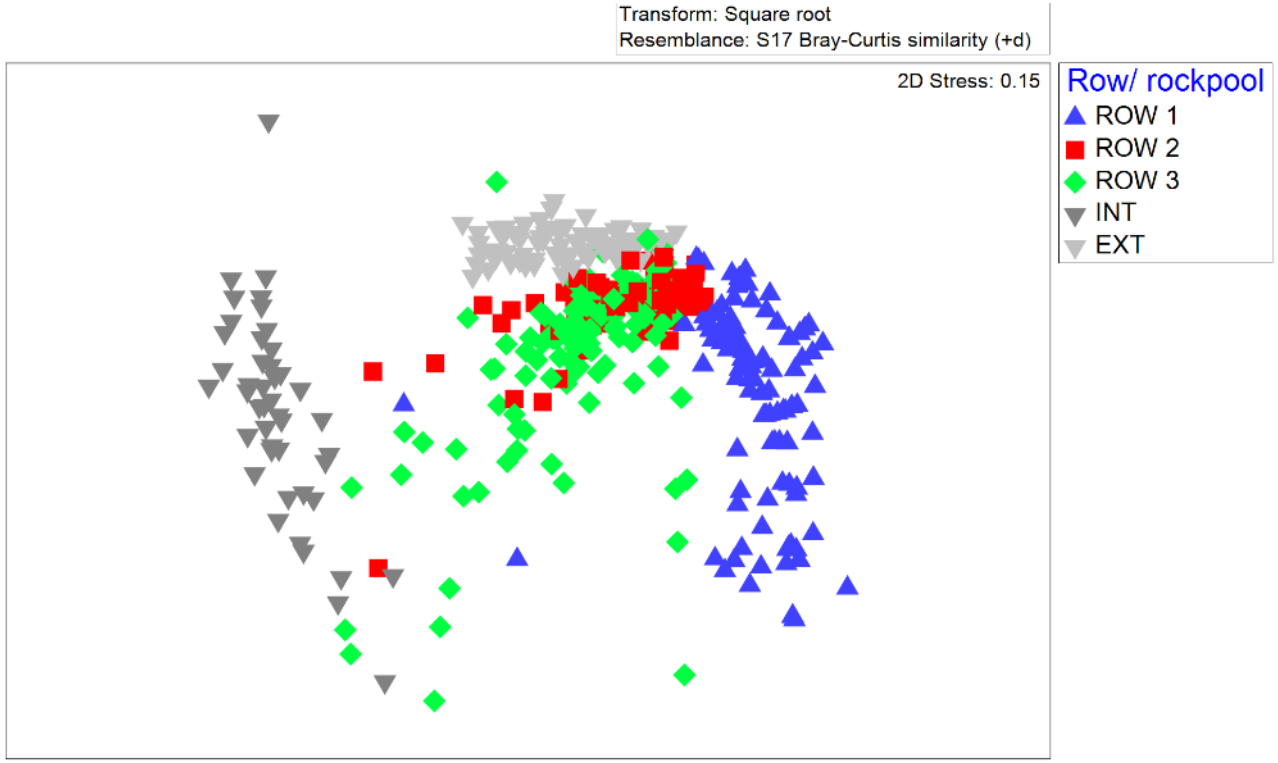
Results – Poole Harbour, Dorset (18 Months)

- Total no. of taxa identified in all rockpool interior: **30** (10 more than at 12 months)
  - Includes 12 species not found on the seawall so far, all seaweeds
- Total no. of taxa identified on all rockpool exterior: **13** (1 more than at 12 months)
- Non-native species identified in/ on rockpool **to date**
  - Barnacle *Austrominius modestus*
  - Slipper limpet *Crepidula fornicata*
  - Red ripple bryozoan *Watersipora subatra*
  - Bryozoan *Bugula neritina*
  - Brown seaweed *Sargassum muticum*
  - Sea squirt *Corella eumyota*

Results – Poole Harbour, Dorset (24 Months)

Using PRIMER-e (Plymouth Routines in Multivariate Ecological Research) canonical analysis of principal components (CAP) was used to visualise variation between sites

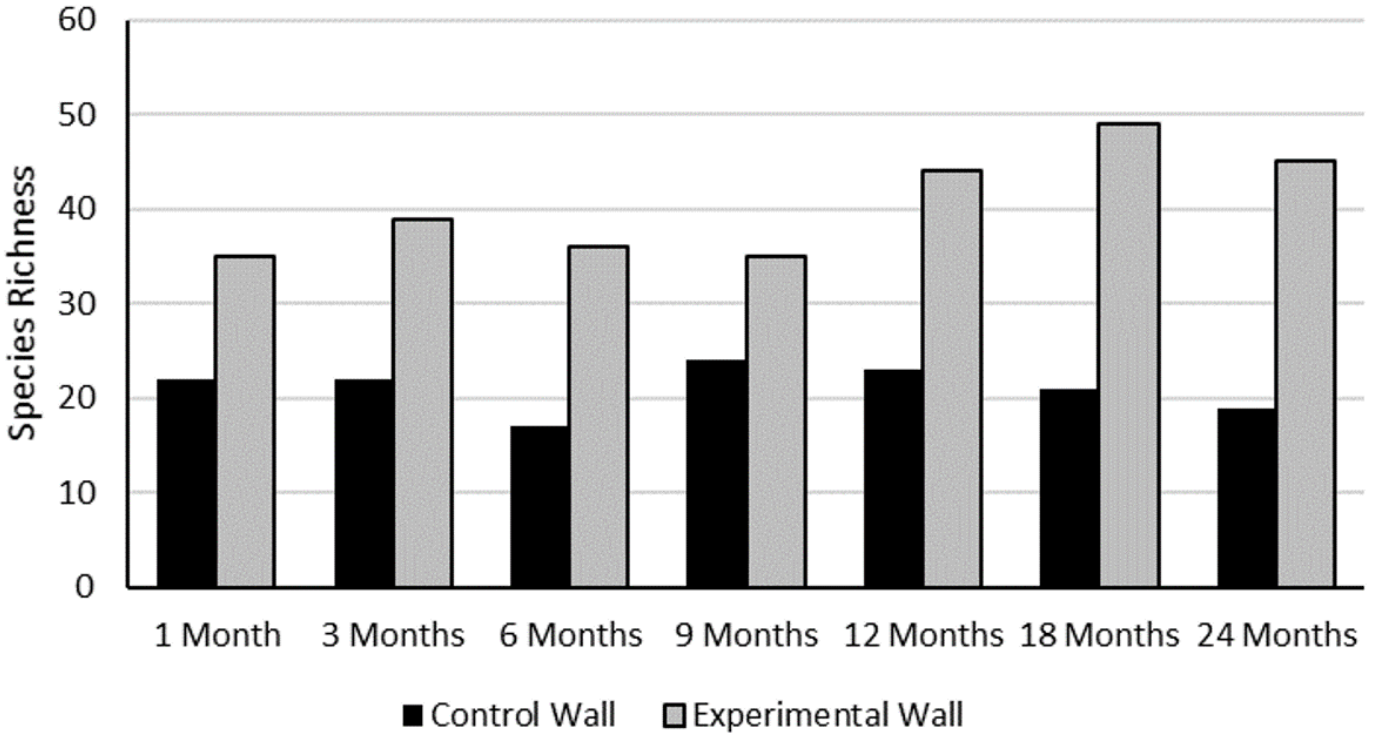
Wall Section



PERMANOVAs pairwise tests were conducted on species abundance data for assemblage comparison (number of unrestricted permutations 9999) – **all pairwise combinations were significant ($p<0.05$) Except 3 rockpools vs. 5 rockpools (NS).**

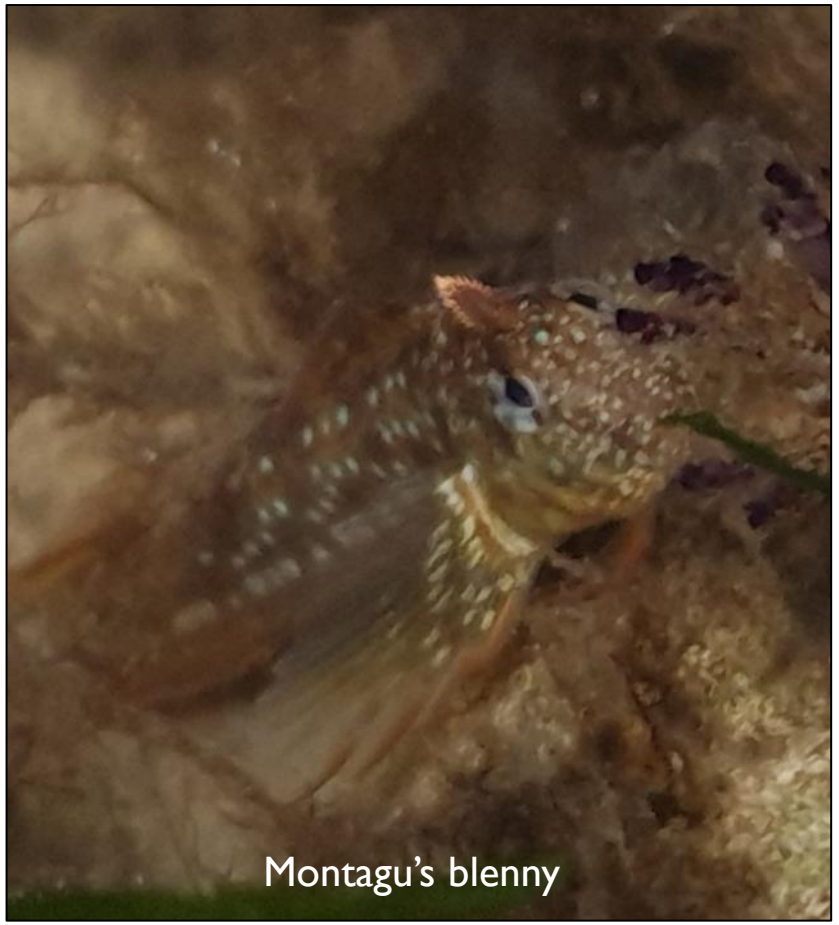
Results Sandbanks, Poole Harbour, Dorset (UK)

Scale: Wall Type



The Total species richness of the control wall and the experimental wall over 24 months.

Results – Findings of interest across time series data


Montagu's blenny

- Lower shore/wall species **are elevated** to higher tidal level e.g. mussels, sponges, *Lithothamnion* sp.
- The rockpool specialist Montagu's blenny (*Coryphoblennius galerita*) was recorded in a rockpool in Poole Harbour (new record)
- Protected species found in the rockpools (native oyster *Ostrea edulis*)

Research Questions

Does the addition of artificial rockpools to a seawall significantly increase benthic species richness at different spatial scales?

✓ Yes -Tidal Zone, Wall Section, Wall Type, Location

Does the addition of artificial rockpools to a seawall significantly modify benthic assemblages at different spatial scales?

✓ Yes - Tidal Zone, Wall Section, Wall Type, Location

(Expt .Wall at Bouldnor still recovering from disturbances)

Enhances natural ‘aesthetic’, improving connection between people and nature

Provides opportunities for recreational activity (‘rockpooling’)

Bournemouth University

Ecostructure Project

Jorge Vaz and Colm Watling

Jorge.vaz@arup.com colmwatling@live.co.uk

Ecological Enhancement for Marine Infrastructure - Workshop

Ecostructure Output Guide

Jorge Vaz

11-12th October 2022

ARUP

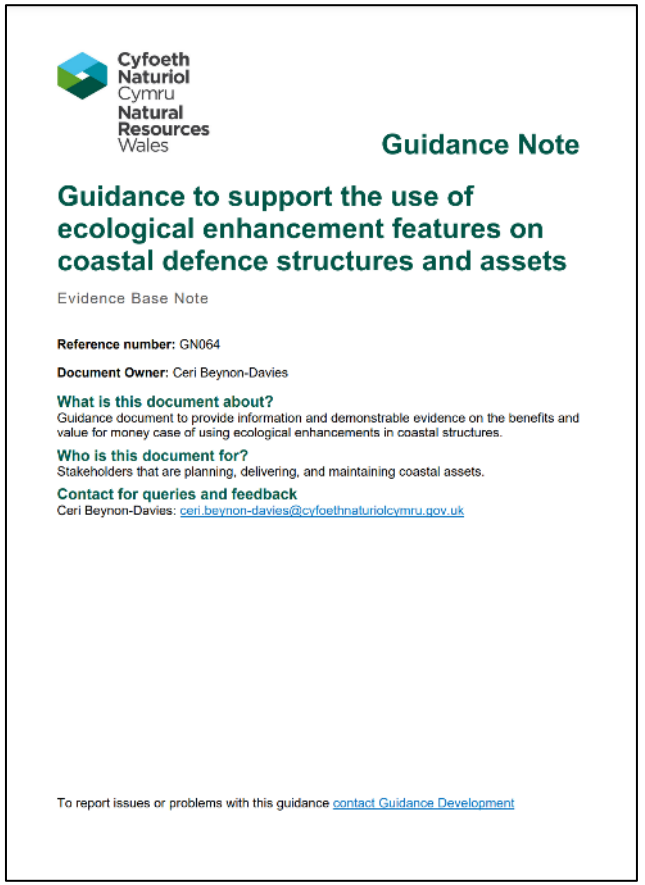
Contact

Jorge Vaz

✉ jorge.vaz@arup.com

Senior Maritime Engineer

- 11 years Professional Experience
- Design of Coastal Structures, Waterfront Developments, Flood and Coastal Erosion Risk Management Projects
- Numerical modelling for coastal and offshore projects
- Arup is delivering ‘Stronger Shores’ project to study seagrass meadows, kelp beds and native oyster reefs and learn lessons about the benefits to society and ecosystems
- Arup is working with ‘Living Seawalls’, a finalist of the 2021 ‘Revive our oceans’ Earthshot Prize as part of our role as Global Alliance Member
- Project Manager for Guidance Note on Ecological Enhancement of Coastal Structures for Natural Resources Wales + Training Toolkit (published July 2022)
- Project Manager for Ecostructure Output Guide



Cyfoeth Naturiol Cymru Natural Resources Wales

Guidance Note

Guidance to support the use of ecological enhancement features on coastal defence structures and assets

Evidence Base Note

Reference number: GN064

Document Owner: Ceri Beynon-Davies

What is this document about?
Guidance document to provide information and demonstrable evidence on the benefits and value for money case of using ecological enhancements in coastal structures.

Who is this document for?
Stakeholders that are planning, delivering, and maintaining coastal assets.

Contact for queries and feedback
Ceri Beynon-Davies: ceri.beynon-davies@cyfoethnaturiolcymru.gov.uk

To report issues or problems with this guidance contact Guidance Development

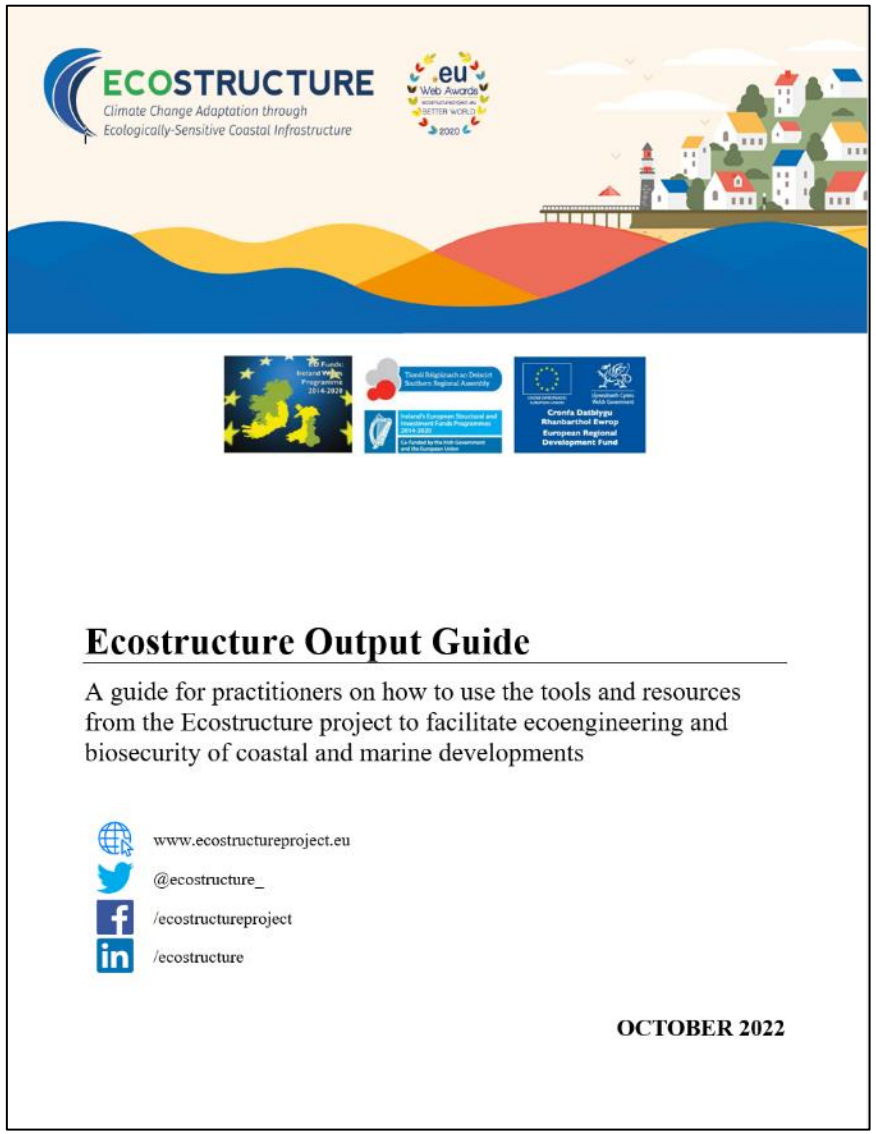
ARUP

Ecostructure Output Guide

Objectives

- Contribute to the legacy of Ecostructure
- Produce a guide for practitioners to:
    - Raise awareness
    - Show how outputs (online tools, papers, etc) can be used to facilitate the incorporation of eco-engineered features into new and existing coastal structures
- Methodology (12-week programme)
    - Baseline review of 13no. Outputs
    - Interviews with researchers
    - Writing the Guide (work-in-progress)

Ecostructure Output Guide



Ecostructure Output	Output summary and objective	Who is it for?				Stage of project			
		Regulators	Designers	Planners	Asset Managers	Planning	Design	Construction	Monitoring
1. Mapping repository of the Irish and Welsh shores	Mapping data set for existing artificial structures along the Irish Sea coastline	✓	✓	✓	✓	✓			✓
2. BioPredict Tool	Online tool to map data collected in the Irish Sea and model relationships between physical and environmental parameters and a range of biodiversity metrics to predict biodiversity in different structures	✓	✓	✓	✓	✓	✓		
3. Ecosystem Functions and Prediction Tool	Downloadable tool for predicting ecosystem functions, rates and processes for coastal intertidal communities around the UK and Ireland		✓	✓	✓	✓	✓		
4. Conservation Evidence Synopsys - Biodiversity of Marine Artificial Structures	Synopsys covering published evidence of conservation interventions to support decision making for enhancing biodiversity of marine structures	✓	✓	✓		✓			✓
5. New approaches to eco-engineering: photogrammetry and 3D printing	Papers "Artificial shorelines lack natural structuralcomplexity across scales" and "Replicating natural topography on marine artificial structures – A novel approach to eco-engineering" which demonstrate the use of photogrammetry and 3D printing to investigate surface complexity at different scales as well as replicating natural surfaces		✓				✓	✓	
6. Guidance for integration of stakeholder interests into eco-engineering project	Guidance document including steps for successful stakeholder engagement, methods and procedures commonly used such as workshops, site visits, community engagement and media & press.		✓			✓	✓		
7. Report on impacts of eco-engineering upon cultural and amenity value of artificial structures	Paper "Species diversity enhances perceptions of urban coastlines at multiple scales" to explore the cultural and amenity perception of artificial structures in the intertidal environment.		✓	✓	✓	✓	✓		
8. Designs for artificial habitat units for european lobster	Research focused on laboratory and in-situ trials of different habitat types for European lobster to support the design of habitat enhancement, both for conservation and commercial activities		✓		✓		✓		✓
9. Policy briefs on coastal eco-engineering, based on a review of relevant policies, legal requirements and management practices	Policy Briefs to help users navigate the planning and licencing process and a Report which details the legal systems in Ireland and Wales, describing national and local authority policies and legal requirements	✓		✓		✓			
10. Larval Dispersal Tool	Online tool to analyse and visualise larval dispersal within the Irish Sea based on user selection of release location, season of release, length of larval lifetime and larval behaviour		✓	✓	✓	✓			✓
11. Models of the effects of existing and proposed offshore renewable energy structures on dispersal of non-native species	Research focused on impacts to connectivity of marine species and populations from present and future offshore renewable energy structures and climate change in the Irish Sea	✓		✓		✓			✓
12. Stakeholder engagement to improve biosecurity in ports and marinas	Paper "Determining the most effective educational interventions to encourage biosecurity and pro-environmental behaviour amongst recreational boaters?"; Online app to raise awareness about biosecurity which can also be replicated and adapted for individual marinas	✓			✓	✓			
13. Methodologies for the early detection of non-native species from environmental DNA in water samples	Paper "The use of environmental DNA metabarcoding and quantitative PCR for molecular detection of marine invasive non-native species associated with artificial structures" which demonstrates the use of two techniques for species detection and in particular INNS	✓			✓	✓			✓

For each output
- Introduction and drivers
- Main findings
- Opportunities and Limitations
- Contact details and resources

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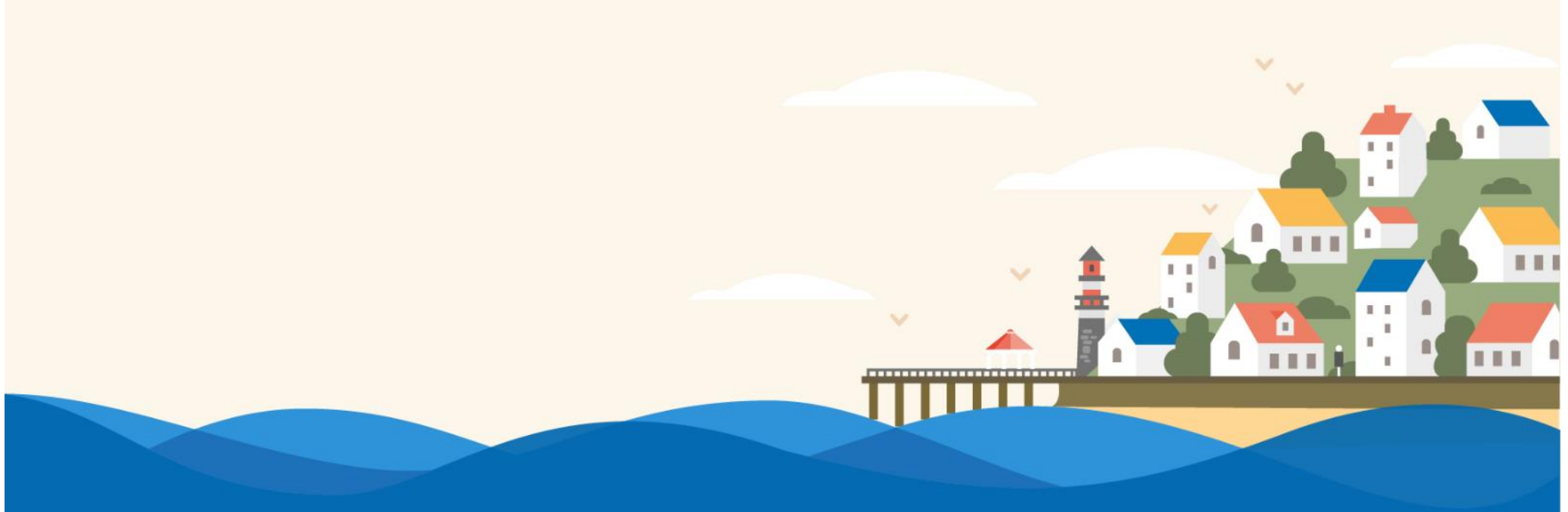


Ecostructures
Eco Engineering Demand

Ecostructures

Intro

What we did

What we found

What that means

What's next?

ECOSTRUCTURE

Climate Change Adaptation through Ecologically-Sensitive Coastal Infrastructure

eu Web Awards
ecostructureproject.eu
BETTER WORLD
2020

Research and tools for ecologically-sensitive coastal and marine infrastructure

Results and resources developed by Ecostructure, a European research project that ran from 2017 to 2022.

Aberystwyth asked for

Report exploring demand for coastal and marine eco-engineering and identifying industrial partners for future research in these areas

Colm Watling & Liz Flint

- Elizabeth Flint
  - A career at the Interface of Academia, Business and Government
- Colm Watling
  - Experience in IP Commercialisation, innovation and engineering

What We Did


Understood the research
Reached out to:
• Academics
• Local Authorities and NRW
• Contractors and Manufacturers
Workshops
Individual Interviews

What We Found

Why are people interested?

- Differentiation in bids

Legislation affects different owners in different ways

- Planning
- Reporting

CSR

Biobanking

How to implement?

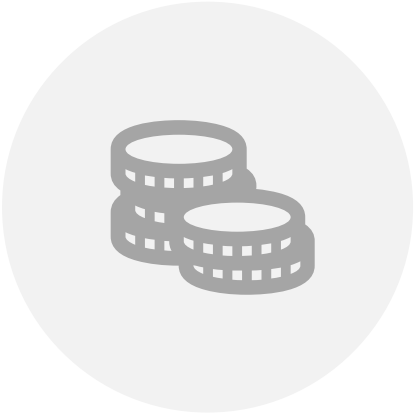
- Owners
- Manufacturers
- Contractors

What that means?

- Drivers largely in place
- Legislation developing
- Supply chain developing
- Awareness growing

What’s Next?

METRICS



ECONOMICS

A STRUCTURE TO WORK TOGETHER

Bournemouth University

3DPARE Project

Sam Greenhill, Bournemouth University

greenhills@bournemouth.ac.uk

3D Printed Artificial Reefs in the Atlantic Region (3DPARE) Results

Speaker: Sam Greenhill

greenhills@bournemouth.ac.uk

Dr Alice Hall, Prof. Rick Stafford, Prof. Roger Herbert

Research Questions

To explore differences in biodiversity and community assemblages by:

1. Habitat
   3DPARE artificial reef, Natural and Artificial Reference sites
2. Material type
   Cement Limestone and Cement Glass
3. Reef Design
   Cubic big overhangs, Cubic small overhang, Random big overhangs, Random small overhangs.
4. Feature Type
   Large holes, Large tunnels, Small holes, Small tunnels, Overhangs, Flat surfaces

Survey methods

When: July-October 2020, April-September 2021, April & October 2022

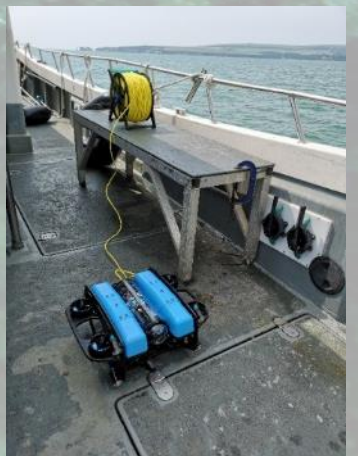
Where: 3DPARE Reef, Adjacent artificial structure, Adjacent Natural Reef

How:

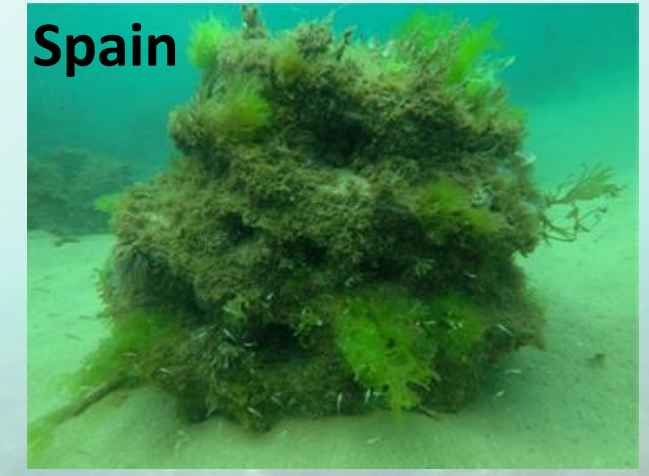
- SCUBA underwater visual census
- Remote Underwater Video (un-baited)
- Photogrammetry
- Remotely operated vehicle (ROV) (UK only)

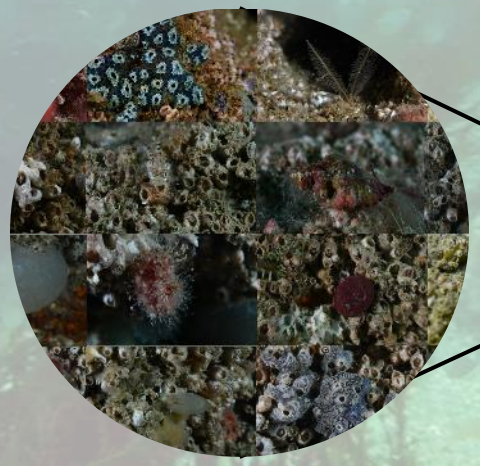


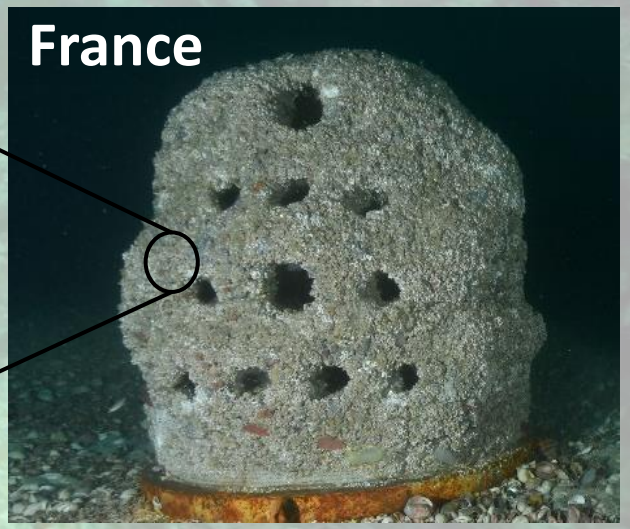




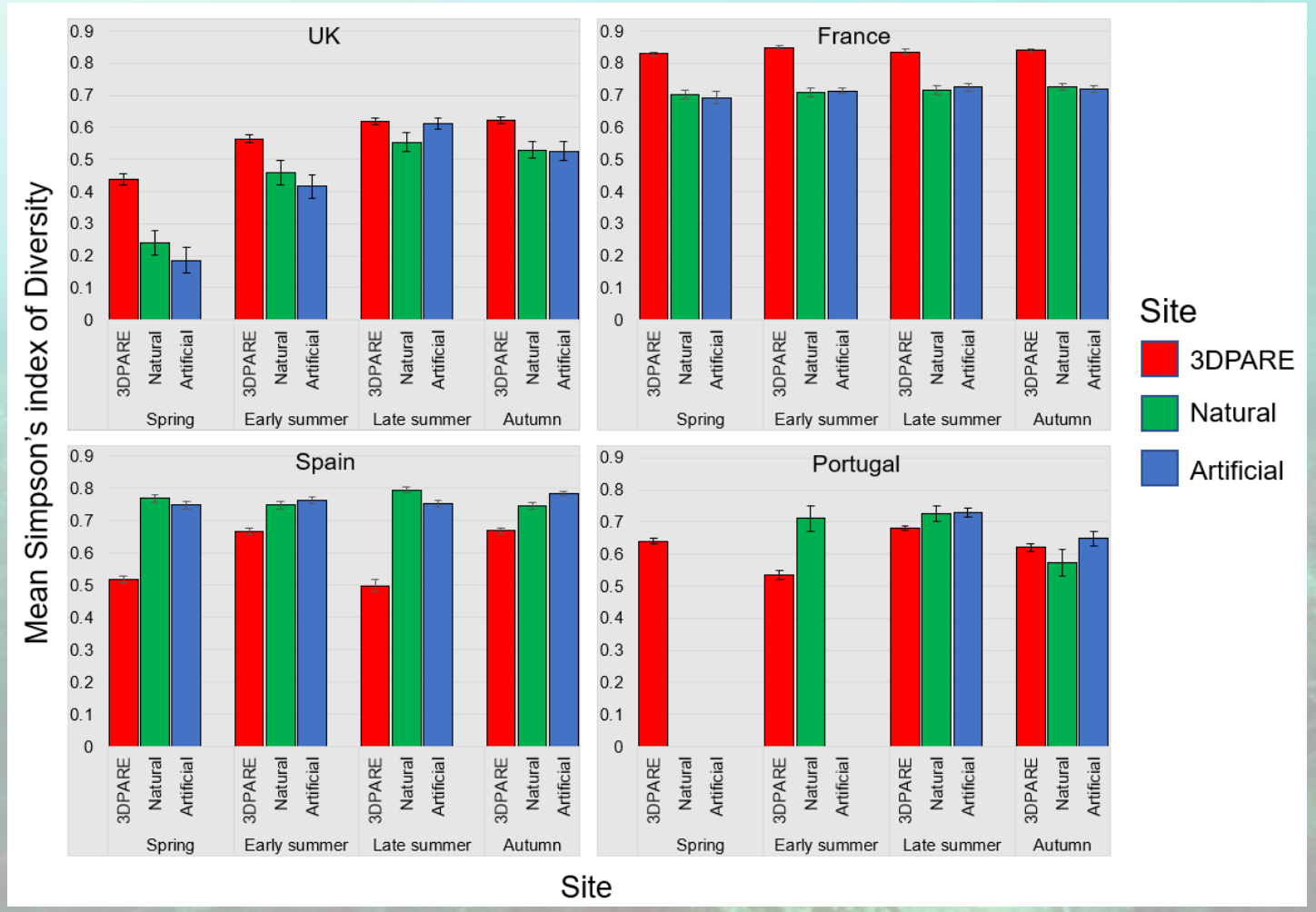
Reef units in each Location





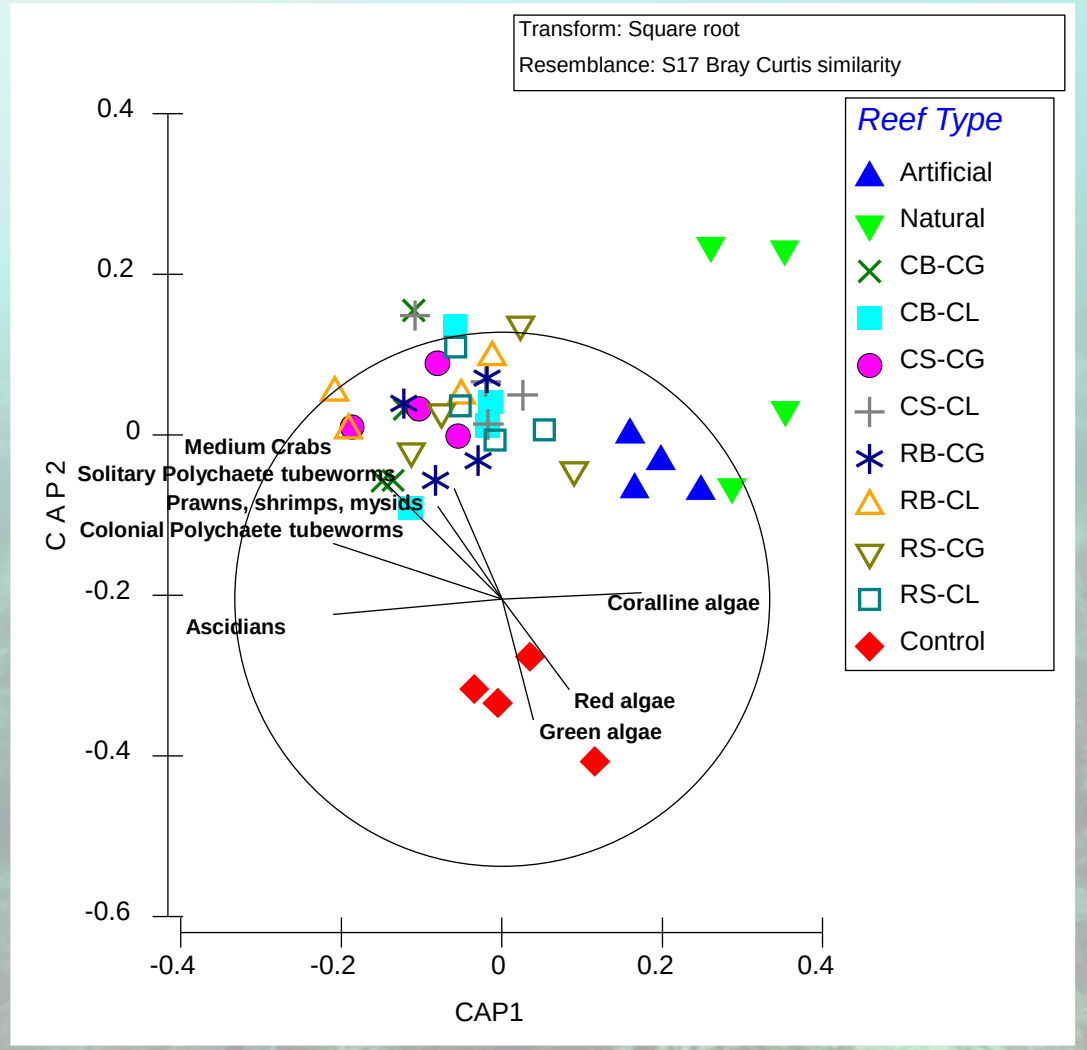


3DPARE reefs vs Reference Sites



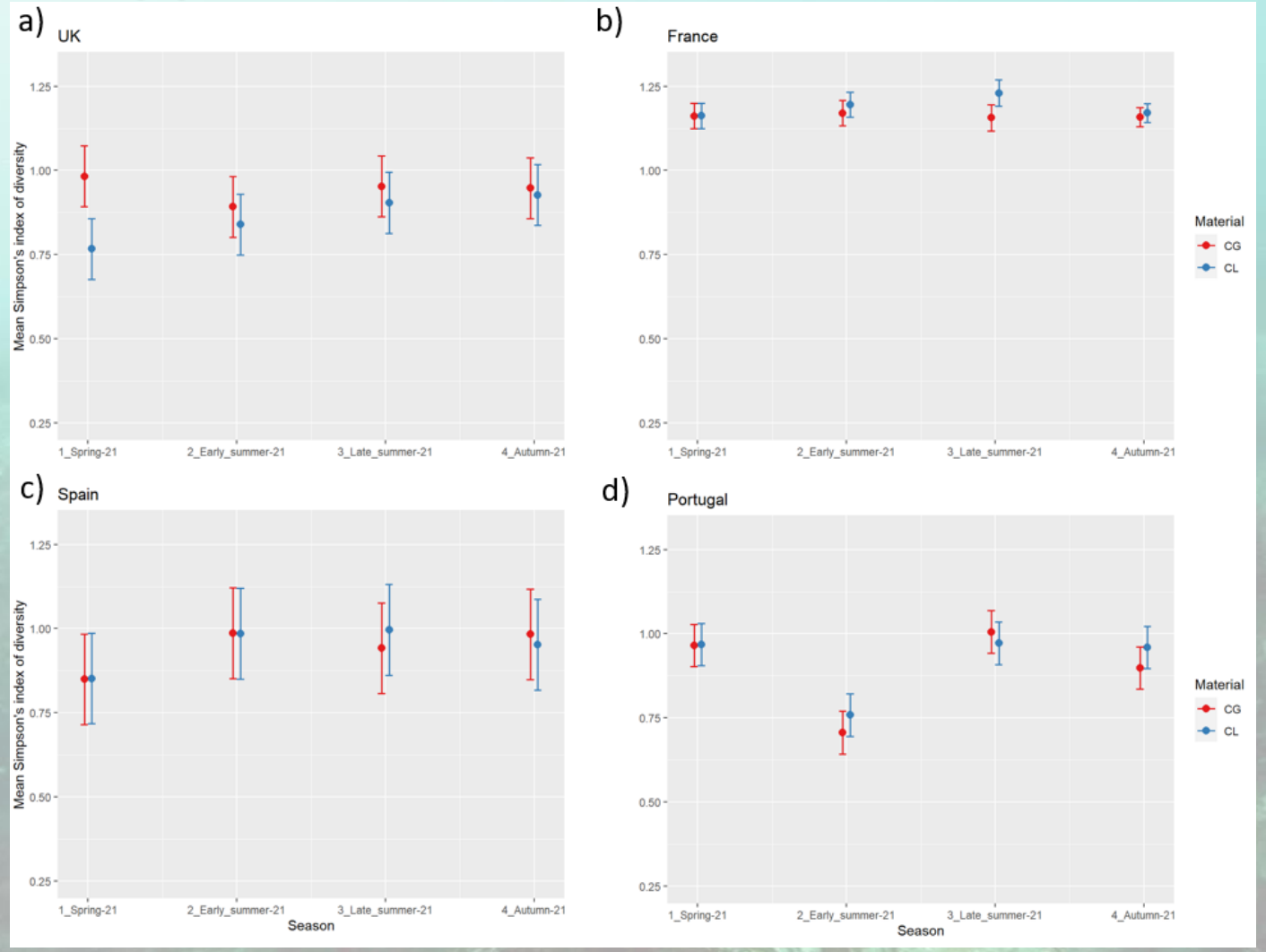
Mean Simpson's index (1-D) values for diversity of marine life at 3D-printed artificial reefs (3DPARE), natural rocky reefs (Natural) and artificial subtidal structures (Artificial) in each country over different seasons in 2021 (± SE)

UK 3DPARE reefs vs Reference Sites



CAP plot representing differences in community assemblage by Reef Type in the UK during 2021

Concrete type

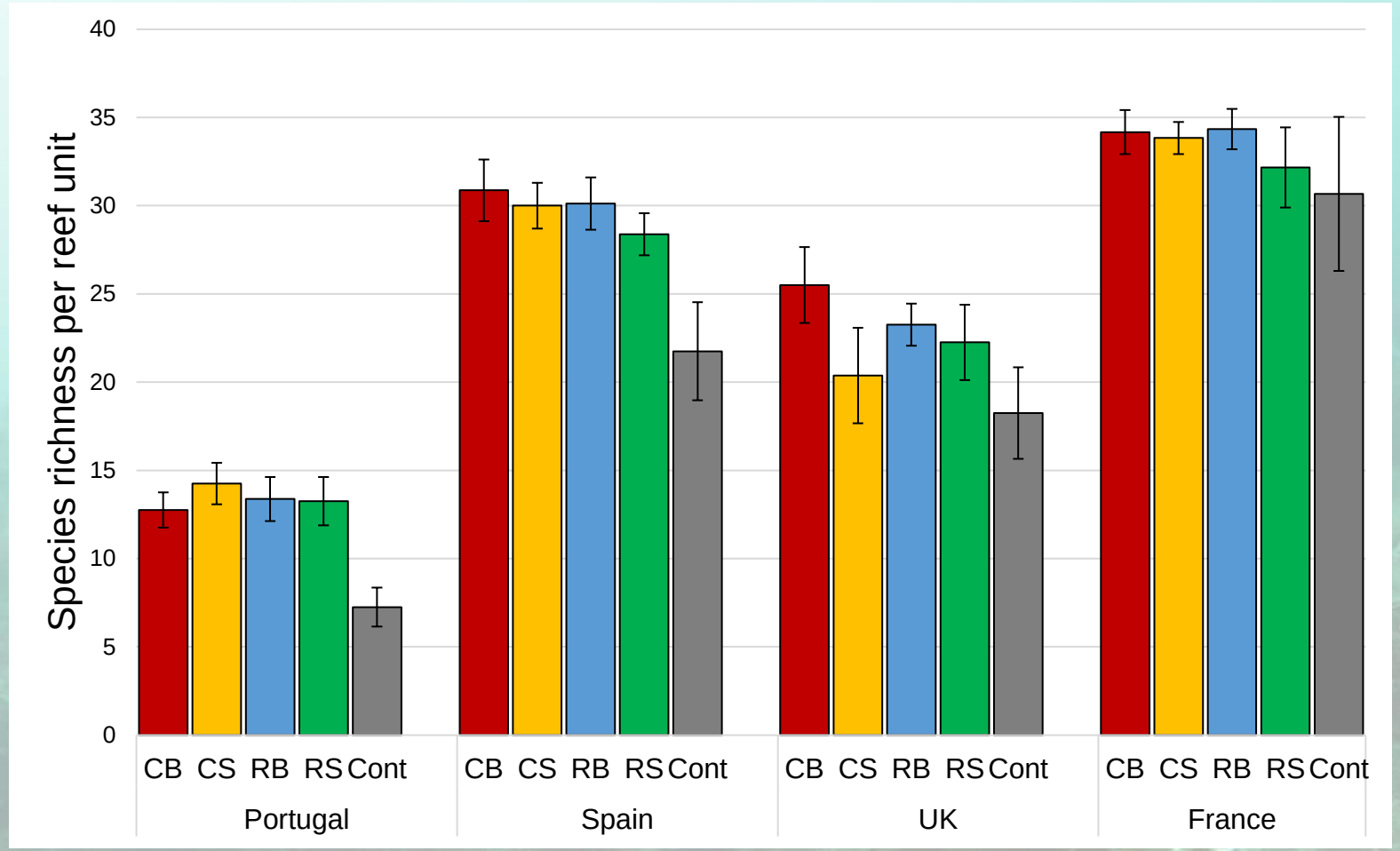


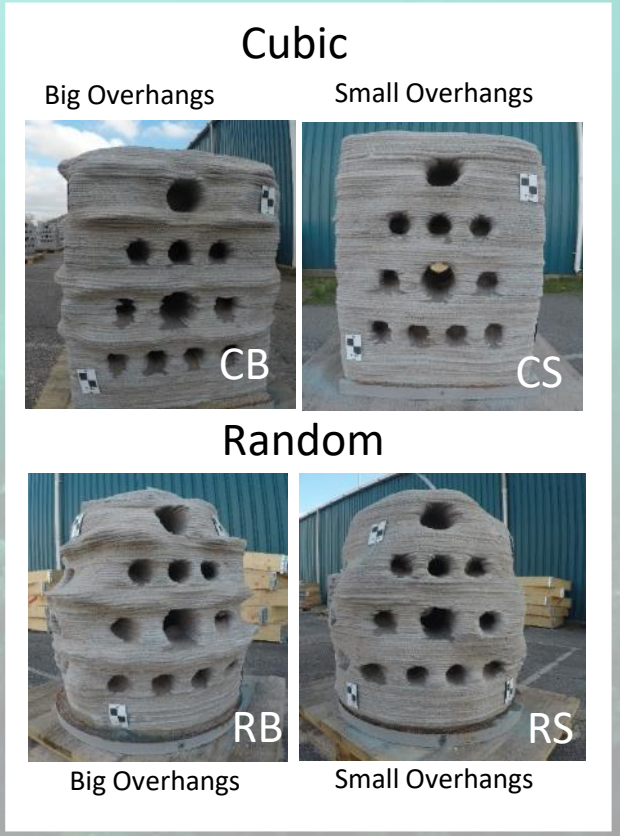
Key:

- CG: Cement Glass
- CL: Cement Limestone

Mean arcsine transformed Simpson's Index (1-D) values for diversity of marine life, comparing the material type used in the construction of reef modules (± 95% Confidence Intervals based on mixed-effects models)

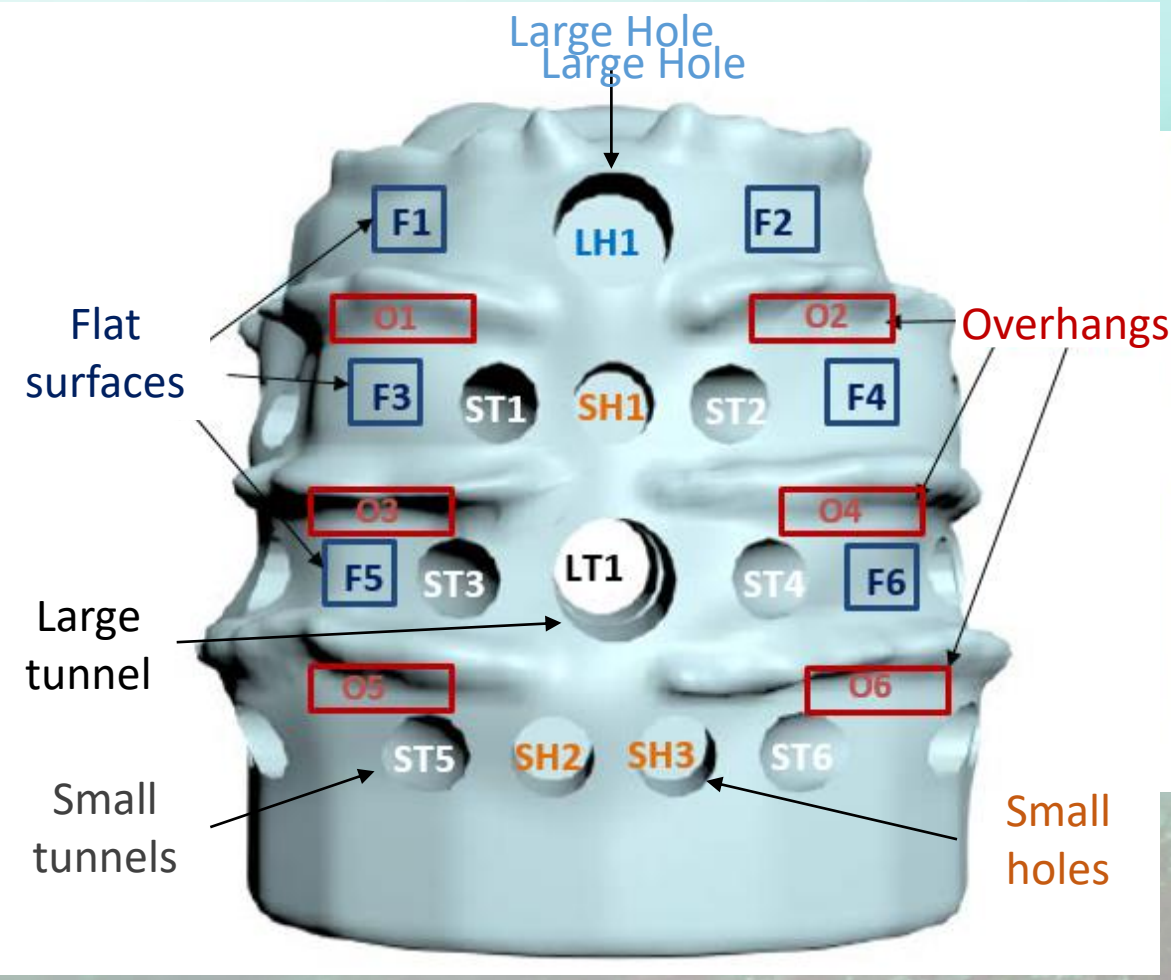
Reef Design

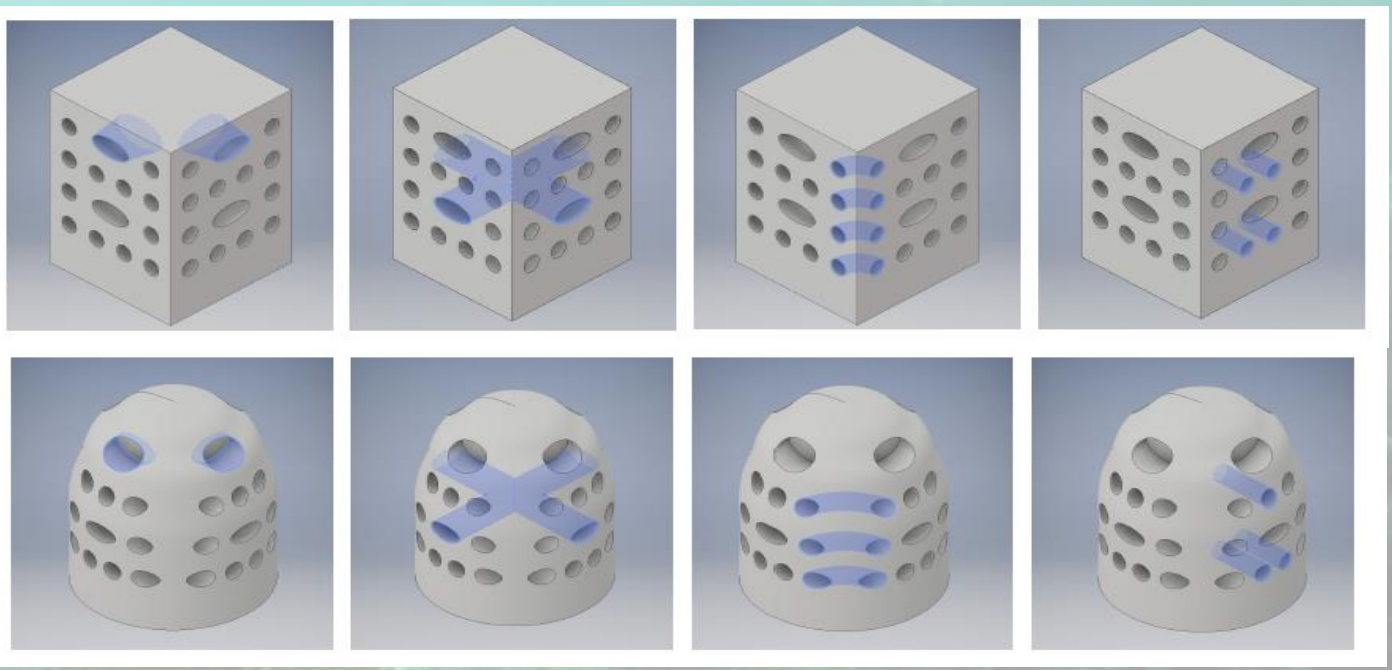




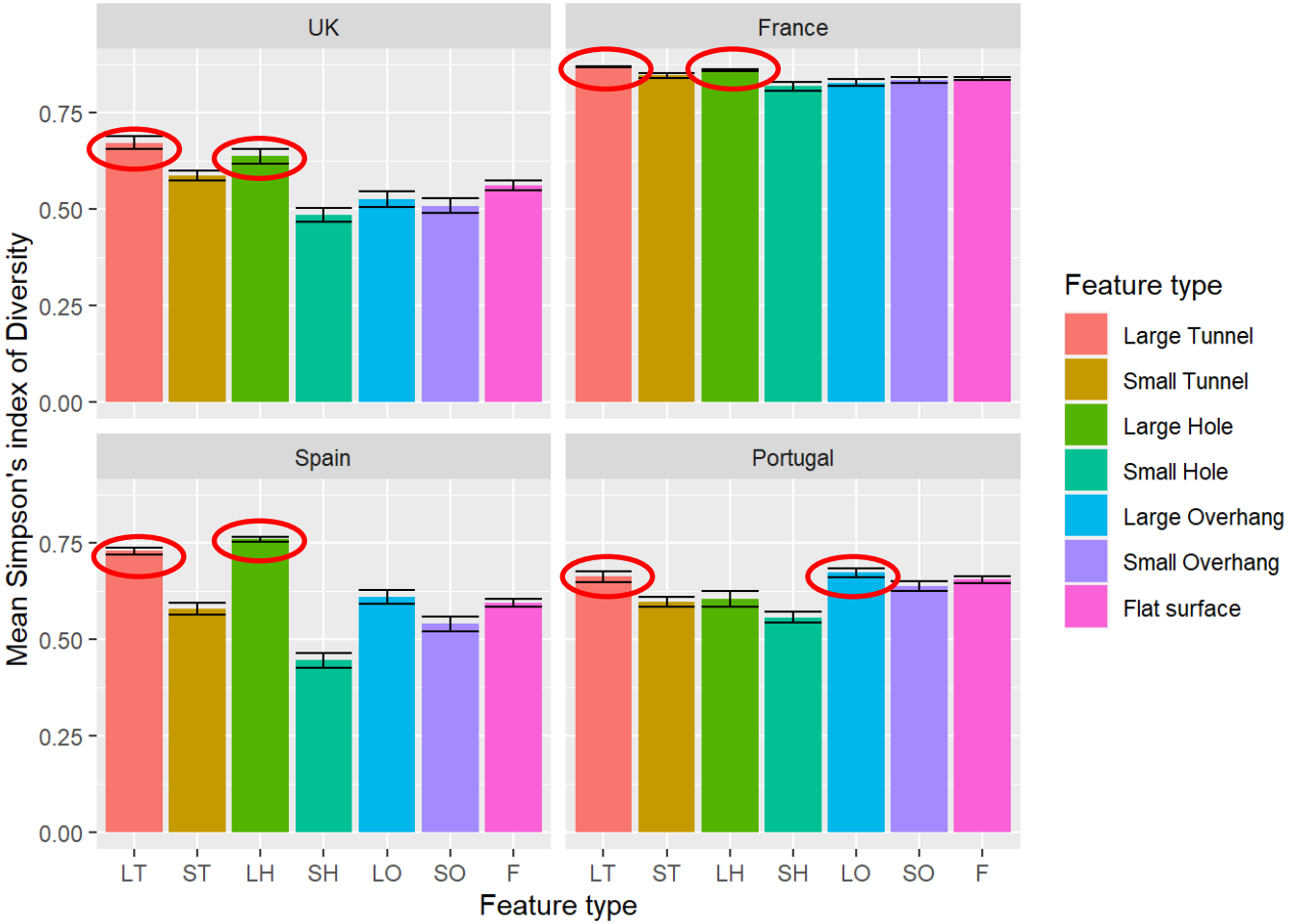
Mean number of species per reef unit, comparing the four designs and the control unit in each country during 2021 (± SE)

3DPARE Features

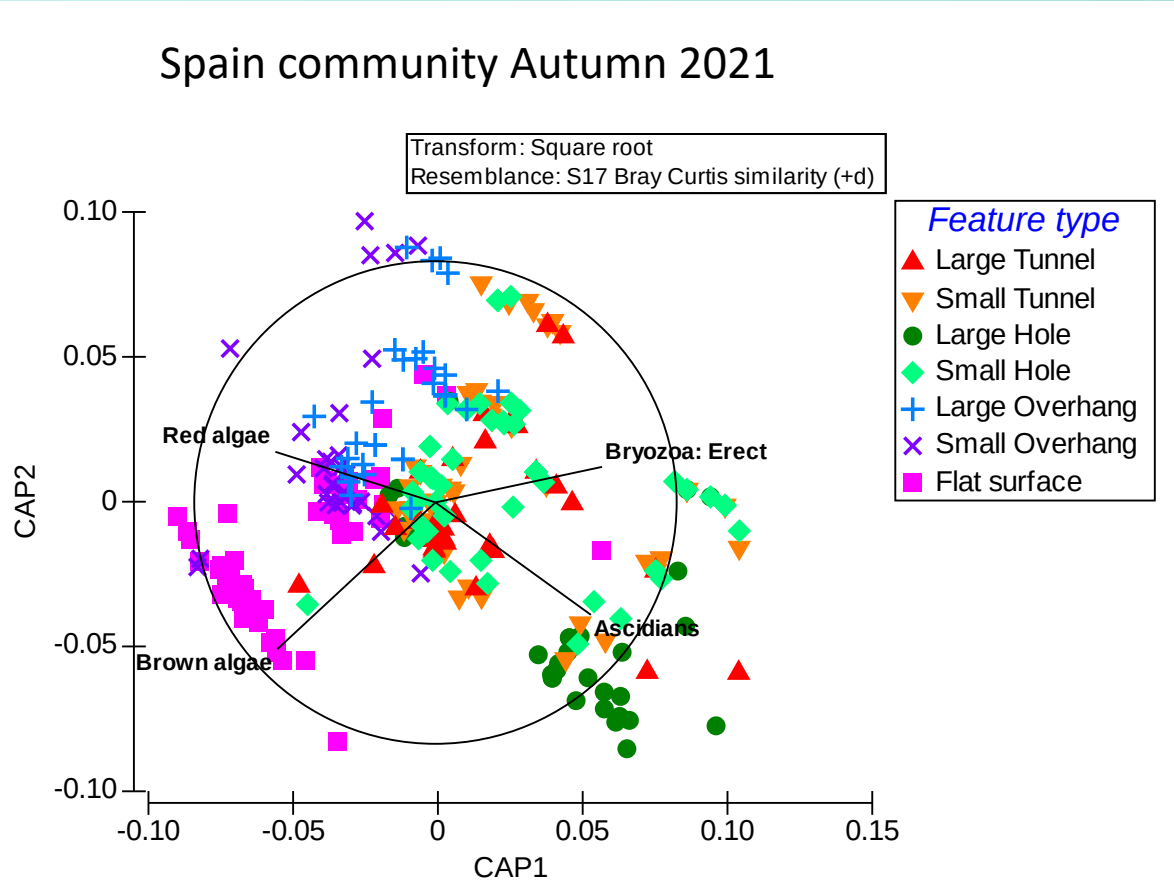




Feature type

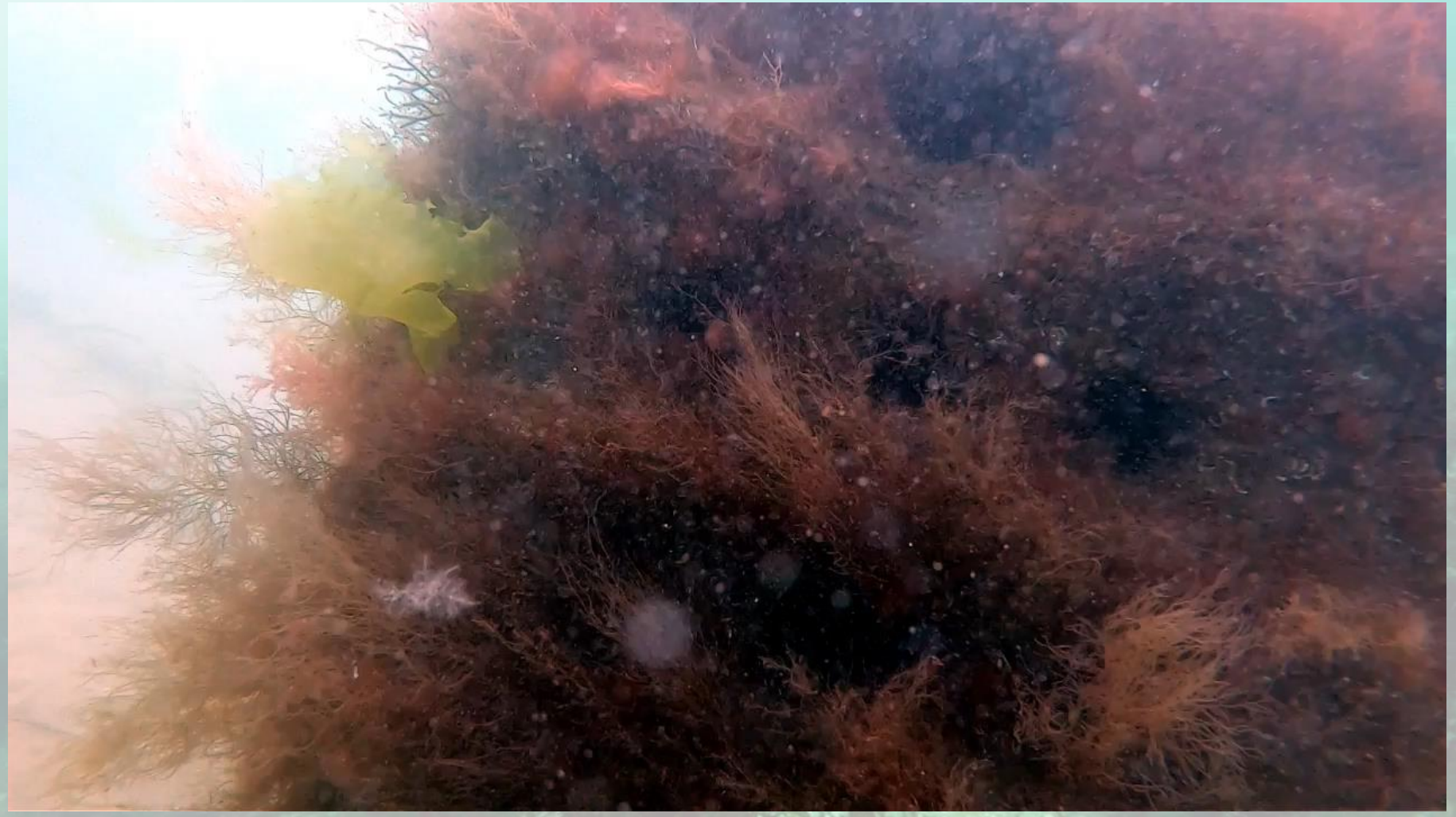


Variation in mean Simpson's index values (1-D) for diversity of marine life by Feature Type in each country during 2021 (± SE)



CAP plot representing differences in community assemblage by Feature Type in Spain during Autumn 2021

UK mobile taxa in Features



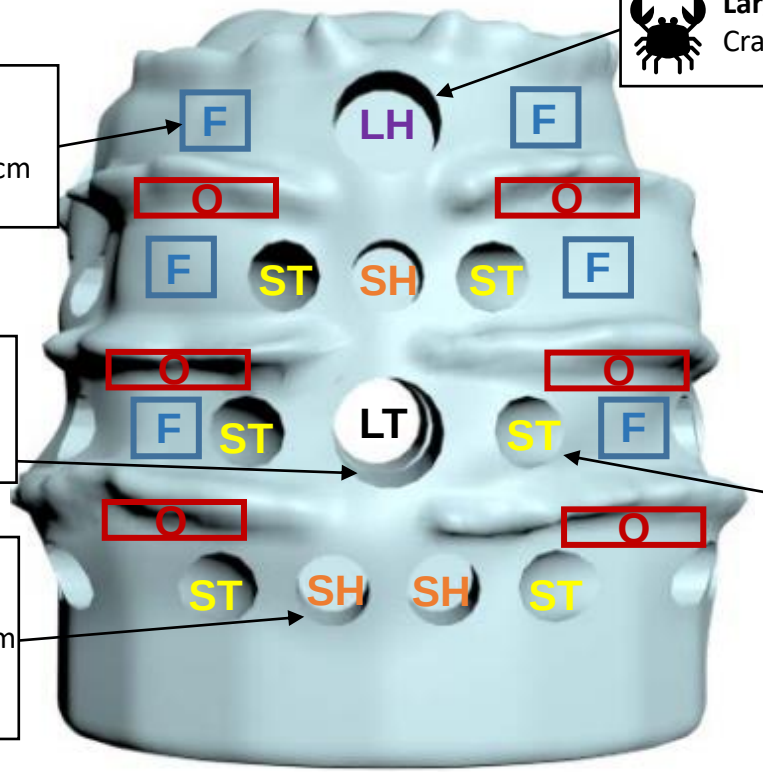
UK mobile taxa in Features

(SIMPER results, % contributed to similarity between samples in feature types)

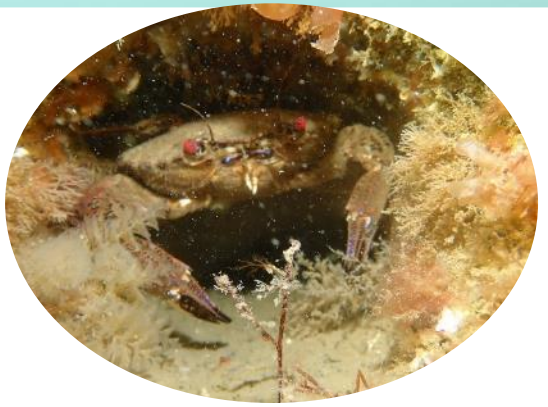
Flat surfaces
Shelled gastropods 1-3cm (100%)

Large Tunnels
Crabs 3-15cm (85%)
Benthic fish >15cm (13%)

Small Holes
Crabs 3-15cm (89%)
Prawns/ shrimps/ mysids 3-15cm (9%)
Benthic fish >15cm (2%)



Large Holes
Crabs 3-15cm (99%)



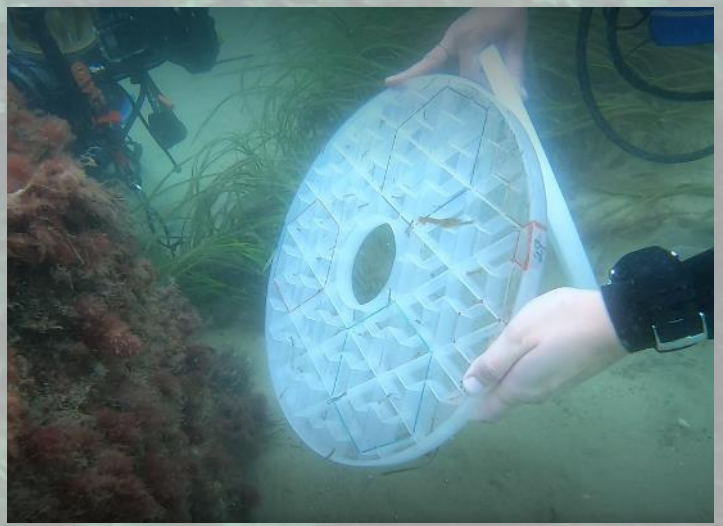
Small Tunnels
Crabs 3-15cm (82%)
Benthic fish 3-15cm (9%)
Benthic fish >15cm (7%)

Credit: Minna Saaristo https://www.researchgate.net/

Ongoing work

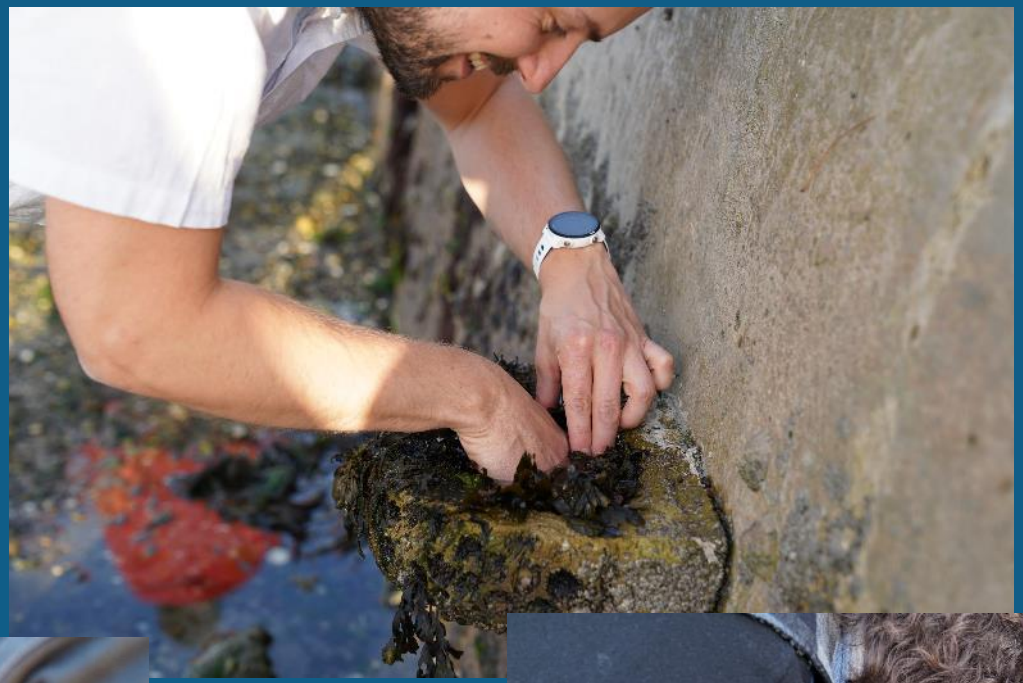
- Juvenile lobsters released on the UK reef in September
- Publication of results to date
- Continue monitoring until Spring 2023 (3 years underwater)
- Deploy specially-designed 3DPARE reef units for aquarium use (Spain)
- Explore further opportunities for future use in multifunctional infrastructure




Thanks
for
listening!

Fieldtrip to Poole Harbour Marineff rockpools



Photos from the workshop