Bournemouth University

Ecological Enhancement for Marine Infrastructure Workshop

11th – 12th October 2022

Cumberland Hotel, Bournemouth

Websites and social media

Website

Facebook

Twitter

LinkedIn

YouTube

Website

Facebook

Twitter

Instagram

LinkedIn

YouTube

Website

No social media but search “3DPARE” on Twitter and YouTube for posts by project partners and staff

Website

Twitter

LinkedIn

YouTube

Programme

- 10.00 – 11.00 Presentation session 1 – intertidal interventions
  - SARCC
  - Ecostructure
  - Independent – various south coast interventions
  - Questions
- 11.00 – 11.15 Refreshment break
- 11.15 – 12.30 Activity session 1 – intertidal case studies
- 12.30 – 13.30 Lunch
- 13.30 – 14.30 Presentation session 2 – subtidal interventions
  - Marineff
  - 3DPARE
  - Independent – Exo Environmental
  - Questions
- 14.30 – 15.45 Activity session 2 – subtidal case studies
- 15.45 – 16.00 Refreshment break
- 16.00 – 16.45 Panel discussion
- 16.45 Close/ comfort break before travel to fieldsite

SARCC Project

David Miko, Exo Environmental for SARCC

david.m@exo-env.co.uk

Interreg
EUROPEAN UNION
2 Seas Mers Zeeën
SARCC
European Regional Development Fund

(Hybrid) Nature Based Solutions for Coastal Cities

David Miko – Exo Environmental
david.m@exo-env.co.uk

Talk Content

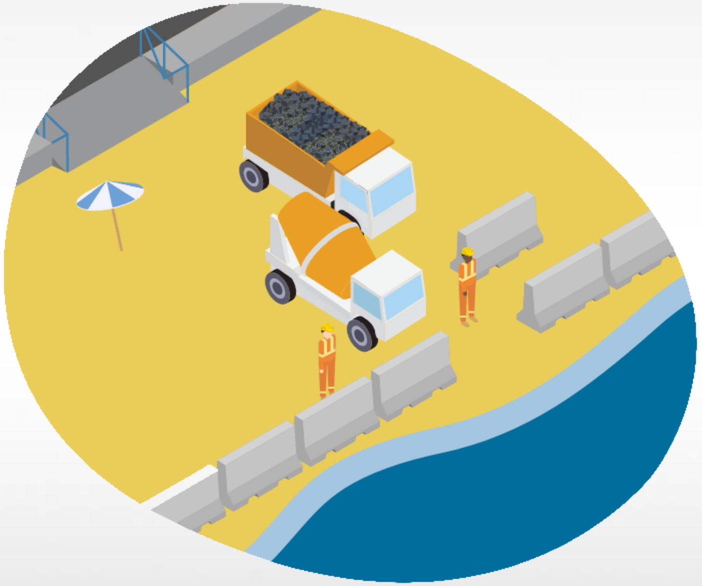
- Cities and climate change
- Hybrid nature based solutions
- SARCC project
- Examples of hybrid nature based solutions
- Barriers preventing uptake
- Public perceptions

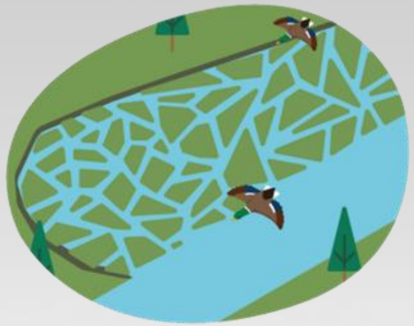
Climate Change and Coastal Cities

- Half of the world's population lives within 60 km of the ocean, and three quarters of all large cities are coastal
- Erosion and flooding are hazards that threaten humans and associated infrastructure in the coastal zone
- Climate change the frequency and severity of these hazards
- Mean Sea Level Rise (SLR) could increase by 1.5m-2.5m by 2100
- Costs linked to coastal flooding in Europe increase from €1.25bn per annum currently to €961bn in just over 80 years (European Commission, 2018)

Hard Engineering Solutions

- Effective flood and erosion control
- Costly maintenance
- Environmentally damaging
- Unforeseen consequences
- Large carbon footprint
- Poor aesthetics





Nature Based Solutions - NBS

- Nature based solutions are actions that are inspired and supported by nature and are used to tackle societal challenges such as climate change whilst providing both benefits to humans and nature
- Examples include:
- Managed realignment
- Saltmarsh restoration
- Sand dune restoration
- Mussel reefs

NBS provide additional ecosystem services

Often require large areas of coastal land

Hybrid NBS

- Space and low value land is at a premium at urban coastlines
- In urban coastal areas, the right balance must be sought between coastal defence and urban development
- HNBS is where NBS are integrated into hard infrastructure

Examples of HNBS

- Living Breakwaters Project – New York
- 600 ECOncrete Armor Blocks and 800 Tide Pools were integrated into the project design to provide ecological enhancement to support local species

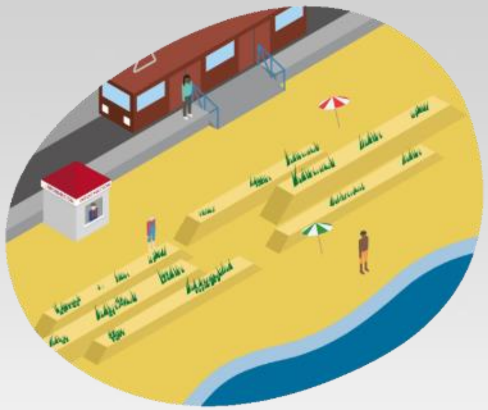
Exo – Eco Rock Armour

BioBlock – Arc Marine

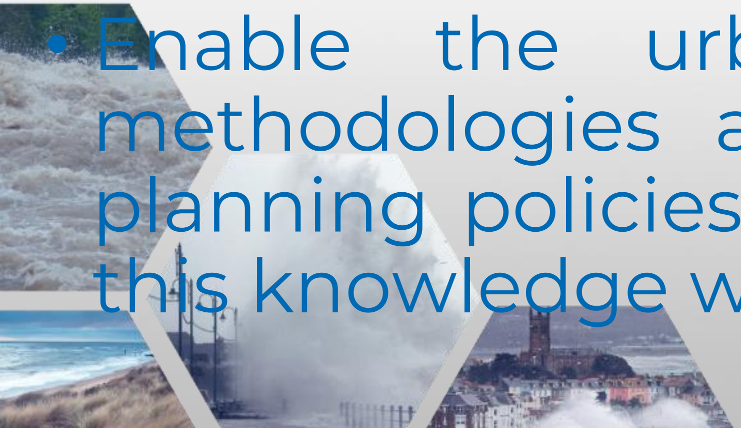
Econcrete Armour Blocks

Vertipools – Artecology

SARCC

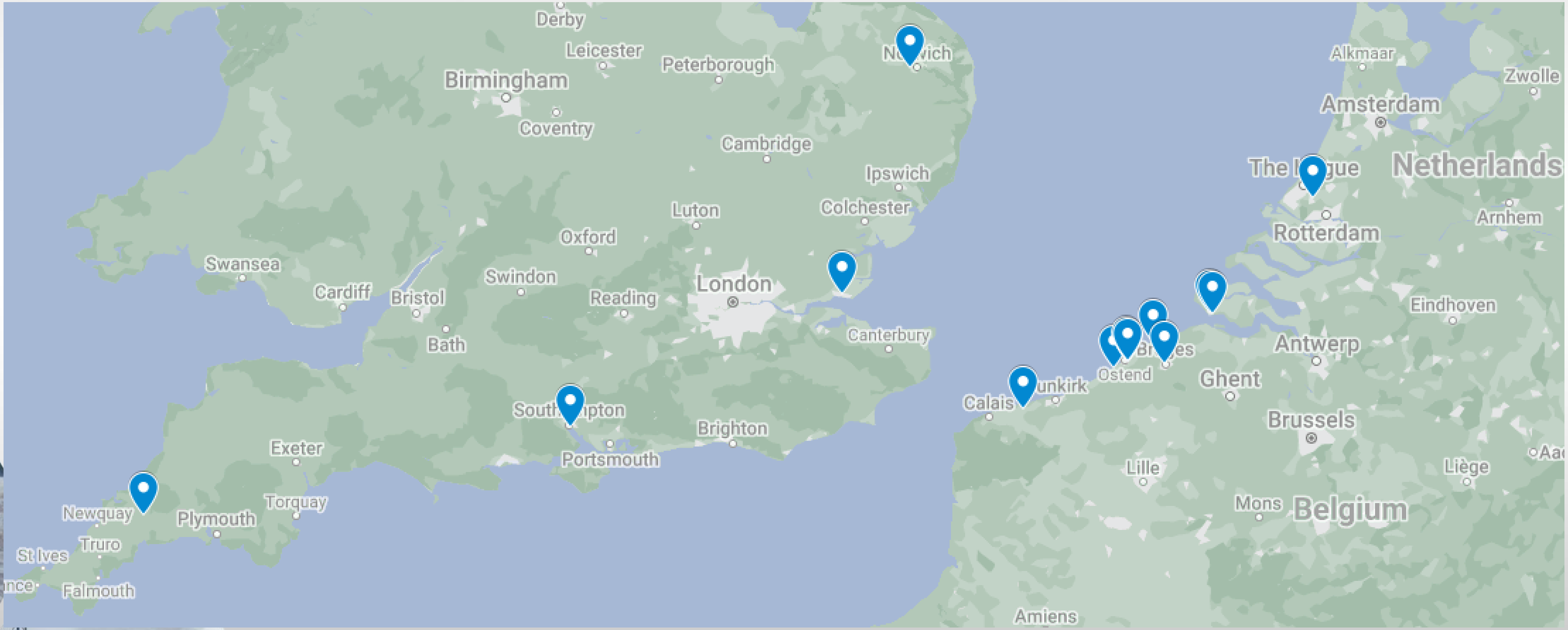


- European funded project with partners in UK, France, Belgium and the Netherlands
- The overall objective of SARCC (Sustainable and Resilient Coastal Cities) is to help mainstream nature based solutions (NBS) and hybrid nature based solutions (HNBS) into coastal management and policy making
- Enable the urban partners to embed new techniques, methodologies and practices into coastal management and planning policies and demonstrate the value of NBS and share this knowledge with other coastal urban landscapes



SARCC Pilots

There are 14 partners involved in the SARCC project and 7 pilots



SARCC Pilot - Vlissingen

- Vlissingen is in a coastal urban area in the Netherlands
- The objective is to focus on natural and green sustainable measures, which in the long term will protect the urban area against flooding during storms
- Sea defences can not be continuously expanded without demolishing homes
- Defences designed to overtop in large storms
- Storm water controlled and directed to water retention area where it is managed

Exo & Environment Agency Pilot

- Exo's Eco Rock Armour
- Complex surface textures that facilitate biocolonisation
- Use recycled materials such as dredged sediment
- 17% reduced total emitted carbon vs conventional concrete
- Deployment of 12 75kg Eco Rock Armour blocks in Newlyn, Penzance Cornwall
- Manufactured from local quarry by-products
- Monitoring in collaboration with Bournemouth University until autumn 2022

Observations so far…

Bio-colonisation of pioneer floral biofilms and later higher trophic organisms are well underway. Species present include filamentous algae *Enteromorpha*, Periwinkles *Littorina saxatalis* and Bladder wrack sea-weed *Fucus vesiculosus*

Barriers and the need for SARCC WP1

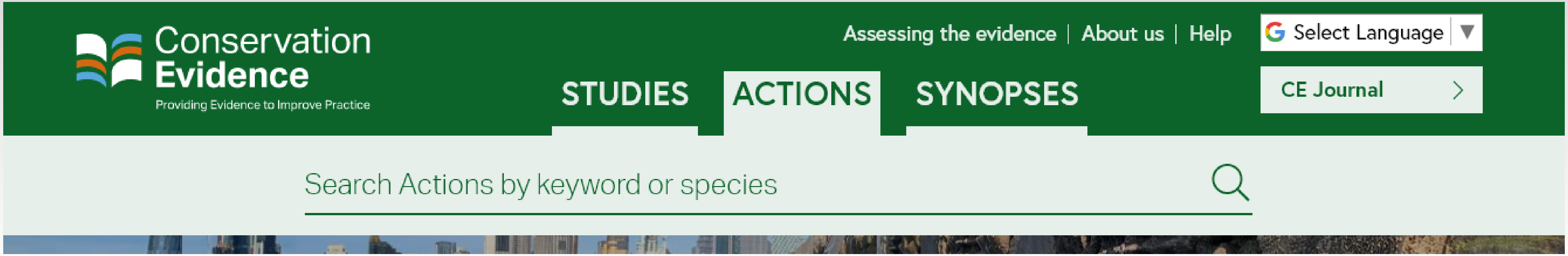
- A clear knowledge gap exists across coastal local authorities to deploy NBS as a means to reduce future coastal flood risk and economic damage
- SARCC WP1 studies the practical aspects of all stages of the pilot projects in order to help mainstream the implementation of NBS.

Commonly Perceived Barriers

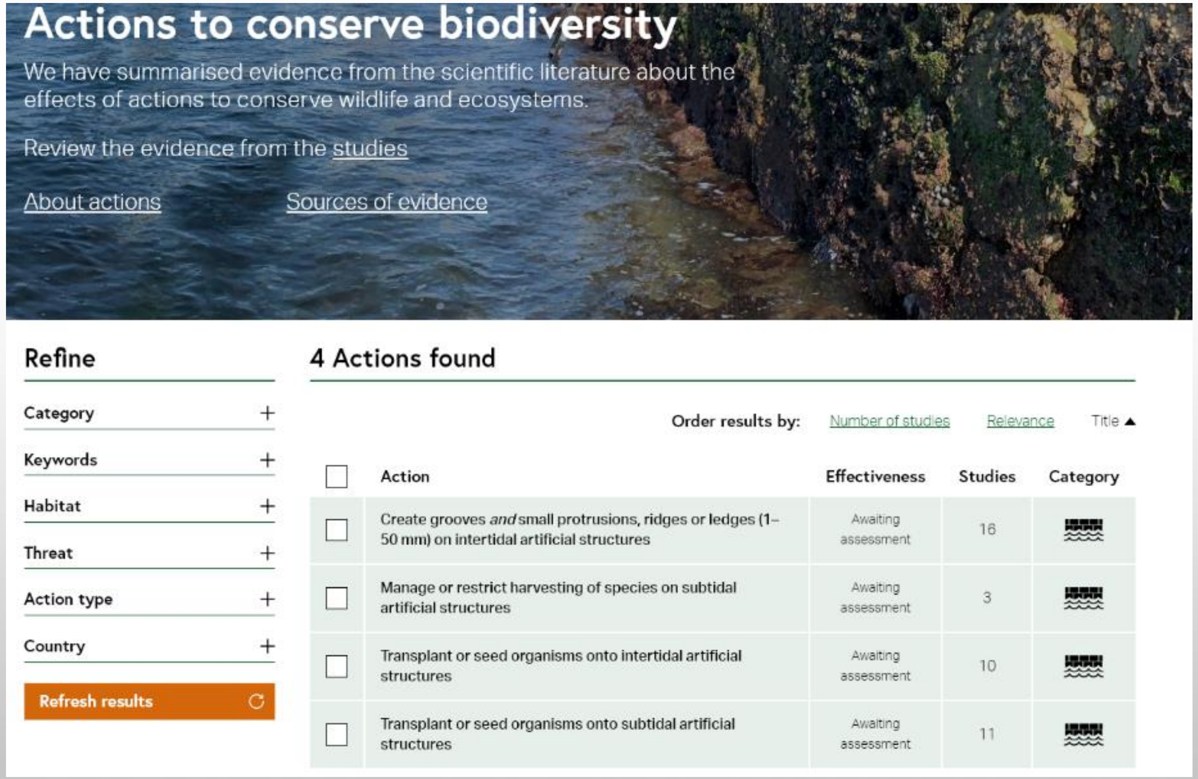
- Cost
- Evidence
- Effectiveness
- Engineering concerns
- Invasive species
- Public perceptions

HNBS 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.

Evidence



- Evidence is growing in academic literature
- Slowly influencing public opinions and policy makers

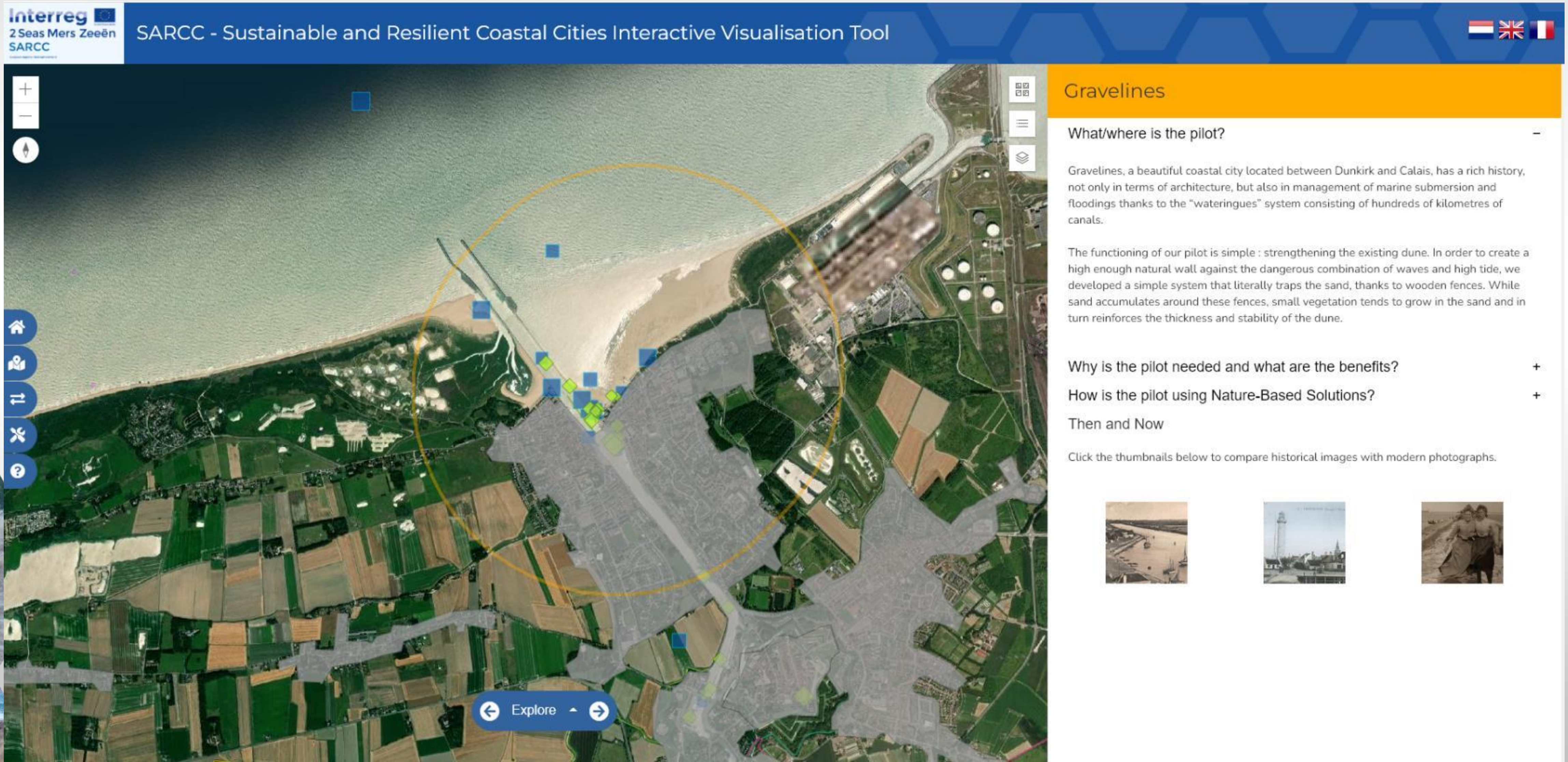


Public Perceptions

- Online survey of different stakeholders in areas where NBS projects have taken place (North Norfolk, Cornwall and Isle of Wight)
- Overall, responses to HNBS/NBS were positive. However, general knowledge of these was low, even in areas with pilot studies involving NBS
- Stakeholders opposed to the higher cost implementation of NBS were primarily business/landowners and decision-makers
- Projects need to collaborative approach to bring views of stakeholders together

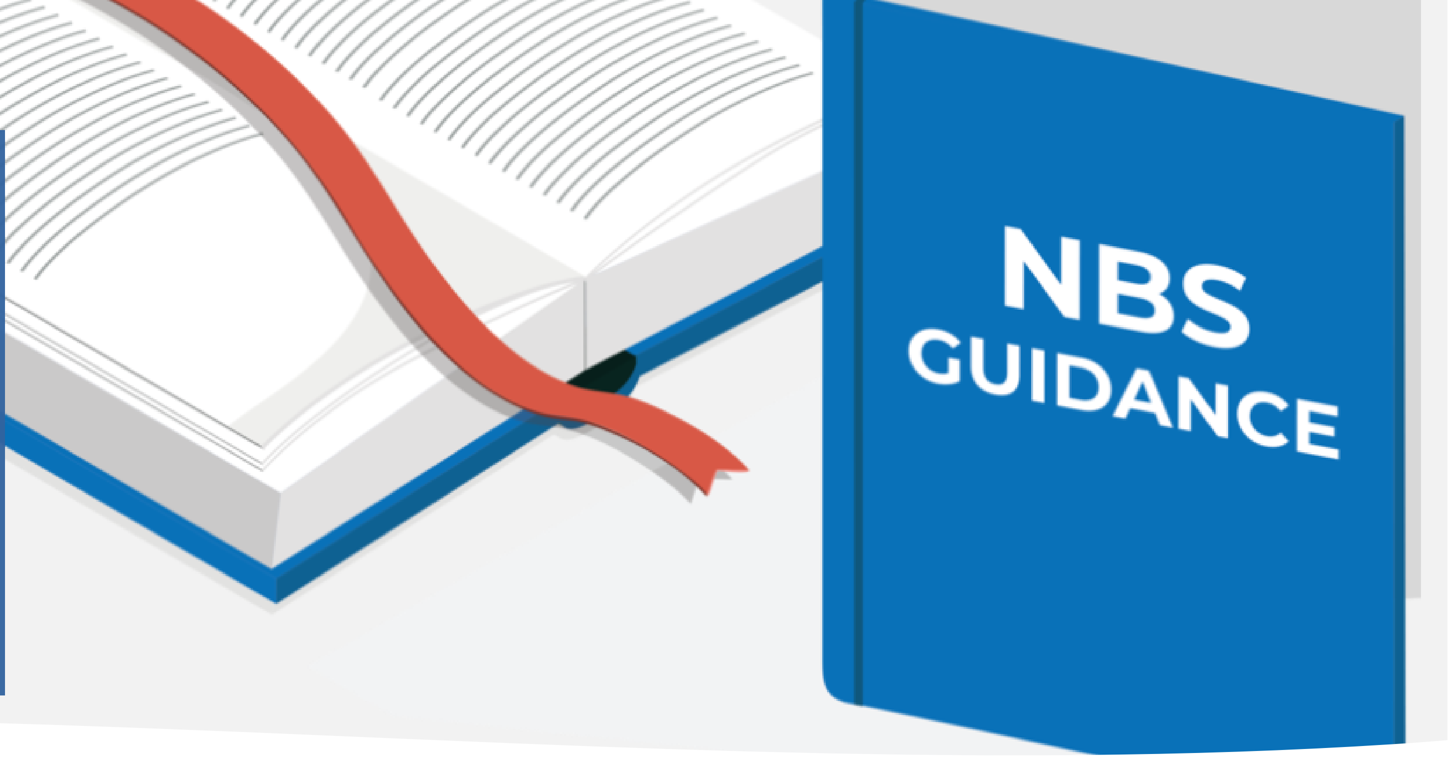
SARCC Interactive Visualisation Toolkit

https://sarcc.maritime archaeologytrust.org/



NBS Guidance Booklet

Coming 2023

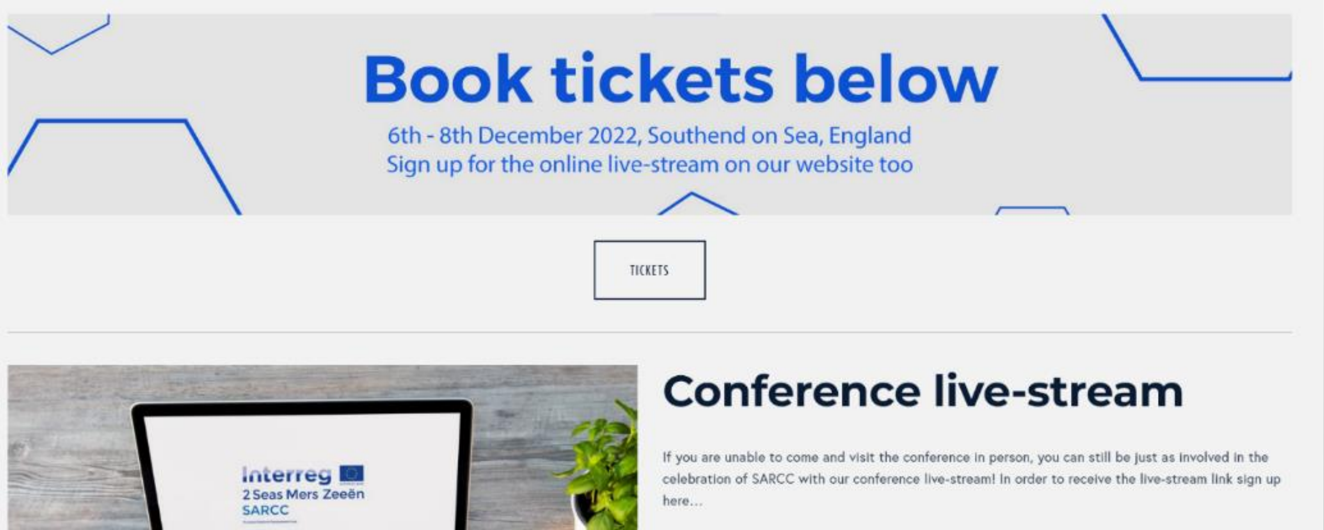


SARCC WP2 – Capacity Building

- **Summary of the activities undertaken in the capacity building programme.**
- **Content on scientific evidence, historic trends, technical solutions and business models.**
- **Aimed at decision makers**

SARCC Final Conference

- Closing conference taking place on the **6th-8th of December, 2022** in Southend on Sea,
- you are all invited to participate in celebrating the achievements of SARCC and it's project partners
- Online tickets:
- https://www.sarcc.eu/sarccfinalconferencebooking



Bournemouth University

Ecostructure Project

Joe Ironside, Aberystwyth University for Ecostructure

jei@aber.ac.uk

Ecostructure: eco-engineered concrete panels based on natural topography.

Joe Ironside[1], Liz Humphreys[1], Pippa Moore[1], Ally Evans[1], Melanie Prentice[1], Morag Taite[1], David Wilcockson[1], Harry Thatcher[1], Paul Shaw[1], Hannah Earp[1], Sarah Dalesman[1], Peter Robins[2], Simon Neill[2], Simon Karythis[2], Sophie Ward[2], Stuart Jenkins[2], Liz Morris Webb[2], Peter Lawrence[2], Andrew Davies[2], Siobhan Vye[2], Alice Goward Brown[2], Tim D'Urban Jackson[2], Jonathan Demmer[2], Nick Woodhall[2], Ruth Callaway[3], John Griffin[3], Tom Fairchild[3], Kathrin Kopke[4], Amy Dozier[4], Maria Del Camino Troya Bermeo[4], Ellen McMahon[4], Christian van den Bosch[4], Sophie Power[4], Jeffrey Black[4], Sarah Culloty[4], Owen McIntyre[4], John O'Sullivan[5], Ciaran McNally[5], Atteyeh Natanzi[5], Md Salauddin[5], Jennifer Coughlan[6], Jens Carlsson[6], Nettan Carlsson[6], Paul Brooks[6], Sonya Agnew[6], Tomas Buitendijk[6], Bryan Thompson[6], Laura Gargan[6], Veronica Farrugia Drakard[6], Aoife Corcoran[6], Philip Crowe[6], Ed Gallagher[6], Emily Cassidy[6], Tasman Crowe[6]

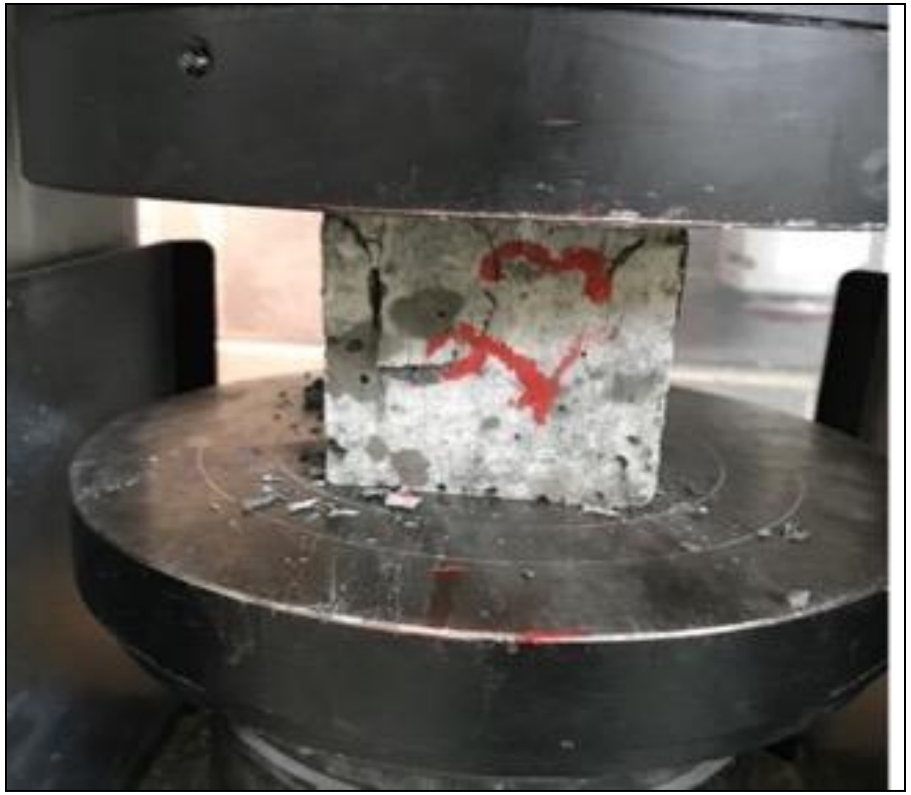
[1]Institute of Biological, Environmental and Rural Sciences, Aberystwyth University, Aberystwyth SY23 3DA, UK; [2]School of Ocean Sciences, Bangor University; [3]College of Science, Biosciences, Swansea University; [4]MaREI, the SFI Research Centre for Energy, Climate and Marine, Environmental Research Institute, University College Cork; [5]School of Civil Engineering, University College Dublin;[6]Earth Institute and School of Biology and Environmental Science, University College Dublin

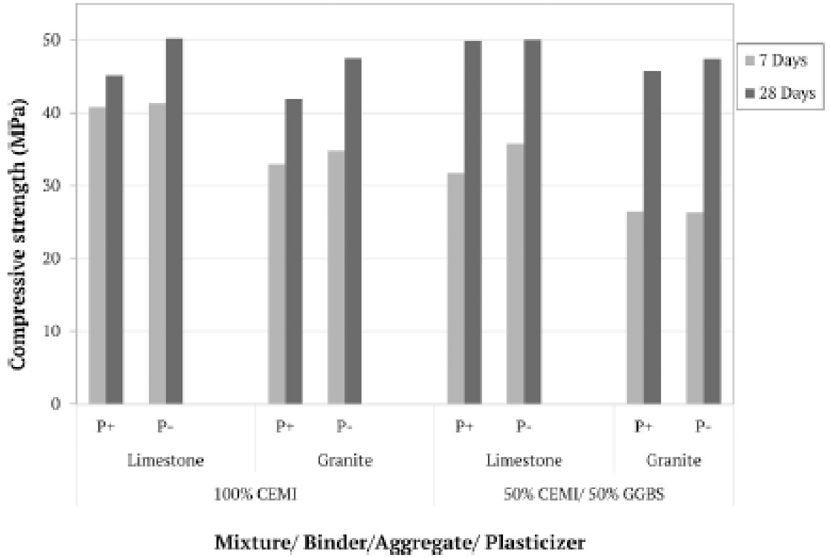
Ecostructure is part-funded by the European Regional Development Fund through the Ireland Wales Cooperation Programme 2014-2020

Joe Ironside: jei@aber.ac.uk

Materials

- Alternative concrete mixes
  - Binders
    - Portland cement (CEM 1)
    - CEM 1 and Ground Granulated Blast-furnace Slag (GGBS)
  - Aggregates
    - Limestone
    - Granite
  - Plasticiser
    - With or without
- Reinforced concrete tiles (200 x 200 x 40mm)
  - Tested for engineering properties
    - Compressive strength
    - Resistance to chloride ingress
    - Acid neutralization capacity



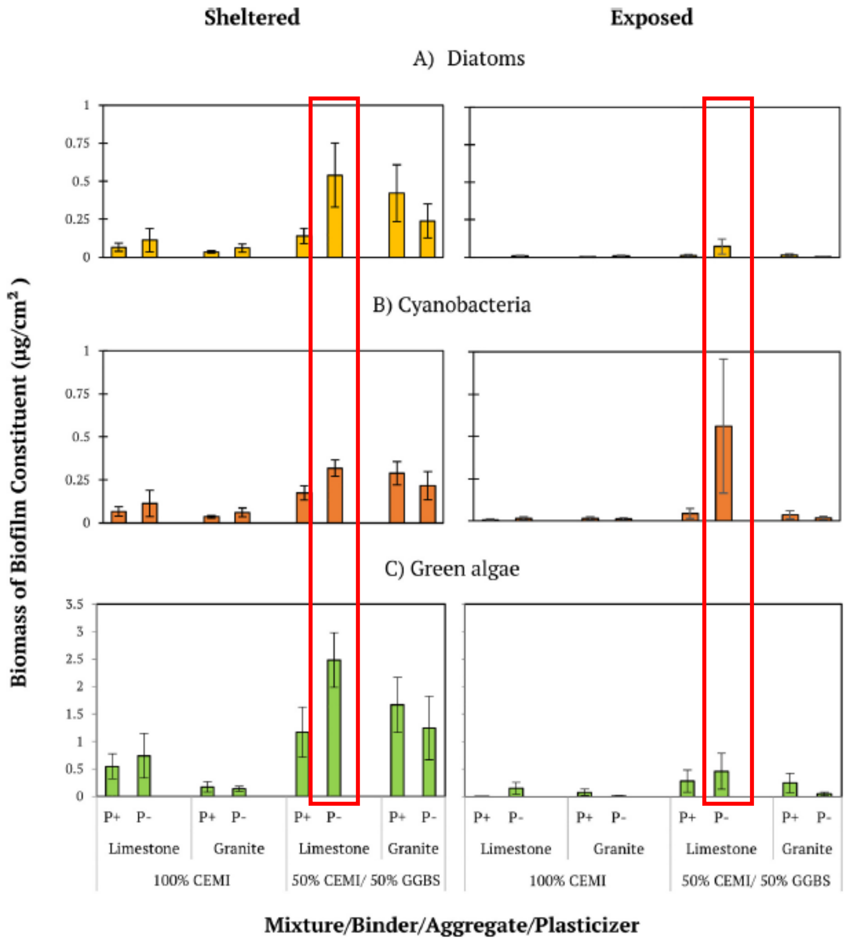


Natanzi, A.S., Thompson, B.J., Brooks, B.R., Crowe, T.P., McNally, C. (2021). Influence of concrete properties on the initial biological colonisation of marine artificial structures. *Ecological Engineering* **159:** 106104

Materials

- Reinforced concrete tiles (200 x 200 x 40mm)
  - Tested for Ecological properties
    - Attached to sheltered and exposed sides of Mornington breakwater (Co. Meath, Ireland)
    - Ecological surveys at 1, 3, 6, 9, 12 and 24 months
      - Biodiversity
      - Barnacle density
      - Biofilm biomass
- Best Results
  - Mix 3: CEM 1+GGBS, limestone, no plasticizer
    - Good structural properties and high biodiversity

Binder	Aggregate	Reinforcement	Plasticiser?	Compression Strength (Mpa)	Acid Neutralisation Capacity
50% CEM 1 +50% GGBS	Limestone	Steel Mesh	No	50.12	1.28



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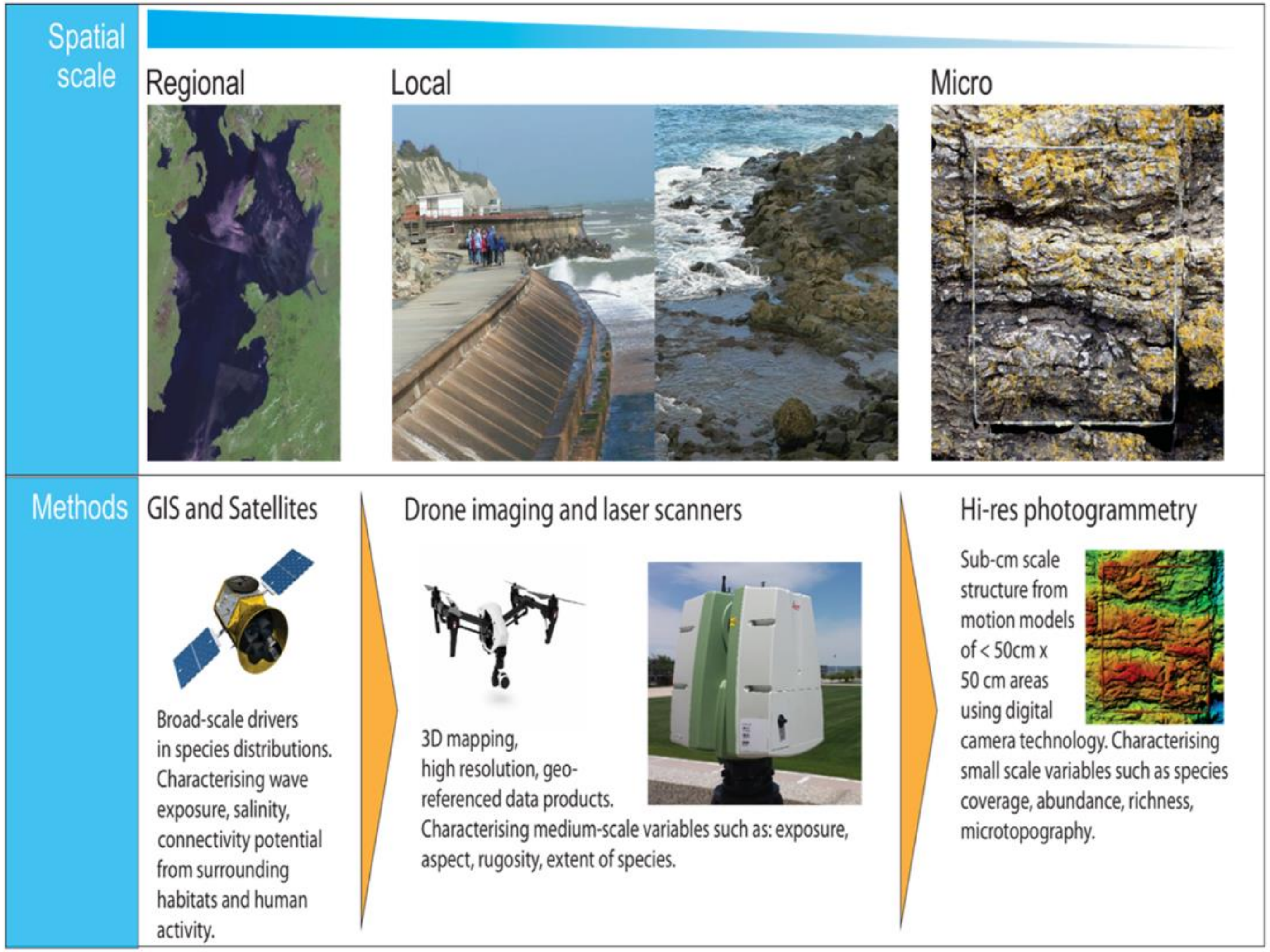
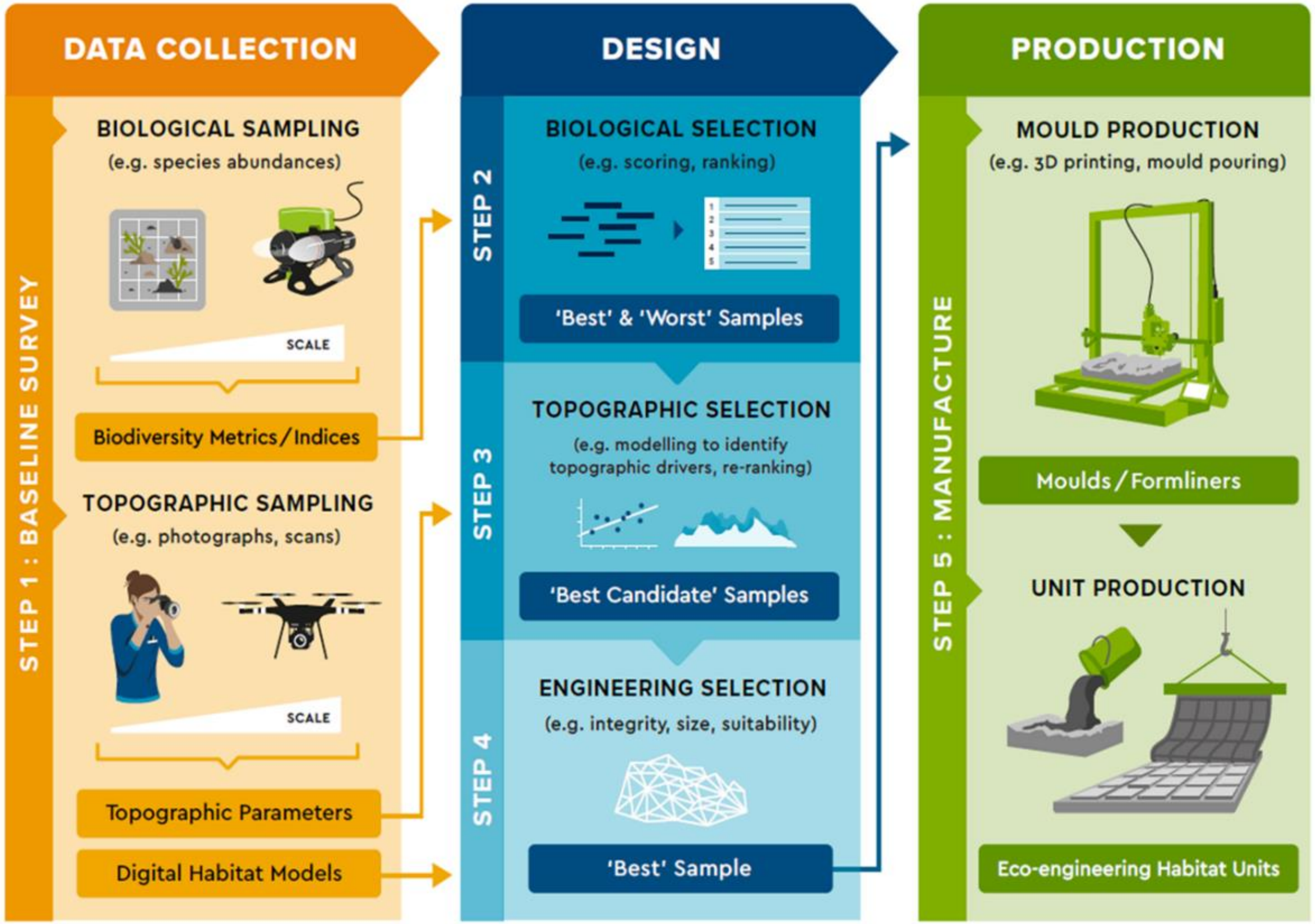
Surveying and predicting biological communities and ecosystem functions on artificial structures

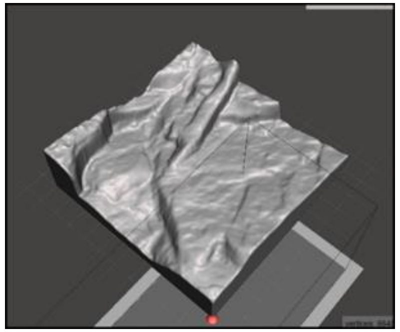
- Natural rocky shores and artificial structures
- 3D images
  - Describe topographic features
- Biological surveys
  - Describe communities
- Features associated with high biodiversity
  - Identified on existing shores
  - Designed into new structures



Topographic tiles: design process

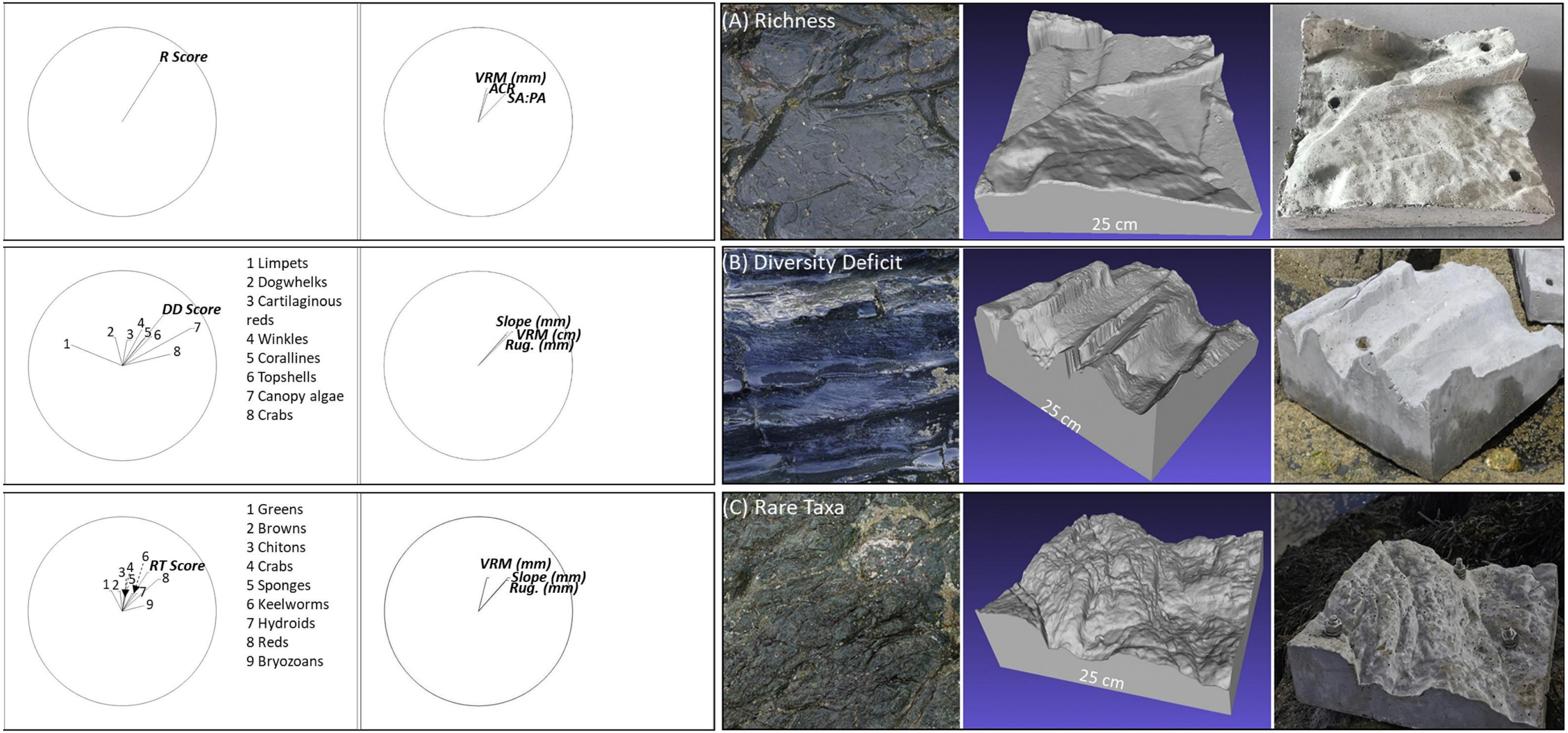
- Biological criteria
  - Richness
    - Number of taxa per quadrat
  - Diversity Deficit
    - Number of species consistently present in natural habitats and consistently absent in artificial habitats
  - Rare taxa
    - Number of rare taxa present





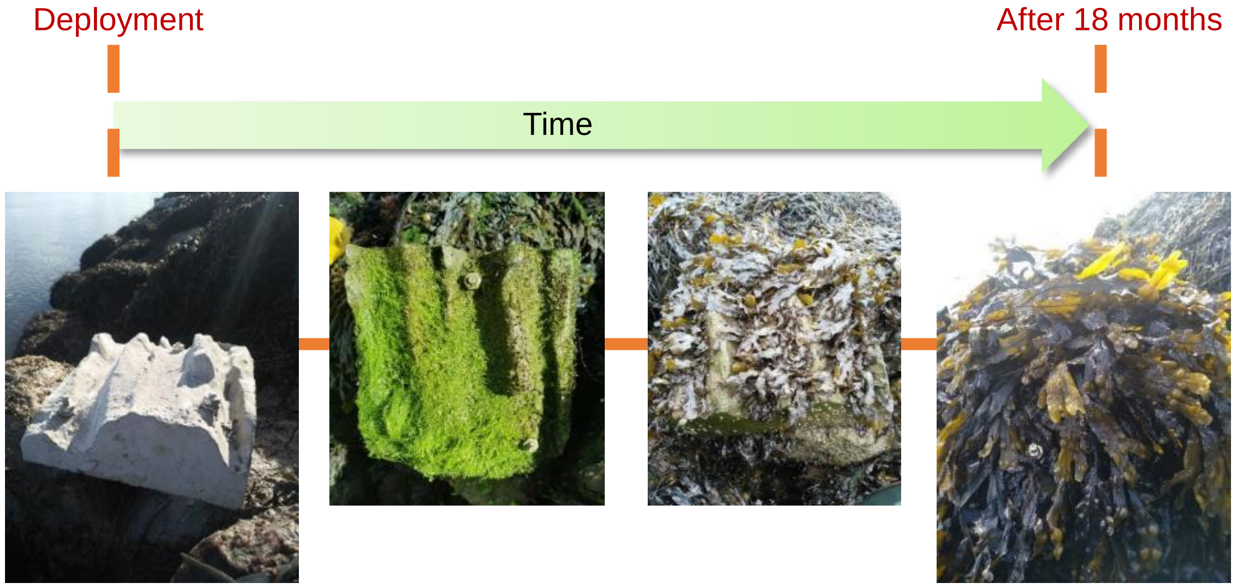

Evans, A.J., Lawrence, P.J., Natanzi, A.S., Moore, P.J., Davies, A.J., Crowe, T.P., McNally, C., Thompson, B., Dozier, A.E., Brooks, P.R. (2021) Replicating natural topography on marine artificial structures – A novel approach to eco-engineering. *Ecological Engineering* **160:** 106144

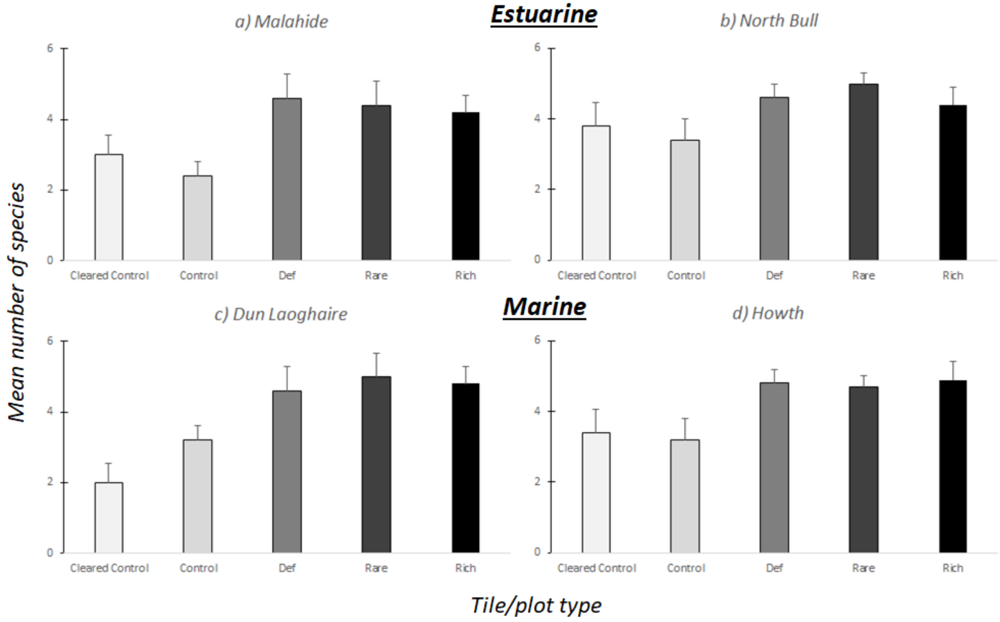
Selected quadrats

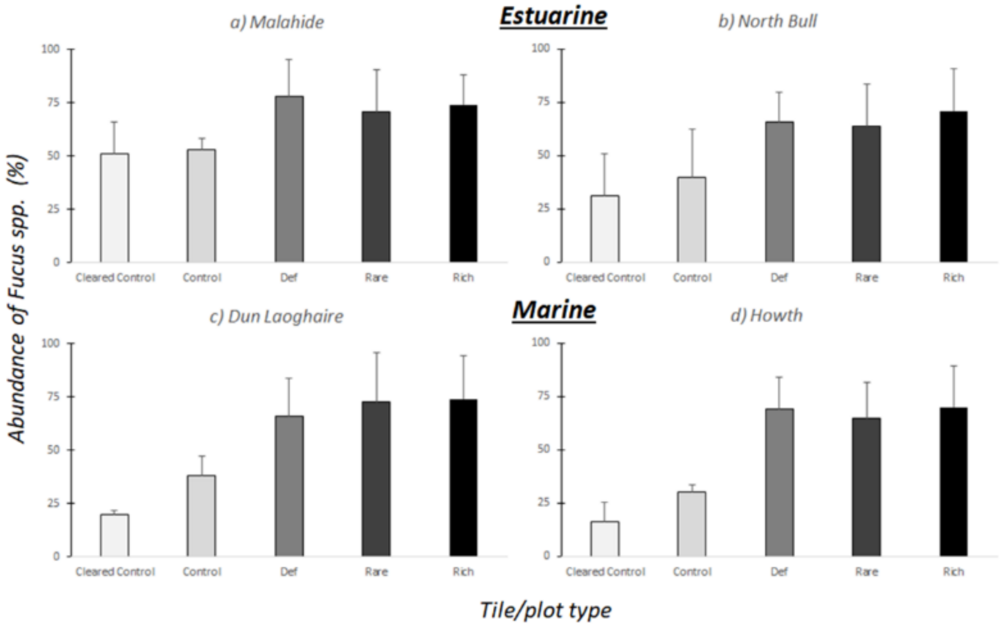


Deployment and monitoring

- Rich, diversity deficit and rare designs + blank and cleared controls
  - 5 replicates of each treatment
  - Deployed on 4 artificial structures near Dublin
    - 2 estuarine, 2 marine
- Preliminary results (after 18 months)
  - All natural topography units show greater species richness than controls
  - All natural topography units show greater abundance of fucoid algae than controls







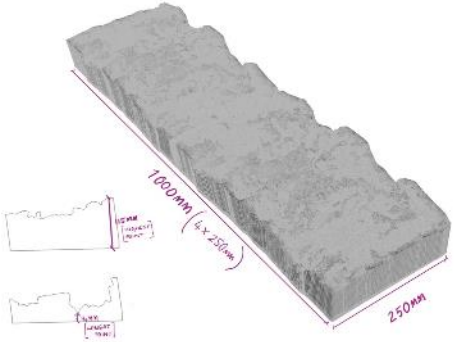
Scaling up

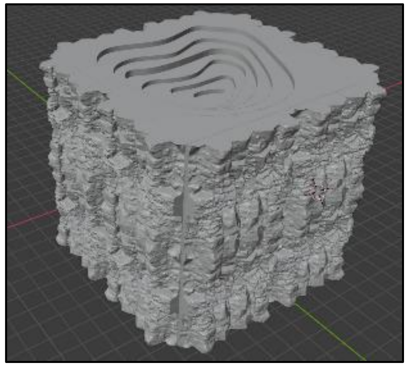
- Larger units being manufactured to engineering standards using formliners
- In collaboration with industrial partners

Phase 1 (WP3)

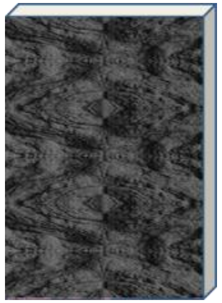
Experimental units:
250 x 250 mm

Phase 2 (WP7)





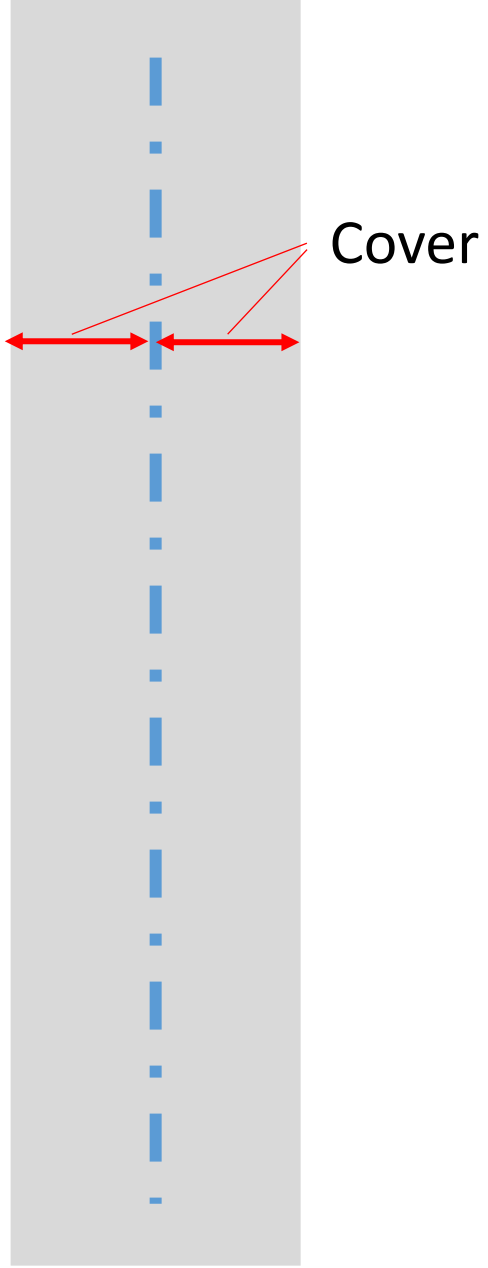
Blocks (subtidal habitat units):
1600 x 800 x 800 mm, 2450 kg



Wall Panels:
1800 x 1500 x 150 mm, ~300 kg

Concrete Production

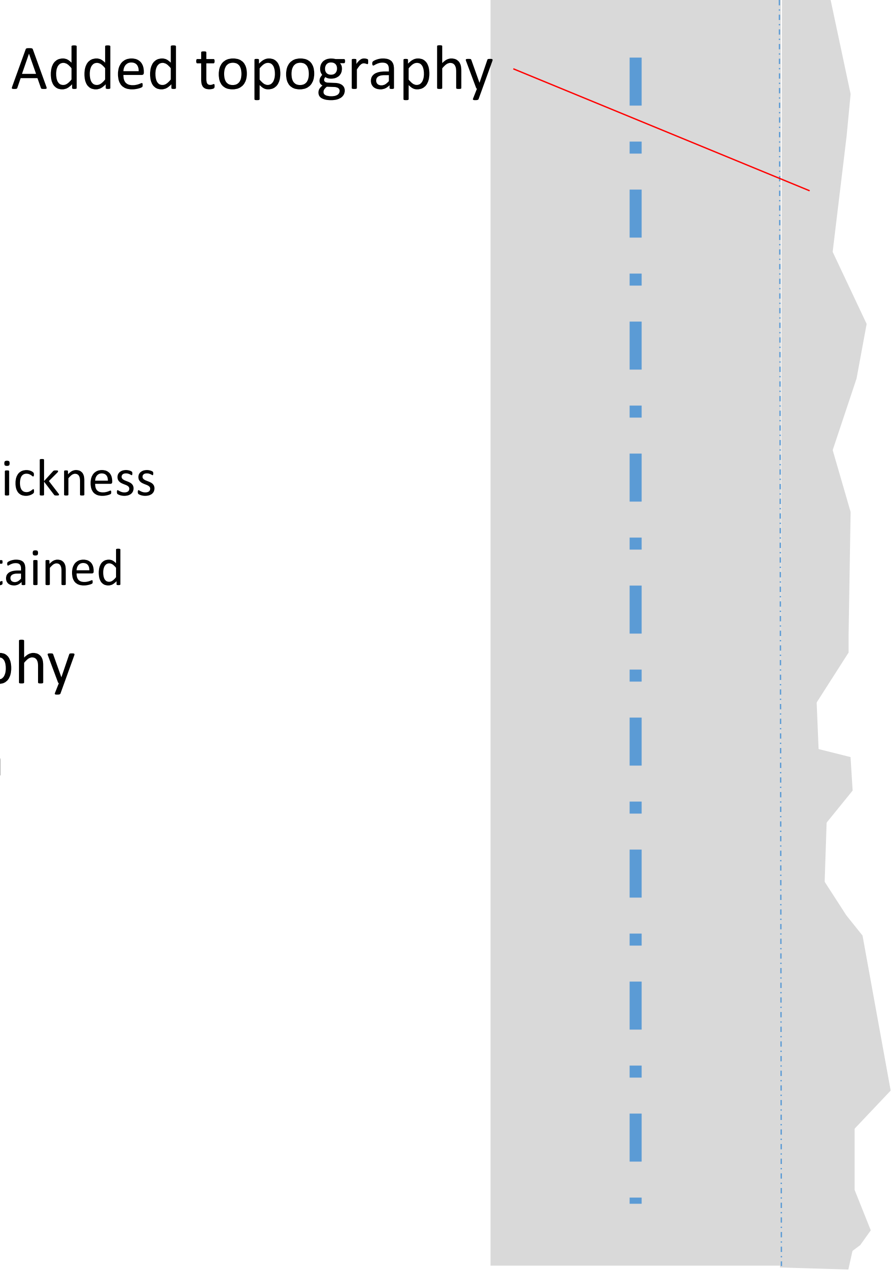
- Larger panels require prestressing
  - Protecting this reinforcement is critical
  - Requires 50 mm on each side
    - Minimum thickness usually 120 mm



ECOSTRUCTURE

Concrete Production

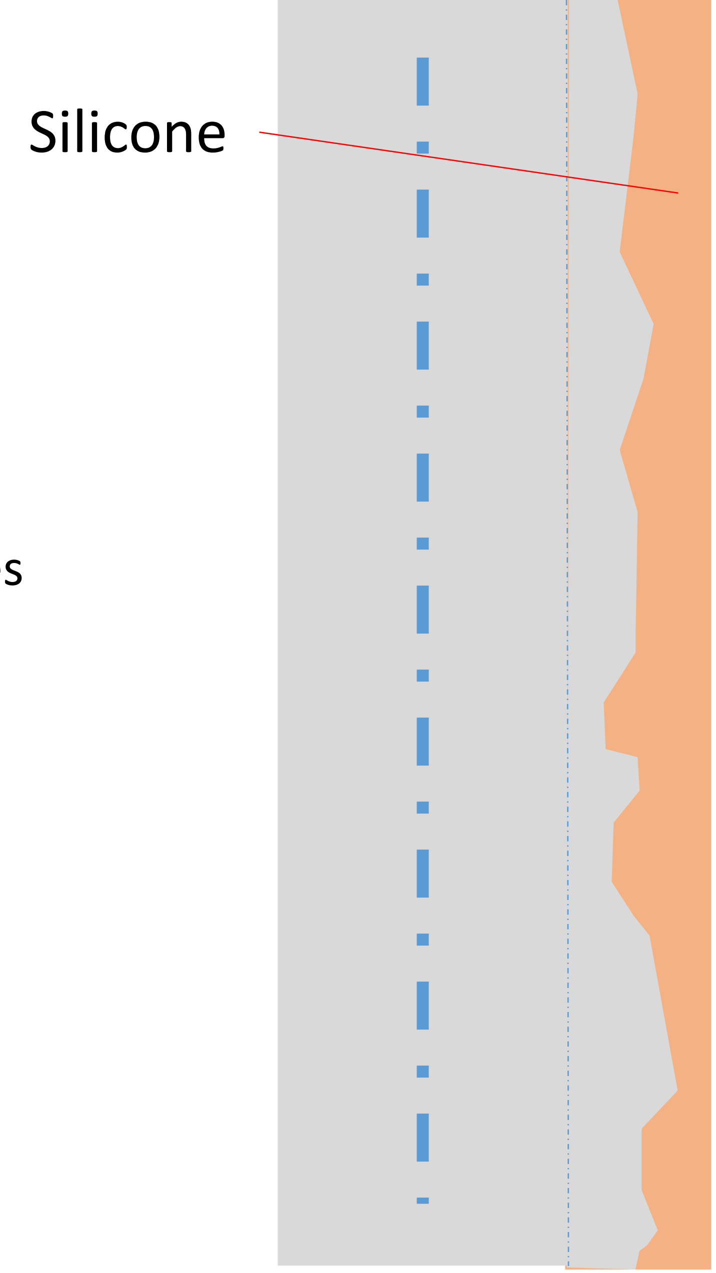
- Concrete topography
  - significantly increases panel thickness
  - minimum cover must be maintained
- 100 mm variation in topography
  - Increases thickness to 250 mm
    - Increase in material usage



ECOSTRUCTURE

Concrete Production

- Formliners
  - essential for providing the topography
  - Manufactured from 3D printed templates
    - using silicone rubber
  - Can be re-used multiple times
  - Up to 100, depending on roughness
- Deeper topography
  - more silicone rubber required



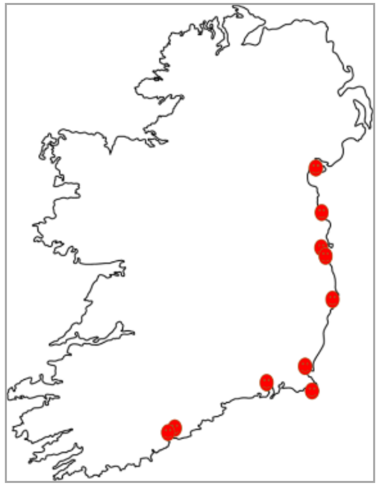
Economics

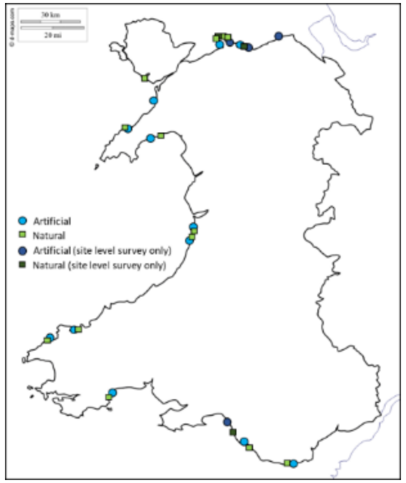
- Formliners are potentially very expensive
  - depending on depth of topography
- For a small trial, the formliner may represent 50% of the cost
- Economies of scale are essential

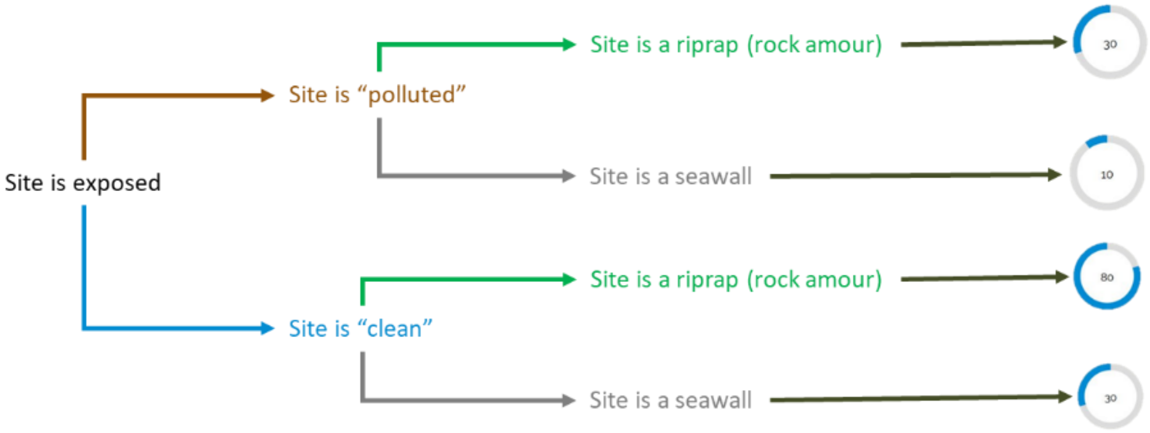
ECOSTRUCTURE

BioPredict tool

- 27 pairs of neighbouring sites selected
  - Artificial coastal structure
  - Analogous natural rocky shore
- Context, topography and ecology characterised
- Data used in modelling approach
  - to predict biological communities from information on proposed structures
    - Implemented as decision tree



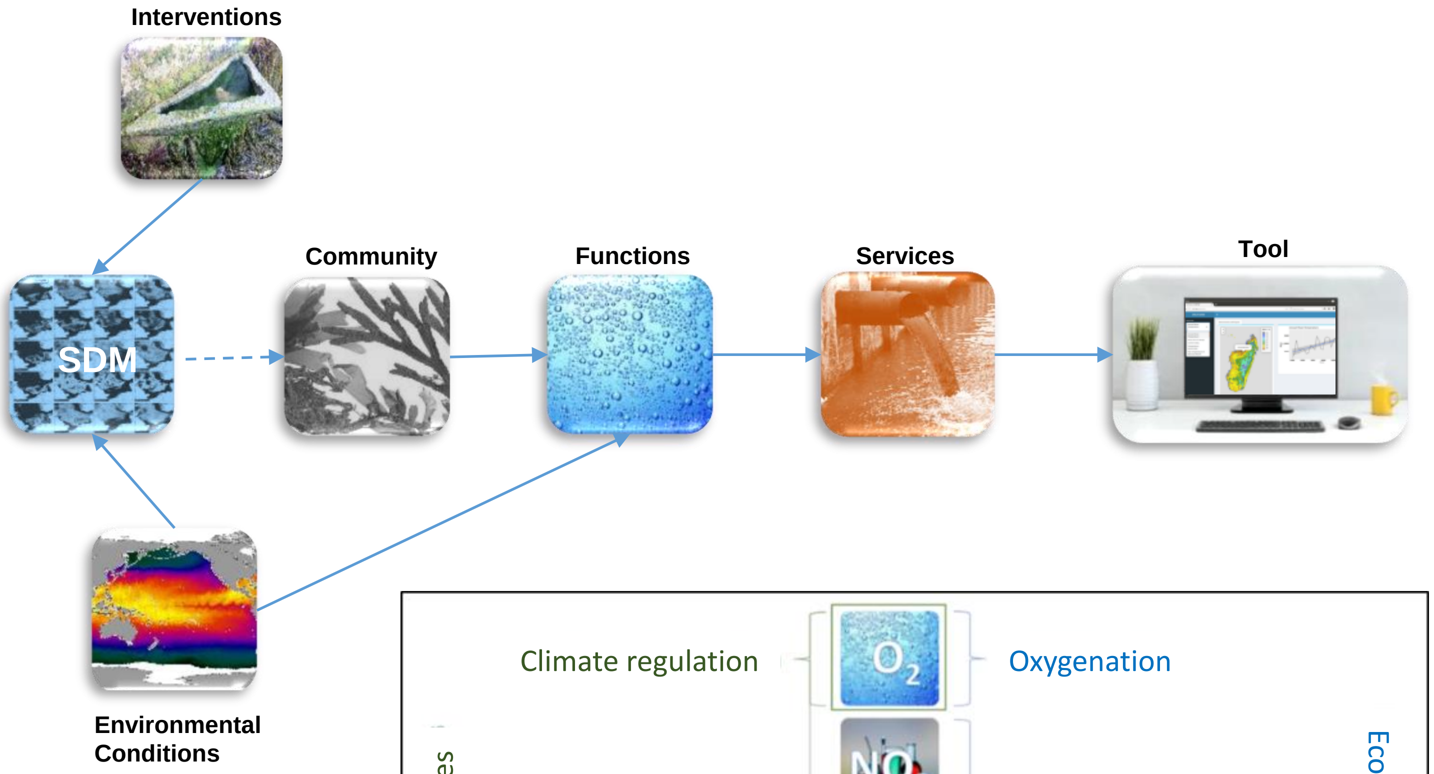


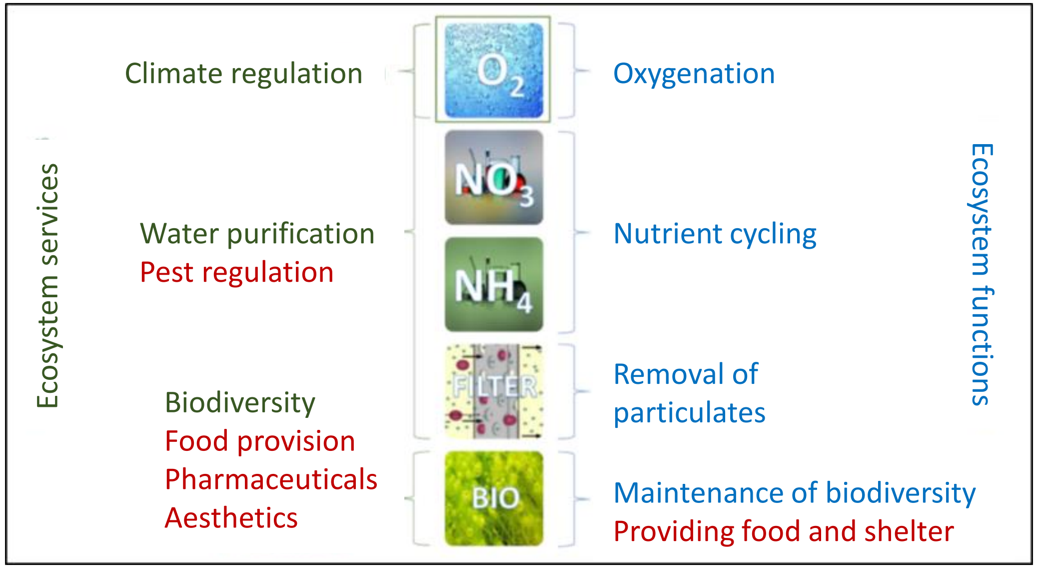


https://rstudio.bangor.ac.uk/BioPredict/

EFPredict tool

- Ecosystem functions
  - Characterised for different biological communities
    - Implemented in predictive tool
- Ecosystem services
  - Inferred from ecosystem functions





https://figshare.com/articles/code/Ecostytem_Functions_and_Prediction_Tool/17197883/3

ECOSTRUCTURE

Climate Change Adaptation through Ecologically Sensitive Coastal Infrastructure

Ecostructure is part-funded by the European Regional Development Fund through the Ireland Wales Cooperation Programme 2014-2020

Bournemouth University

Intertidal pilots from the south coast of England

Jess Bone, Bournemouth University

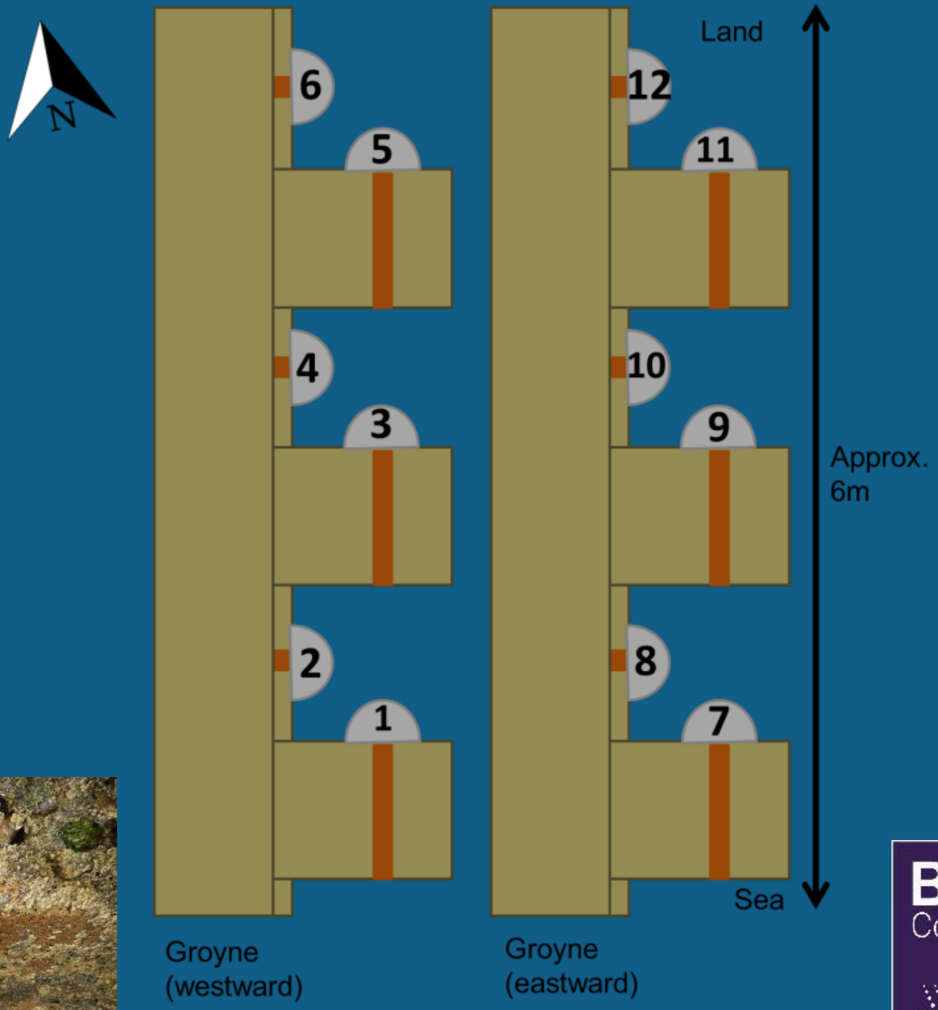
jbone@bournemouth.ac.uk

Locations


London
Swindon
Bristol
Bath
Chippenham
Reading
Croydon
Southend-on-Sea
Ilford
Margate
Canterbury
Maidstone
Basingstoke
Winchester
Salisbury
Southampton
Portsmouth
Chichester
Worthing
Brighton
Eastbourne
Hastings
Folkestone
Dover
Dorchester
Weymouth
Poole
Yeovil
Taunton
Bridgwater
Trowbridge
Weston-super-Mare
North Wessex Downs AONB
Surrey Hills Area of Outstanding Natural Beauty
South Downs National Park
High Weald AONB
Le Touquet
Berck
Hythe
Hamble
Littlehampton
Bournemouth

Bournemouth Artificial rockpools

- Installed: x12 rockpools July 2015
- Material: Ordinary Portland cement, 20mm flint aggregate, sand casted
- Method of installation: Stainless steel straps and bolts



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Bournemouth Artificial rockpools

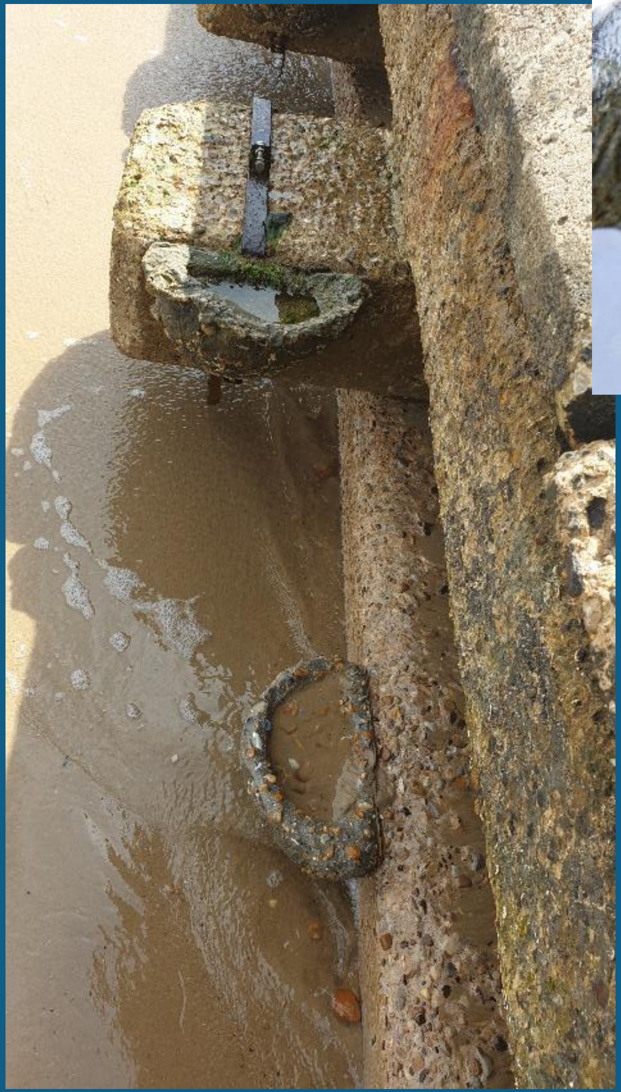
- Notes: Beach renourishment in spring 2016, burying all rockpools until January 2017
- Outcome:

27 species found on and in rockpools compared to 20 species on the groyne

Rockpools had greater diversity of mobile fauna

Only 1 rockpool remains (correct as of Feb 22)

Importance of fixing retrofitted ecological enhancement



BCP Council

ARTECOLOGY

Hamble
Seawall with pools and crevices

- Installed: August 2021
- Material: CEMIII concrete with 20mm limestone aggregate
- Method of construction: In situ with textured formliners and custom moulds

Hamble
Seawall with pools and crevices

- Notes: Monitored quarterly since installation
- Outcome:

More 'natural' aesthetic using rock-textured formliners

Use of wood to create custom moulds effective and relatively straightforward

Slow to recolonize but original wall also poorly colonized

Most of the cubic voids dry out between high tides

Monitoring to continue…

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Hampshire County Council

Littlehampton Mud pools

- Installed: January 2018
- Material: Vicat Prompt cement (Vertipools™)
- Method of installation: Retrofitted to steel sheet piling in-pan using custom bracket drilled into piling

Environment Agency

MACKLEY

ARTECOLOGY

Bournemouth University

Littlehampton Mud pools

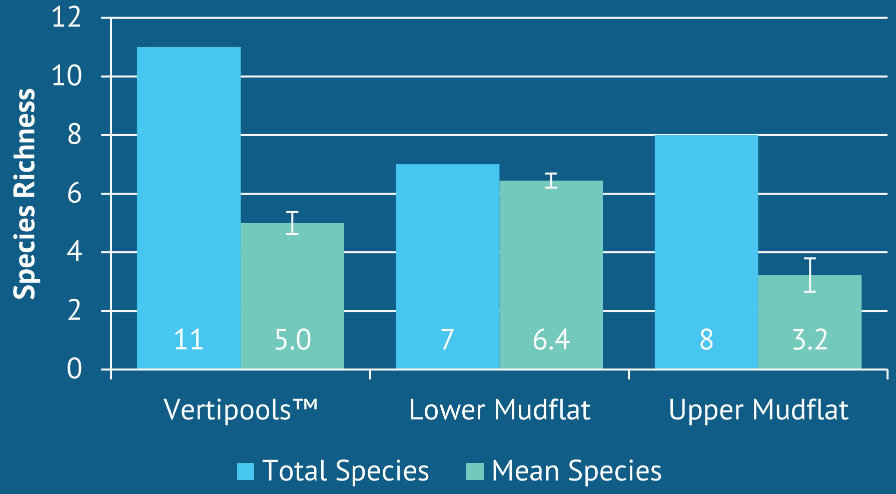
- Notes: One-off survey sampled mud in rockpools and compared to mud from adjacent mudflats
- Outcome:

Usually retain water and act as rockpools but retained mud and provided proof of concept of an “artificial” mudflat habitat

Basins keep mud wetter for longer during low tide and so had more species than mudflat at same tidal height

Paper published (scan QR)

Shortlisted for BIG Biodiversity award 2021



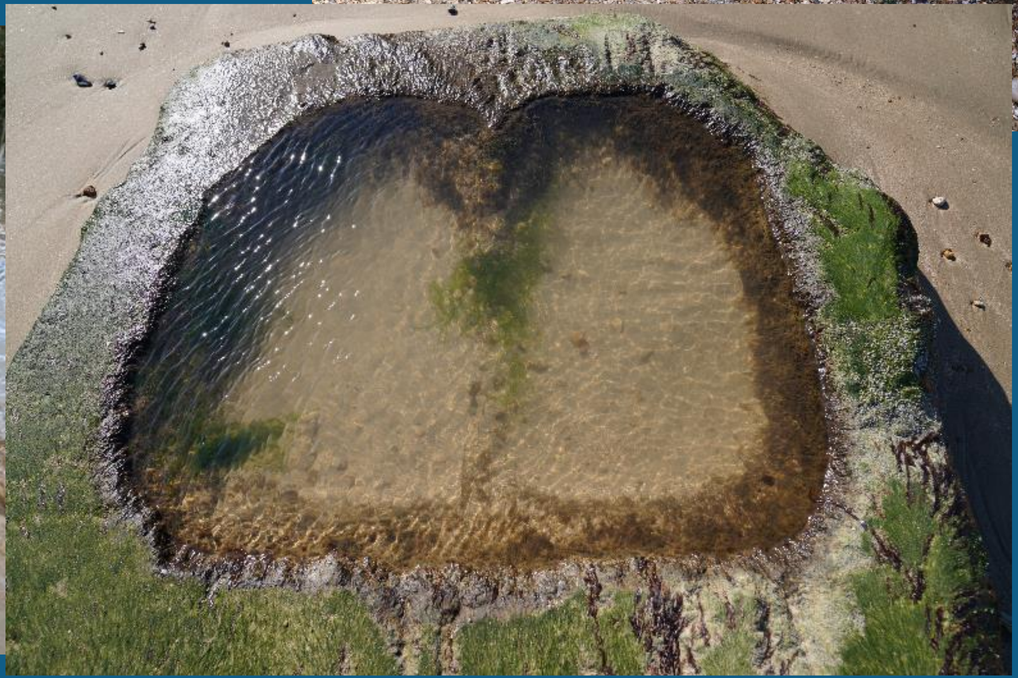
Environment Agency

MACKLEY

ARTECOLOGY

Hythe
Artificial rockpools and timber enhancements

- Installed: Autumn 2020
- Material: Vicat Prompt cement/ granite/ recycled timber
- Method of construction: Timber enhancements and Vertipools™ fixed to timber groynes by drilling into wood, granite pools made using a rock wheel



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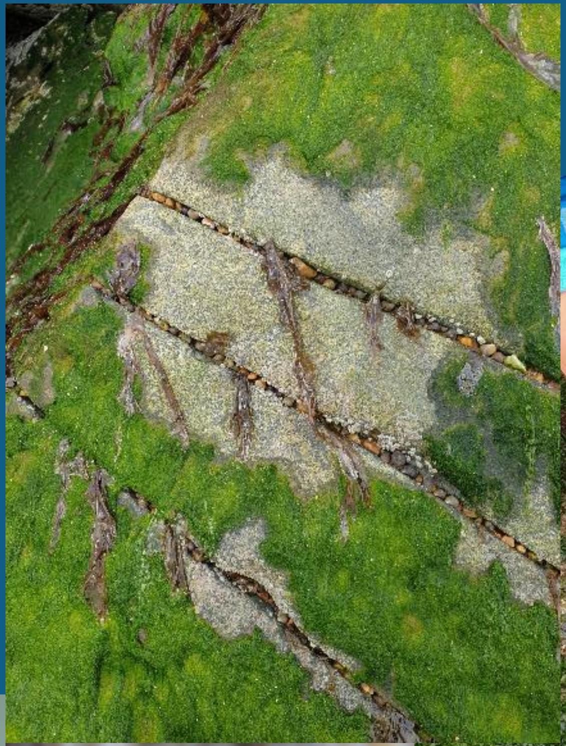
Hythe
Artificial rockpools and timber enhancements

- Notes: Vertipools™ were 'off the shelf', other interventions created by Mackley team as part of coastal defence works
- Outcome:

Some interventions worked better than others, honeycomb block, Vertipools™, granite rockpools were most diverse

Emphasised the importance of tidal height

Emphasised the importance of multiple surveys



BU Bournemouth University | BUG Bournemouth University Global Environmental Solutions

MACKLEY

ARTECOLOGY

Programme

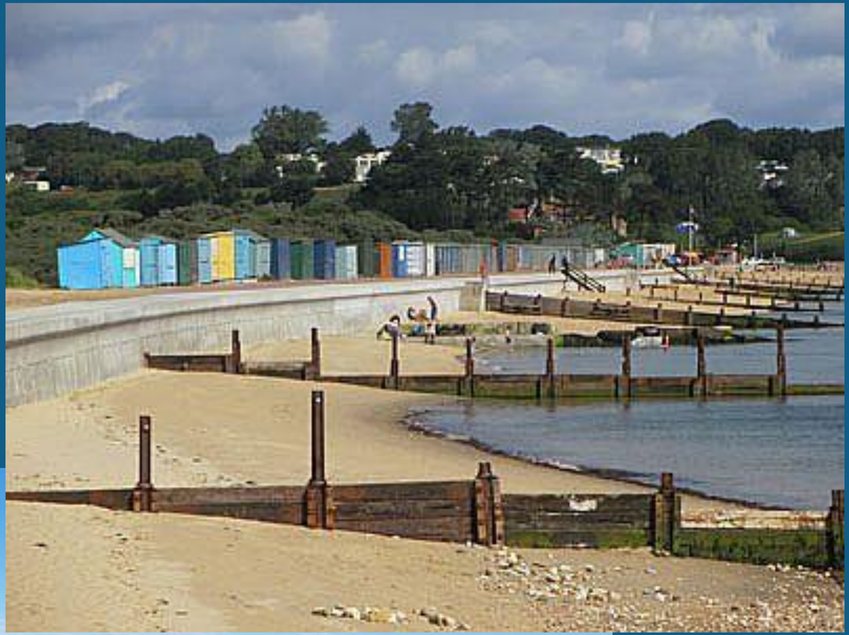
- 11.00 – 11.15 Refreshment break
- 11.15 – 12.30 Activity session 1 – intertidal case studies
- 12.30 – 13.30 Lunch
- 13.30 – 14.30 Presentation session 2 – subtidal interventions
    - Marineff
    - 3DPARE
    - Independent – Exo Environmental
    - Questions
- 14.30 – 15.45 Activity session 2 – subtidal case studies
- 15.45 – 16.00 Refreshment break
- 16.00 – 16.45 Panel discussion
- 16.45 Close/ comfort break before travel to fieldsite

After the break, please sit at the numbered table that corresponds to the number on your name badge

Activity 1 – Intertidal Case Study

- Each table has a case study about an intertidal coastal site
- Fill out the questionnaire you are given independently (5 – 10 minutes)
- Collaborate with the other people on the table to bring your ideas together as how the coastal infrastructure might be enhanced
- Use the ‘play dough’ and pens, paper to visualize and explain ideas
- Ask us questions as necessary
- Present your answers to the rest of the workshop at the end
- Consider – materials? How will this be constructed/ retrofitted? Public engagement? Stakeholders to engage? Policy?

Intertidal Case Study 1 – St Helens



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Intertidal Case Study 2 – Long Groyne

Intertidal Case Study 3 – Sandbanks

Intertidal Case Study 4 – Cowes

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Marineff Project

Jess Bone, Bournemouth University for Marineff

jbone@bournemouth.ac.uk

The Marineff Project

Speaker: Jess Bone
Research Assistant, Bournemouth University

Professor Roger Herbert – Principal Investigator
Professor Rick Stafford – Co-Principal Investigator

€ 5.7 million total budget

selected by

Interreg France (Channel Manche) England

co-funded by

European Union

European Regional Development Fund

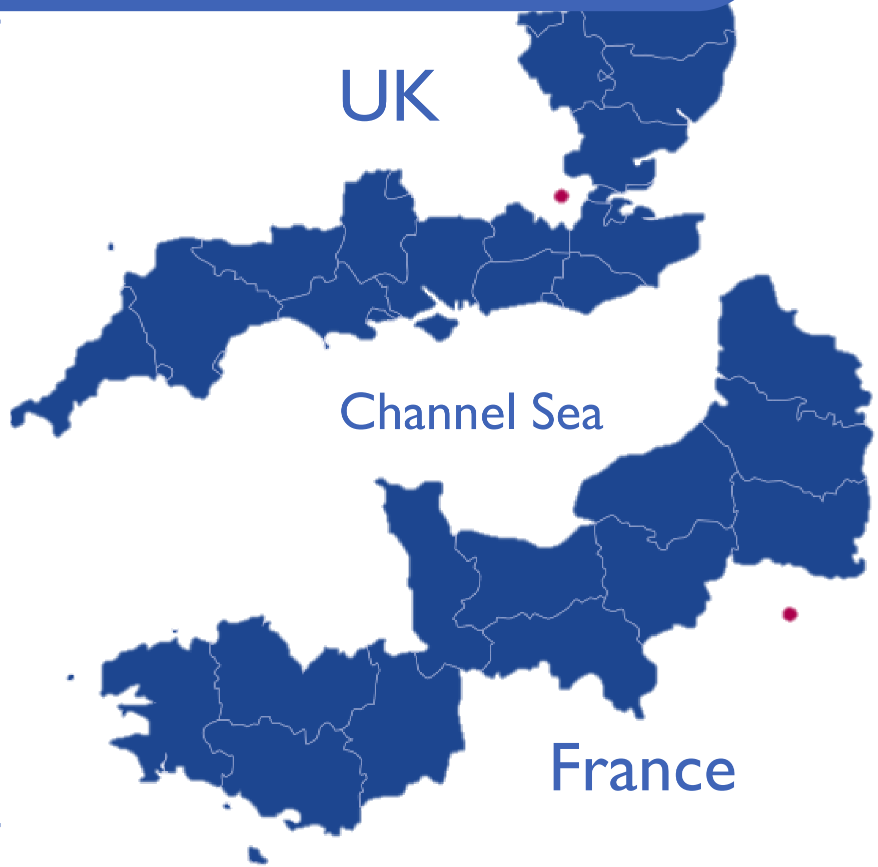
Nine project partners with multidisciplinary background:

- Marine ecologists/ biologists
- Coastal engineers
- Materials scientists
- Maritime industry professionals

The Marineff project aims to increase biodiversity on coastal infrastructure by producing proven concrete eco-engineering solutions that will provide habitat and be easily incorporated in development.

Running until June 2023

Project Area



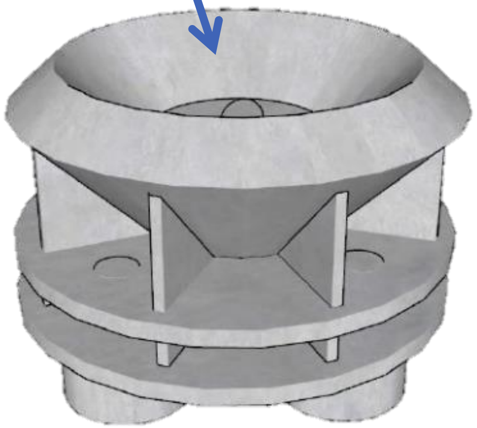
ESITC CAEN · Muséum national d'Histoire naturelle · Ports de NORMANDIE · TPC · VINCI CONSTRUCTION MARITIME ET FLUVIAL · UNIVERSITY OF Southampton · Bournemouth University · UNIVERSITY OF EXETER · UNICAEN UNIVERSITÉ CAEN NORMANDIE

MARINEFF

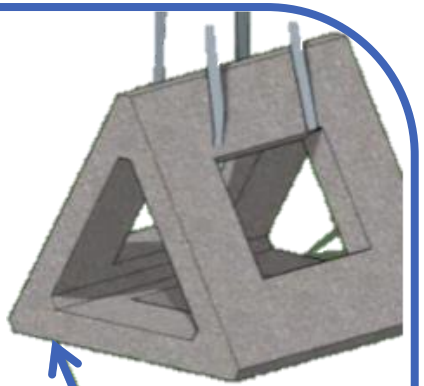
The Marineff eco-engineering modules

three subtidal units

boat mooring module



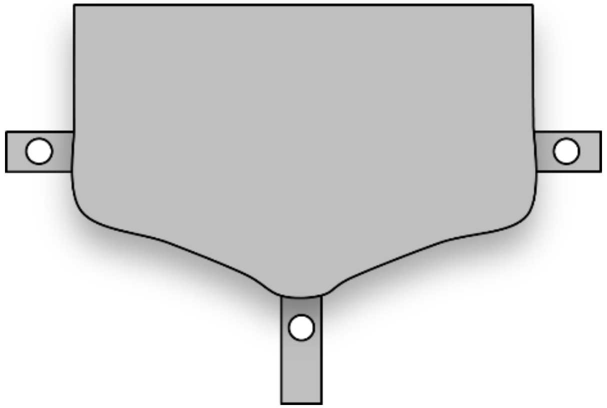
breakwater block



oyster prism

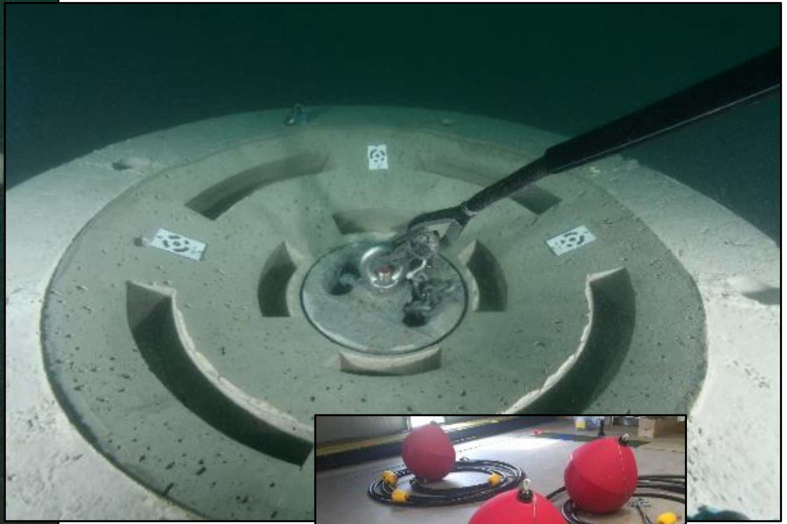
one intertidal unit

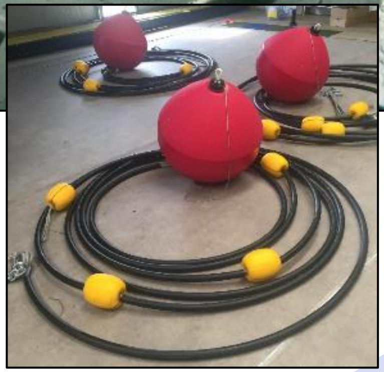
artificial rockpool



Boat moorings - design

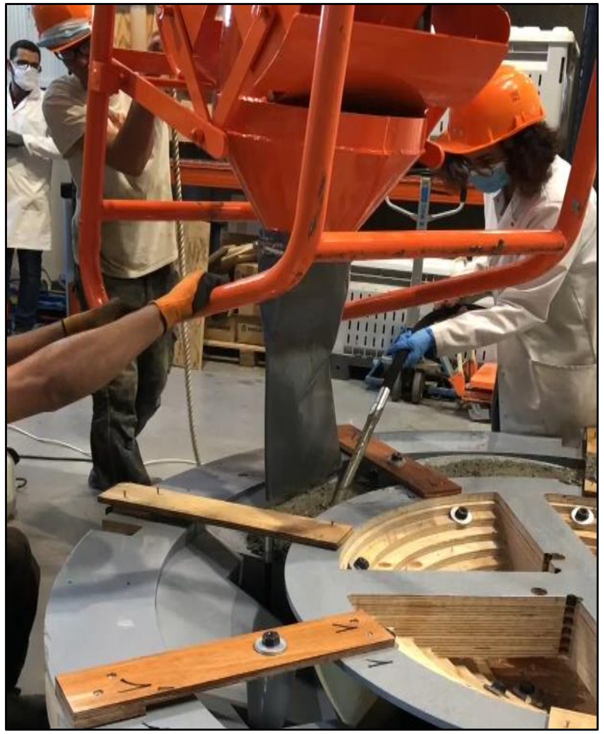
Diameter: 160cm
Height: 130cm
Weight: 2,900 kilos





Boat moorings – manufacture and deployment

- Deployed subtidally off coast of France in three offshore locations



Boat moorings – dive footage

https://youtu.be/Q6uFERKjVt4

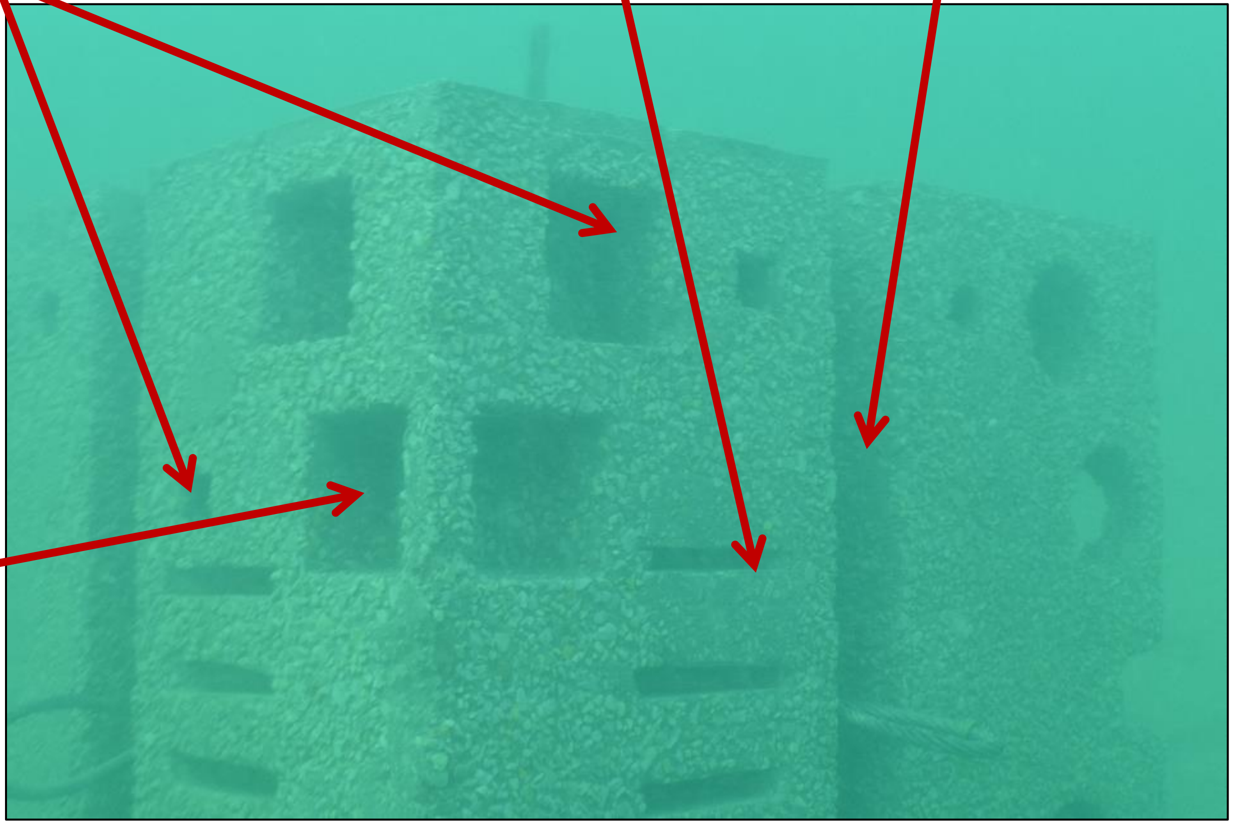
Breakwater blocks - design

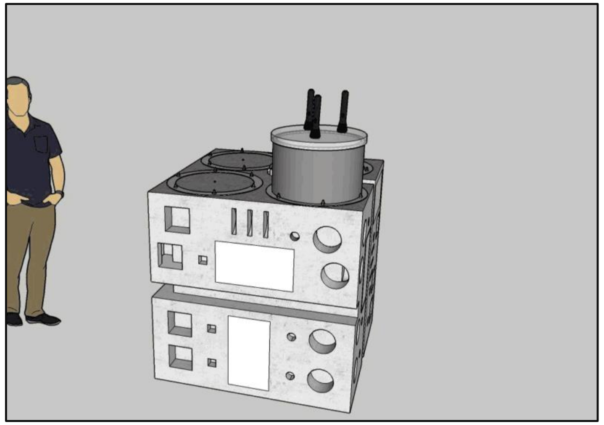
2 different shapes and size for various species

Groove

Gutter for suspension feeders

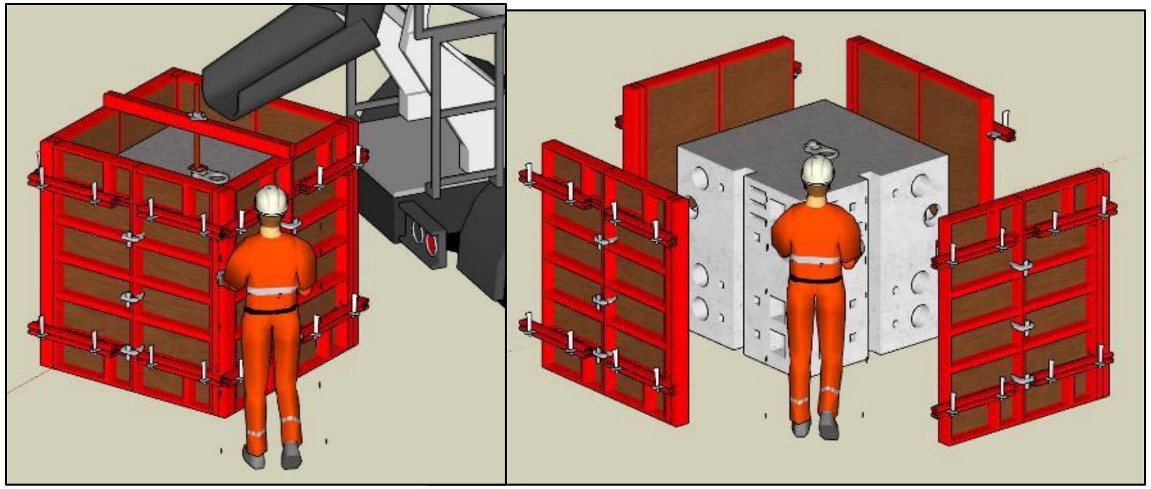
Tunnel allowing escape





Breakwater blocks – manufacture and deployment

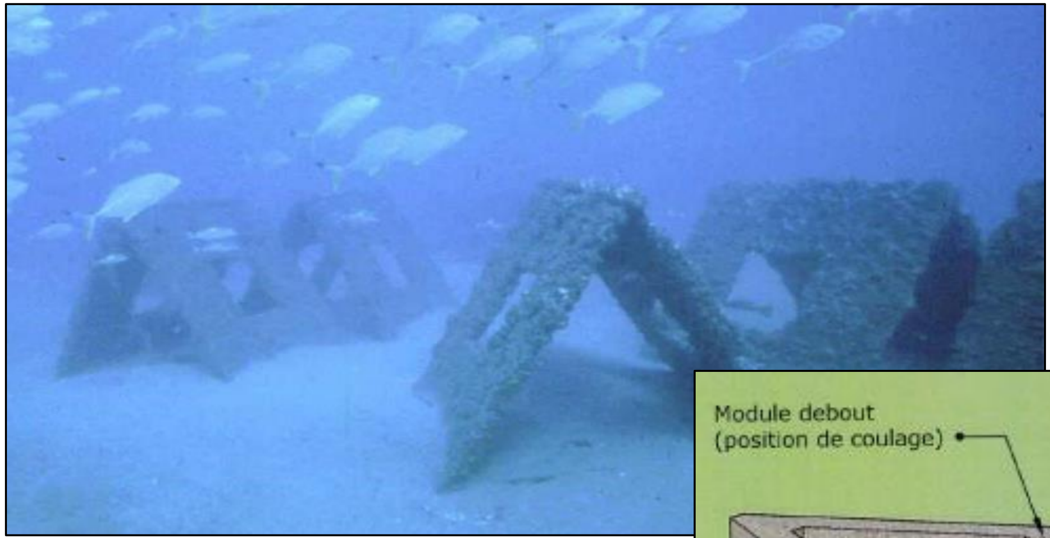
- Made with CEM II cement and 20% shell aggregate
- Deployed subtidally off coast of France in Cherbourg Harbour and offshore in the bay of Bernieres sur Mer

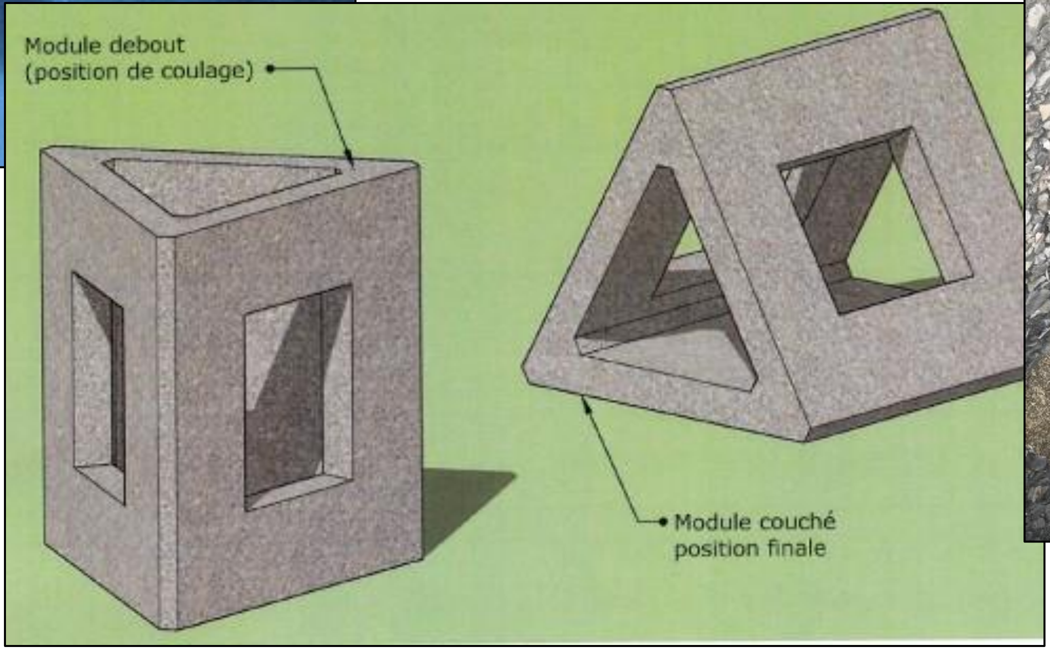


Breakwater blocks – corkwing wrasse

https://youtu.be/Vo3pkMcE1IE

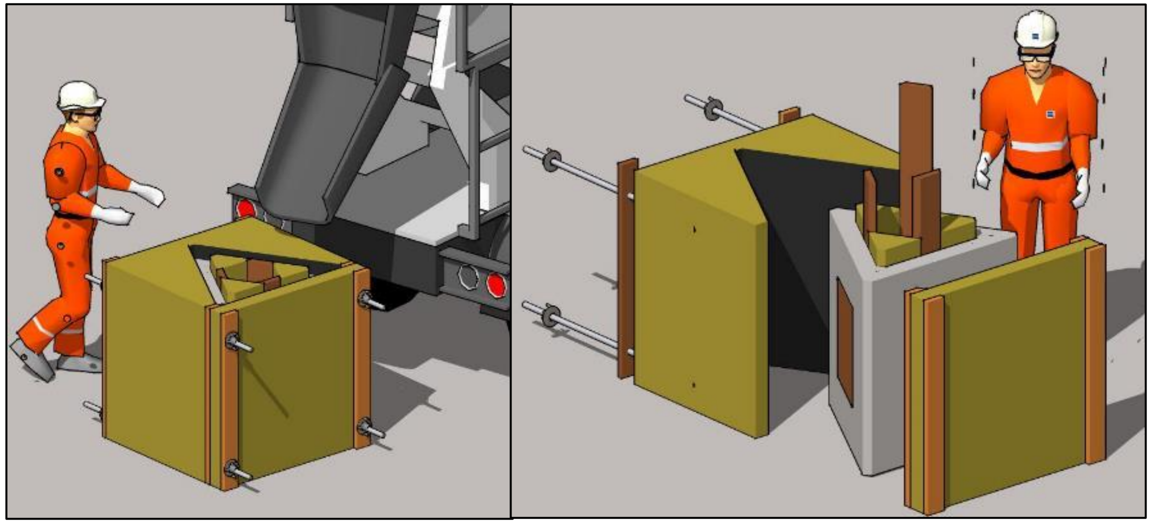
Oyster prisms - design





Oyster prisms – manufacture and deployment

- 26 deployed subtidally off coast of south England in the Solent Sea
- MMO license granted (four meetings with stakeholders and 7 months from application submission to permission granted)



Oyster prisms – dive footage

https://youtu.be/-9ePTVXuAWA

Thanks for watching!

Find and follow the Marineff project on:

@marineffproject

www.marineff-project.eu

@marineffproject

www.youtube.com
(Search Marineff Project)

Marineff ESITC Caen

Subscribe to our quarterly newsletter at our website on the 'Resources' page

3DPARE Project

Sam Greenhill, Bournemouth University for 3DPARE

greenhills@bournemouth.ac.uk

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

Speaker: Sam Greenhill

greenhills@bournemouth.ac.uk

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

The need for multifunctional coastal infrastructure

Ocean Sprawl

The rapid proliferation of hard artificial structures in the marine environment, replacing natural habitats (Firth et al 2016):

- **Coastal Defence** - Seawalls, groynes, breakwaters
- **Infrastructure** - Harbours, piers, pipelines, oil rigs, wind farms

- Increased pressure due to climate change mitigation and population growth (Bulleri and Chapman 2010)

3DPARE

Aim:

To deploy and monitor artificial reef units which have been designed and fabricated using novel 3D printing technology and sustainable, low-impact, bio-receptive materials.

Applications:

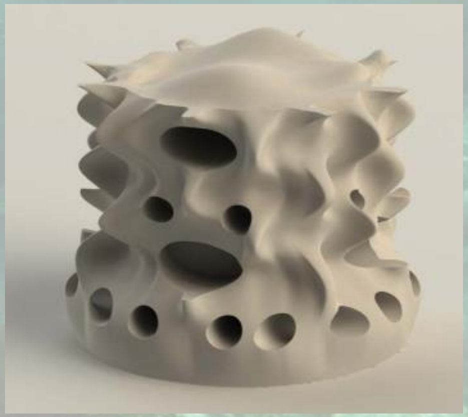
- Enhance marine infrastructure
- Increase local biodiversity
- Mitigate loss of natural habitat
- Enhance food production
- Enhance recreational amenity

www.3dpare.eu

Interreg
Atlantic Area
European Regional Development Fund
EUROPEAN UNION
3DPARE

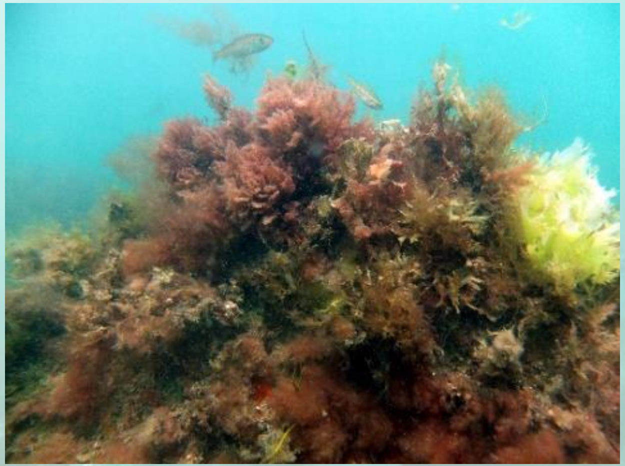
Advantages of 3D Printing

- ✓ Increase complexity of shapes, voids and textures
- ✓ Not limited by traditional moulds
- ✓ Cost-effective way to produce customised shapes
- ✓ Replicate easily around the world



3DPARE Project Development (2018-2020)

Review of existing artificial reefs in NE Atlantic region



Survey existing natural and artificial habitats in each region

6 concrete formulations tested – 3 geopolymer & 3 cement mixes

Immersed for 1, 3, 6, 12, 24m to test bioreceptivity

Top 2 concrete mixes chosen after resistance tests

Cement Limestone (CL) & Cement Glass (CG)

Pilot reef units created

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European Regional Development Fund
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3DPARE

Trials of 3D printing



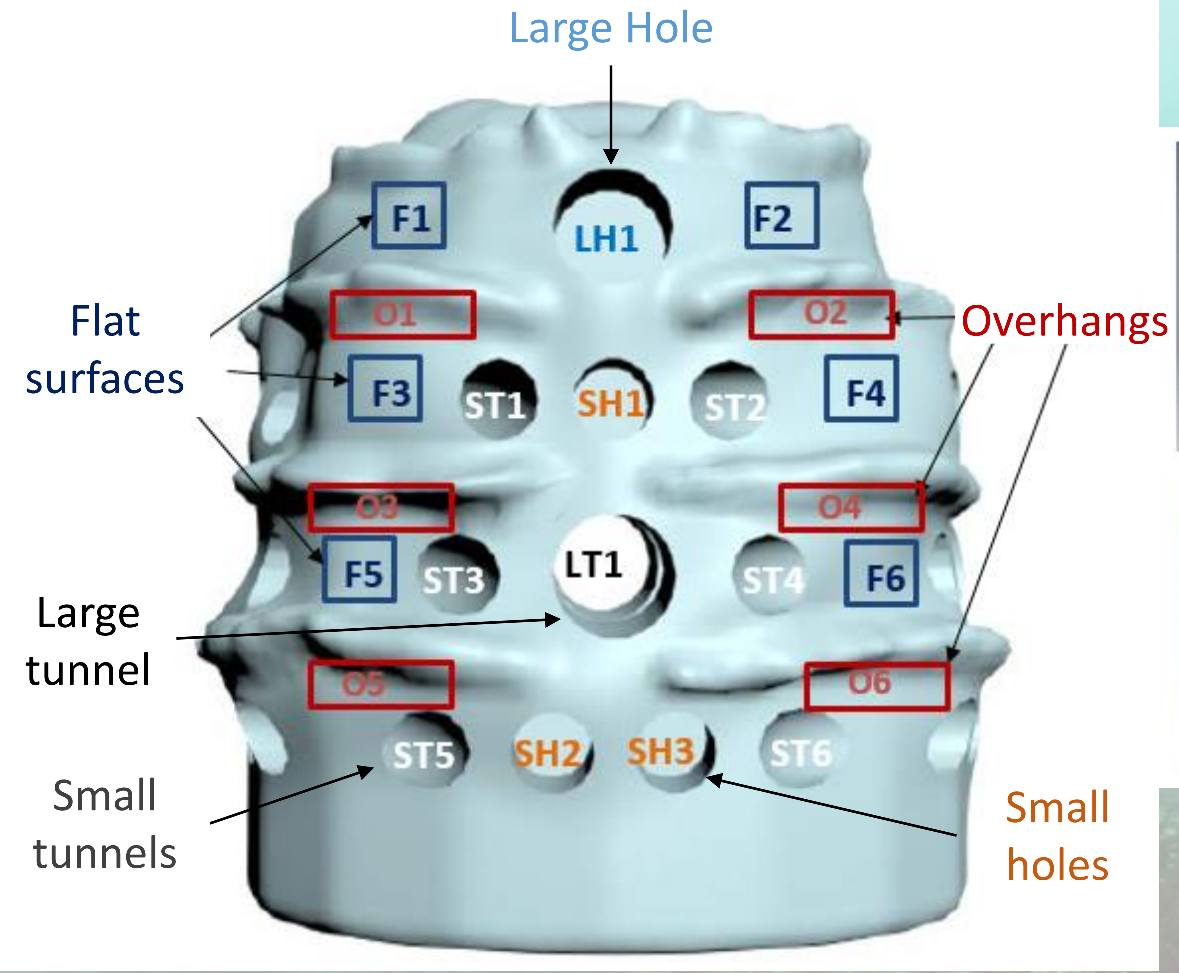


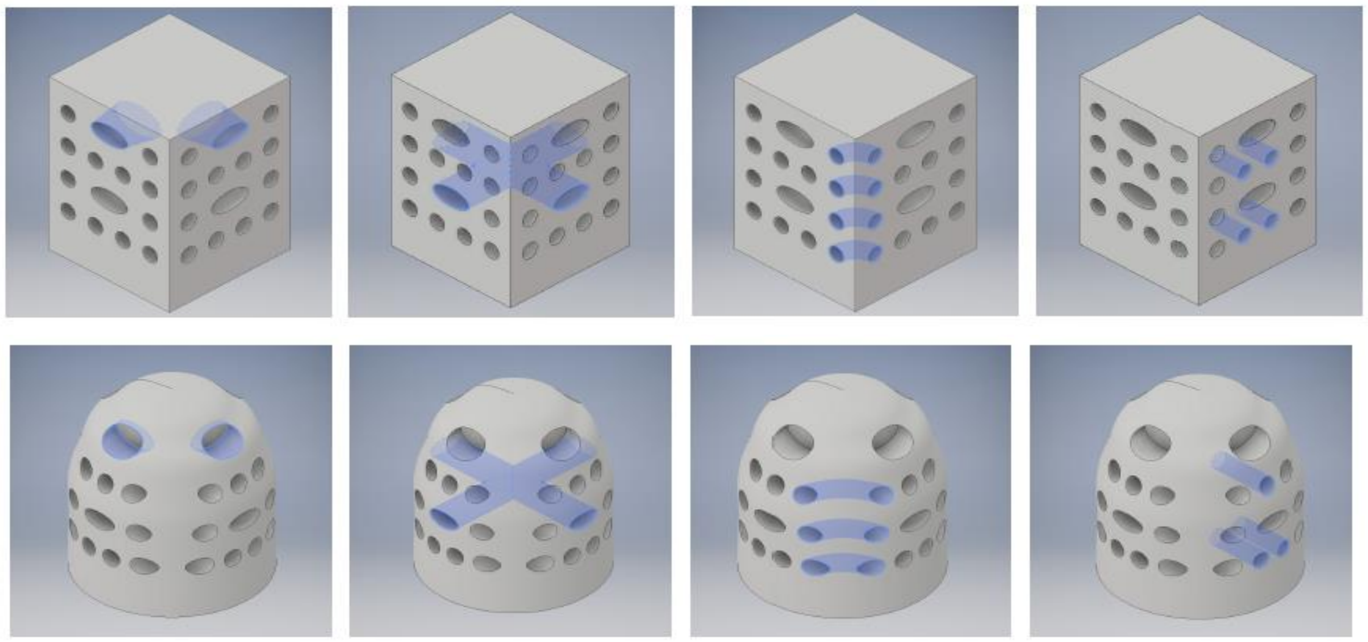

Fabrication

https://youtu.be/lOVRYpTu44c

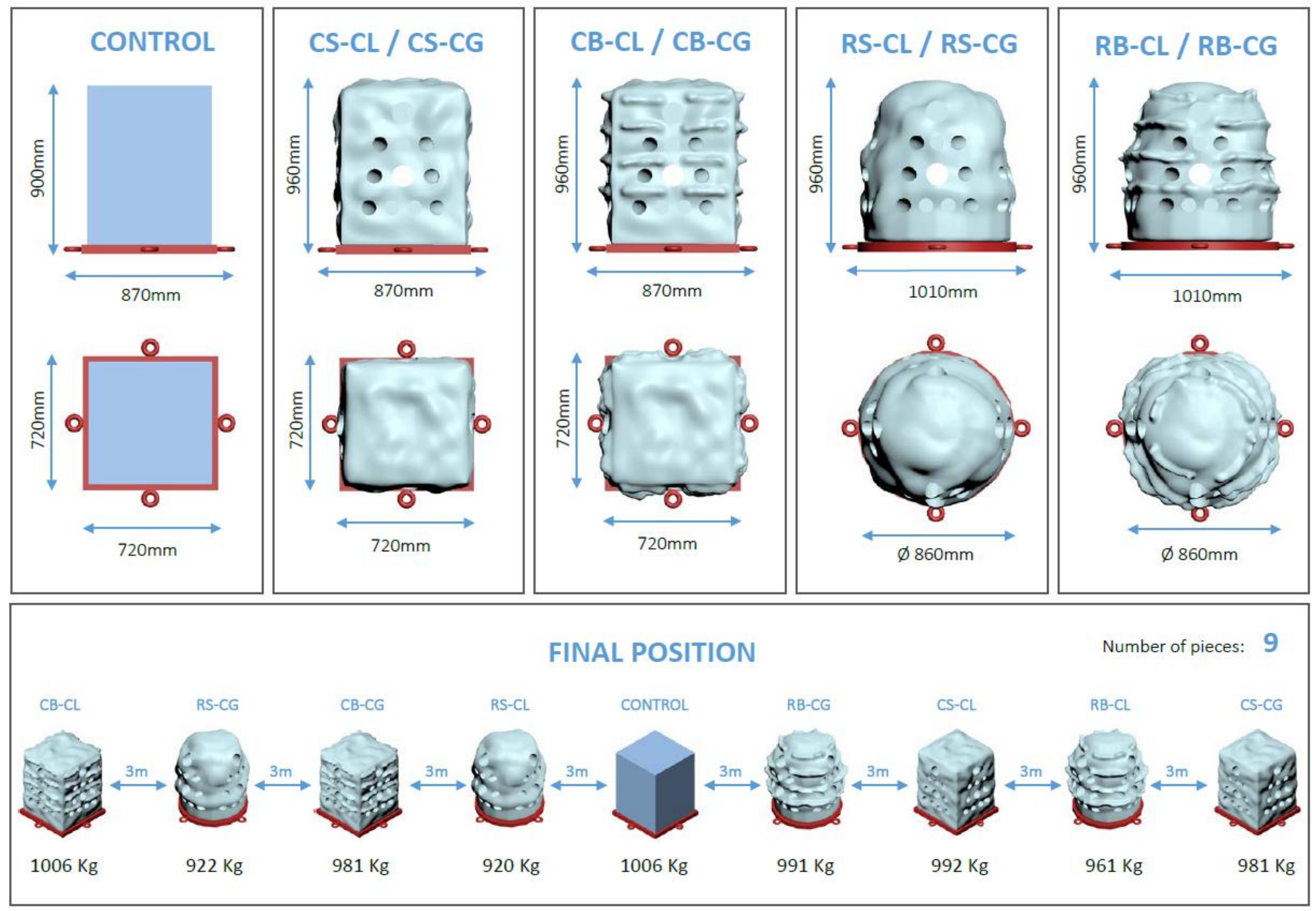
3DPARE Artificial Reef Design

3DPARE Artificial Reef Design



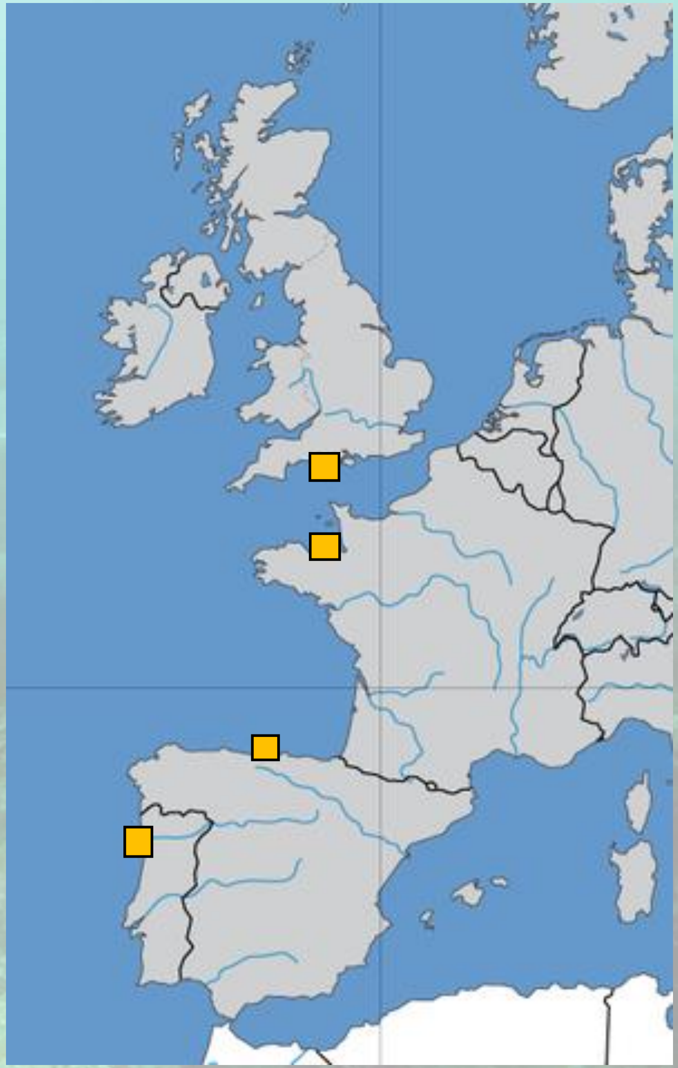


3DPARE Artificial Reef Design



Reef Deployment Sites

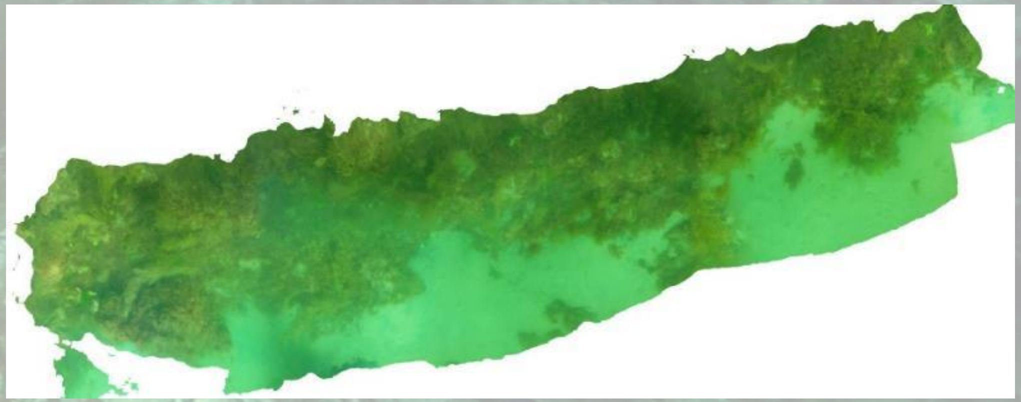
- UK - Poole Bay
- France - Saint-Malo
- Spain – Santander Bay
- Portugal – Porto



UK Reef Deployment Site

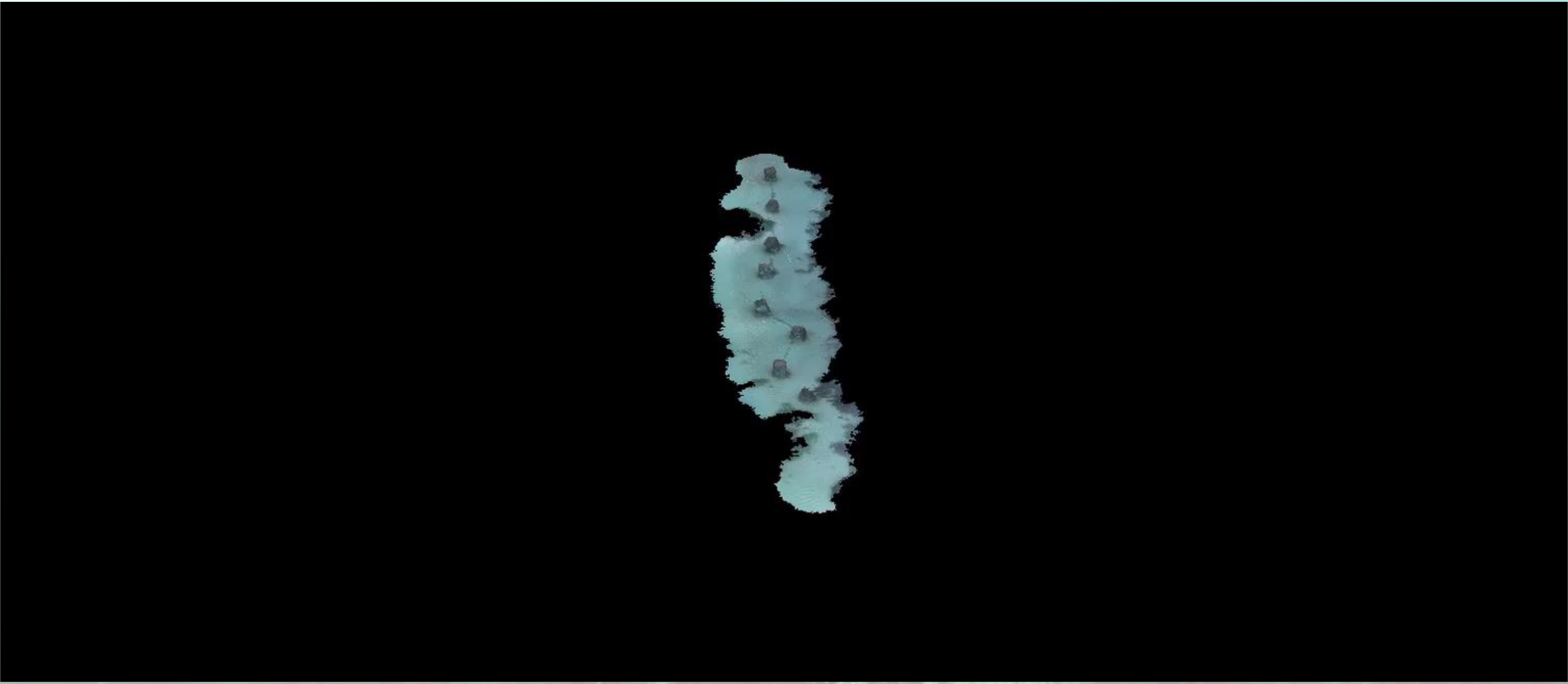
UK Location

- Training Bank, Poole Bay
- Depth 5-6m
- Sandy seabed



UK Reef Deployment March 2020

Photogrammetry of the 3DPARE reef



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Up to April 2022 survey

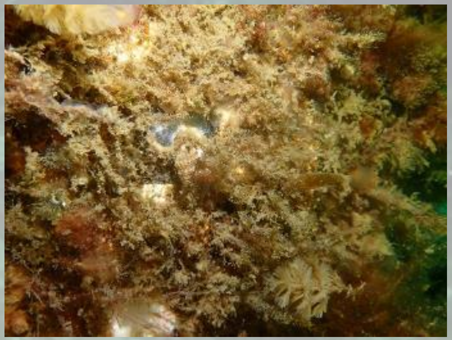
(2 years immersion time)

- 113 species recorded in total from dive and RUV surveys - red, brown, green algae, keelworms, tubeworms, nudibranchs, sea squirts, hydroids, bryozoans, sponges, echinoderms, anemones, barnacles, molluscs, bivalves, crabs and fish



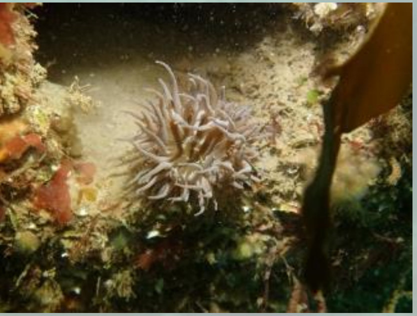




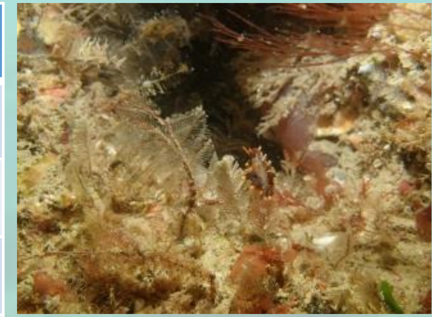



Up to April 2022 survey
(2 years immersion time)



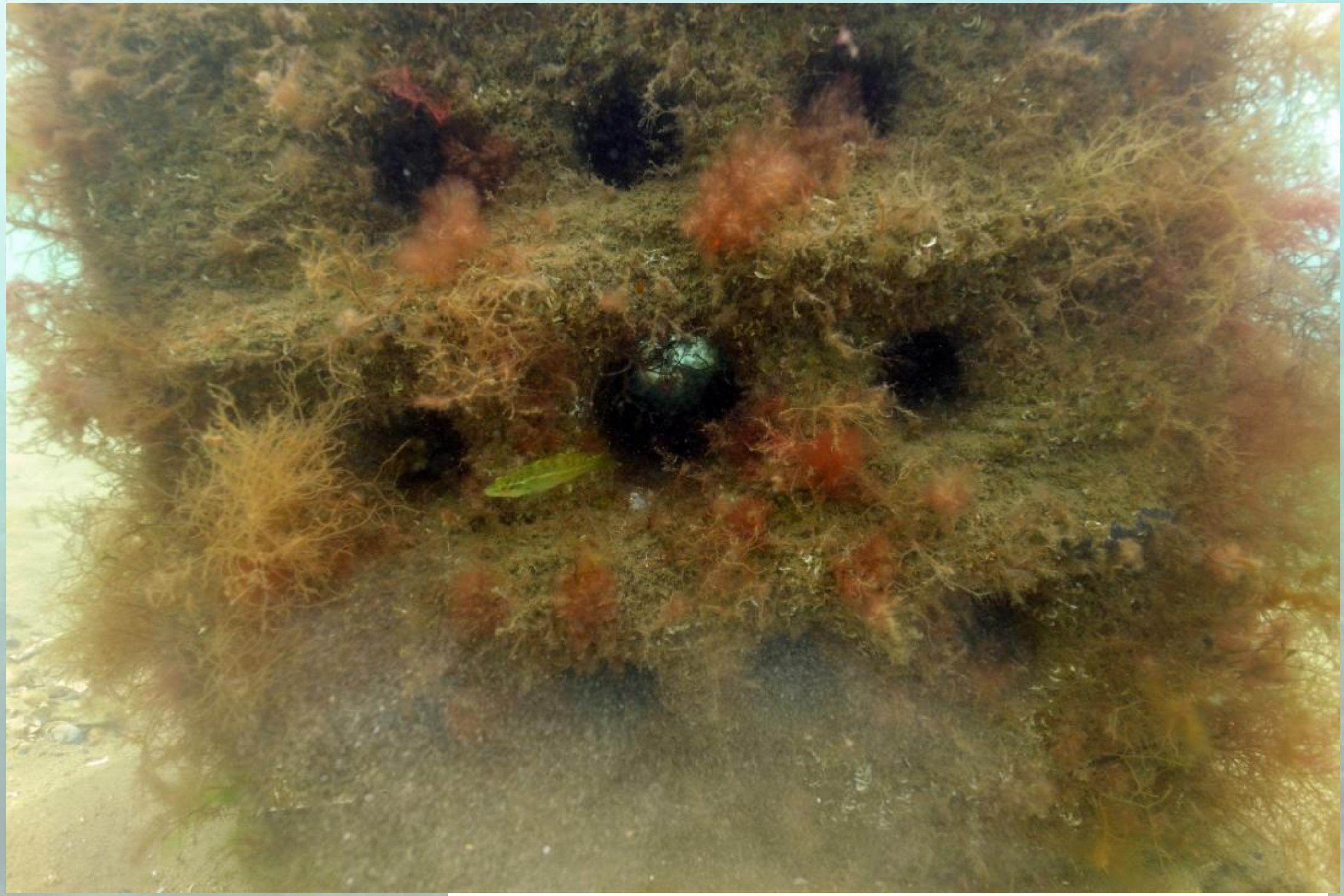


Taxonomic Group	Total number of species
Algae	25
Fish	23
Crustaceans	9
Gastropods	10
Cephalopods	1
Sea squirts & Tunicates	12
Hydroids	8
Bryozoans	8
Sponges	8
Tubeworms & Keelworms	4
Anemones	2



3DPARE reef units July 2021

Thank You!



3DPARE

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European Regional Development Fund
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Bournemouth University

Independent presentation by Exo Engineering

Will Melhuish, Exo Engineering

will.m@exo-env.co.uk

Exo Engineering – Will Melhuish

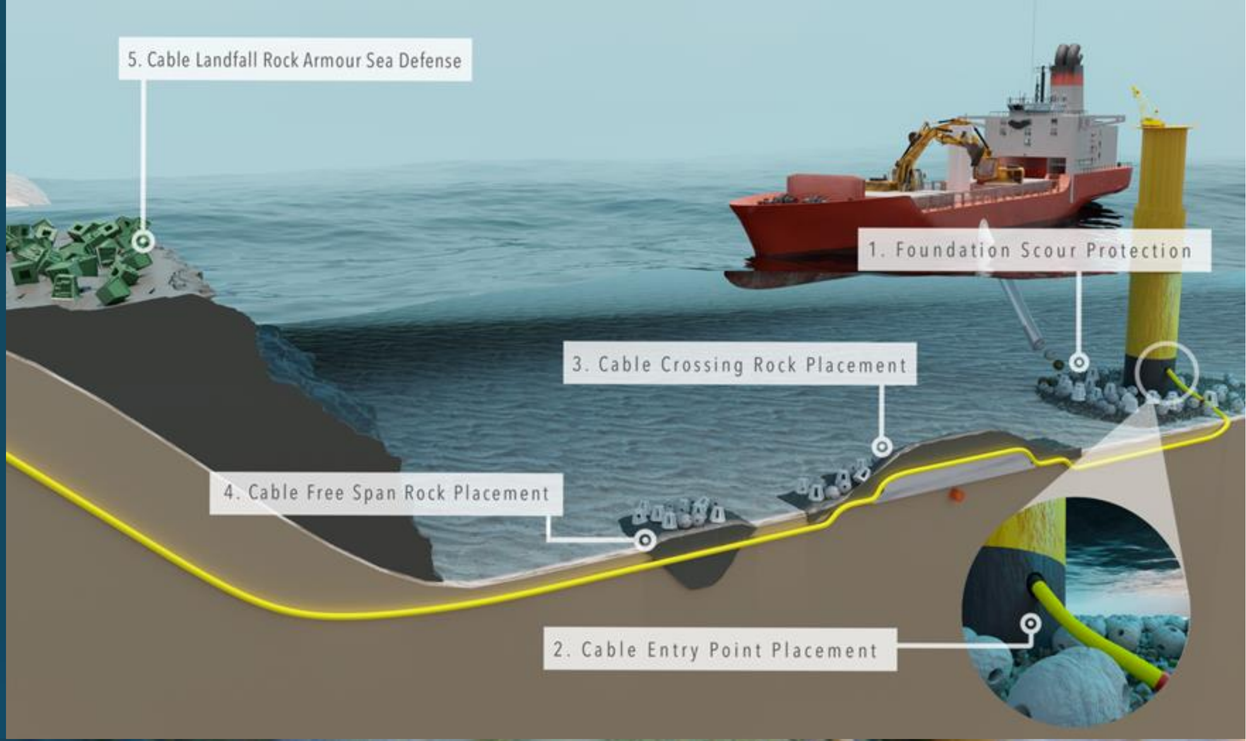
Nature Inclusive Scour Protection at Scale

Exo Engineering

Mission statement: Achieve large-scale environmental net gain for coastal and offshore infrastructure using ecological engineering designs.

Scour Protection

- Scour protection at turbine foundations and cable crossings
- Hard rock deployed on soft substrate
- Opportunity to use windfarms to enhance biodiversity and restore hard substrate habitats



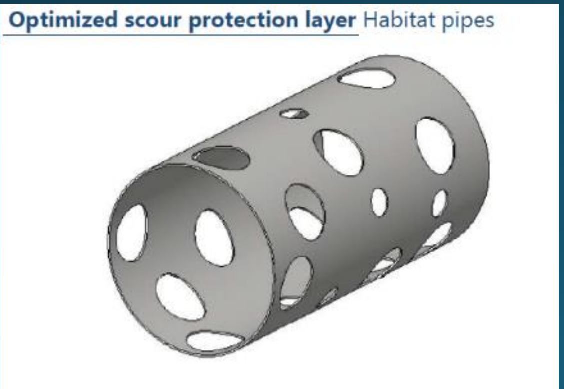
Artificial Reefs

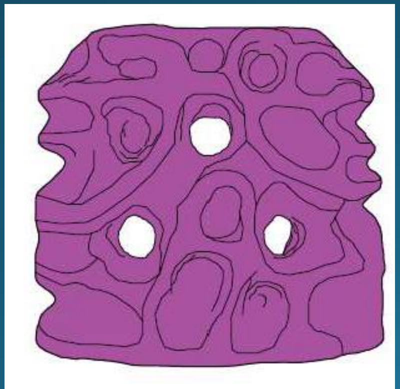
Scour protection can incorporate nature inclusive design to enhance “reef effect”

- Shelter for target species such as lobsters juvenile cod
- Encourage biocolination of sessile species
- Development of oyster reefs

Barriers to uptake:

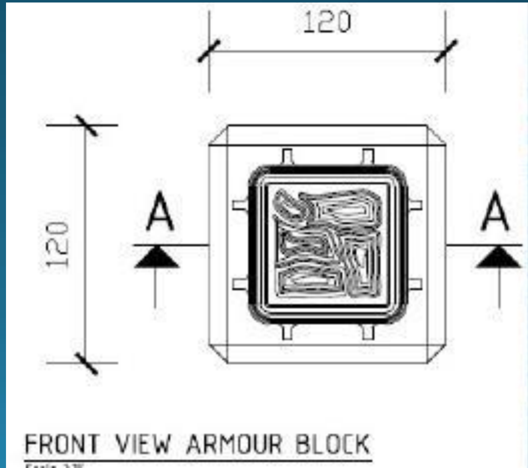
- Evidence lacking
- Cost per unit
- Deploying at scale
- Lack of incentives
- Legislation





Nature-Inclusive Design: a catalogue for offshore wind infrastructure

Technical report
The Dutch Ministry of Agriculture, Nature and Food Quality



Exo Engineering's Eco Reefs

- Designed for mass deployment.
- GeoBlock® technology: Using recycled materials to achieve carbon savings of 17% compared to conventional concrete.
- Greening the Grey®: Surface textures and microhabitats.

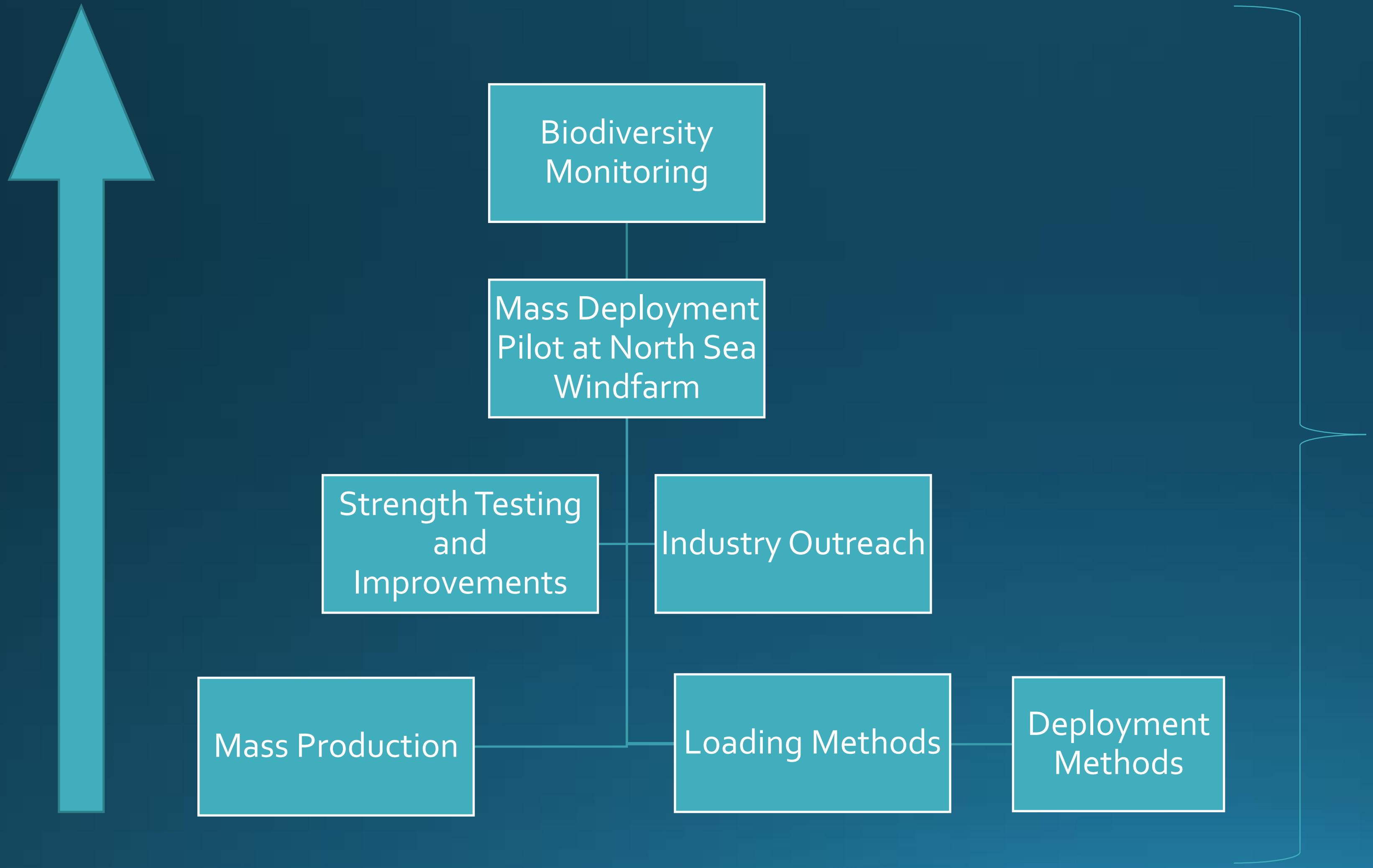
Living Windfarms Project

Aim: Establish mass production of Eco Reef scour protection units and full-scale pilot studies focusing on large scale deployment to enhance biodiversity gain.

Project Length

2022-2024

Steps to Mass deployment



Inform improvements in product design:

- Target species
- Environmental conditions
- Suitability for conventional deployment methods
- Inform adaptations to deployment methods

Open discussions between private and public sectors

- Build evidence base
- Understanding policy

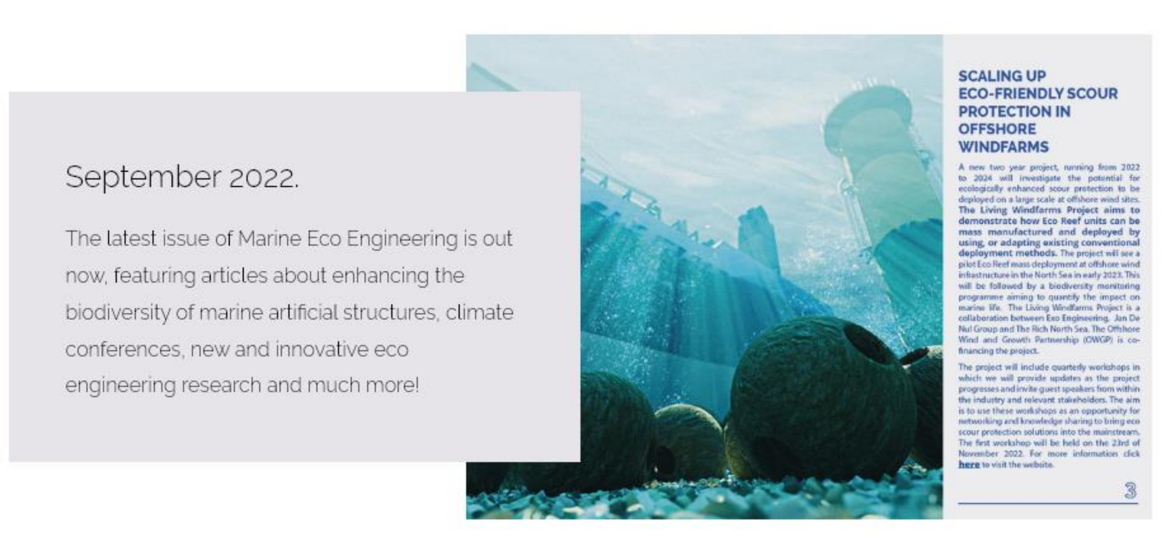
Collaboration Opportunities

Open to collaboration opportunities and involvement in workshops

- How can we target specific species?
- How can we target a range of environments?
- How can we predict the community assemblages where these units are deployed?
- How can we monitor biodiversity?
- How can we developer requirements?
- How can we navigate existing and upcoming policies and legislation?

Stay up to Date

- https://www.livingwindfarms.com/
- @Exo_Engineering
- https://www.exo-engineering.co.uk/news



September 2022.

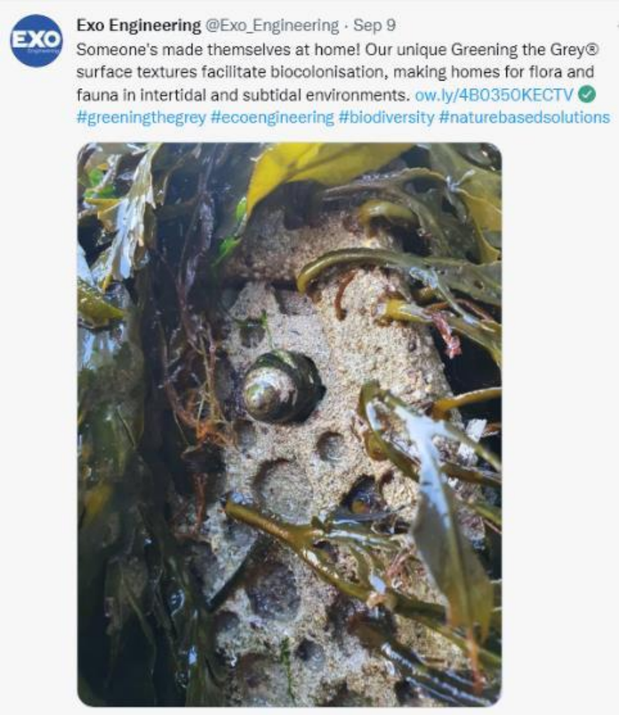
The latest issue of Marine Eco Engineering is out now, featuring articles about enhancing the biodiversity of marine artificial structures, climate conferences, new and innovative eco engineering research and much more!

SCALING UP ECO-FRIENDLY SCOUR PROTECTION IN OFFSHORE WINDFARMS

A new two year project, running from 2022 to 2024 will investigate the potential for ecologically enhanced scour protection to be deployed on a large scale at offshore wind sites. **The Living Windfarms Project aims to demonstrate how Eco Reef units can be mass manufactured and deployed by using, or adapting existing conventional deployment methods.** The project will see a pilot Eco Reef mass deployment at offshore wind infrastructure in the North Sea in early 2023. This will be followed by a biodiversity monitoring programme aiming to quantify the impact on marine life. The Living Windfarms Project is a collaboration between Exo Engineering, Jan De Nul Group and The Rich North Sea. The Offshore Wind and Growth Partnership (OWGP) is co-financing the project.

The project will include quarterly workshops in which we will provide updates as the project progresses and invite guest speakers from within the industry and relevant stakeholders. The aim is to use these workshops as an opportunity for networking and knowledge sharing to bring eco scour protection solutions into the mainstream. The first workshop will be held on the 23rd of November 2022. For more information click **here** to visit the website.

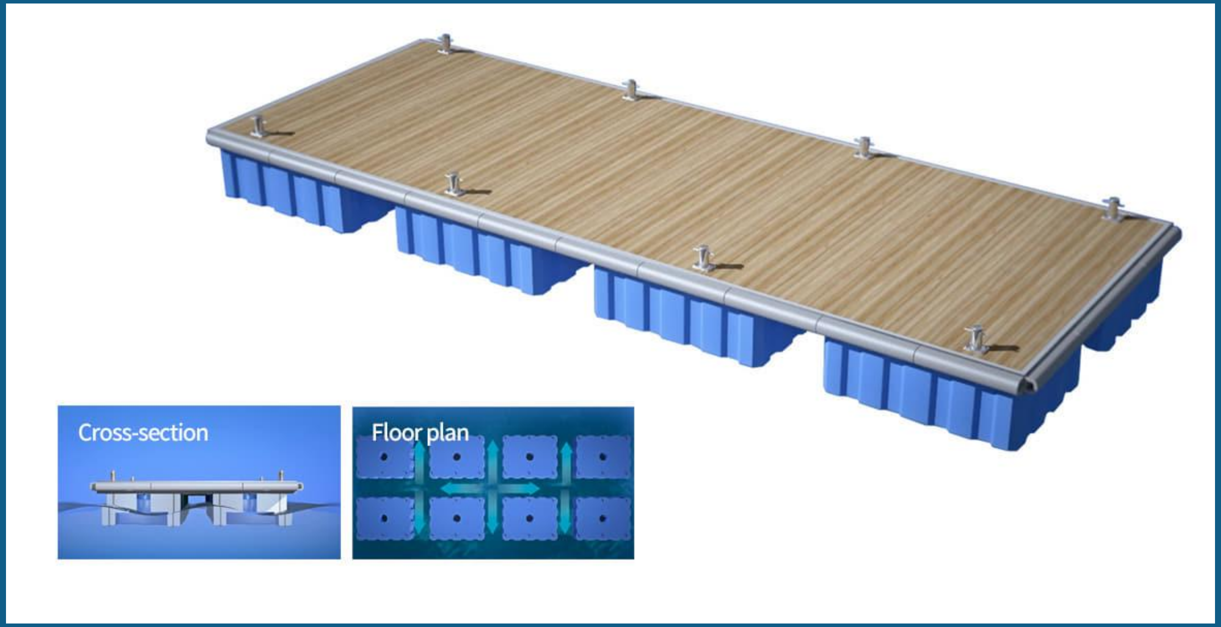
3



Activity 2 – Subtidal Case Study

- Each table has a case study about a subtidal site or structure
- Fill out the questionnaire you are given independently (5 – 10 minutes)
- Collaborate with the other people on the table to bring your ideas together as how the coastal infrastructure might be enhanced
- Use the ‘play dough’ and pens, paper to visualize and explain ideas
- Ask us questions as necessary
- Present your answers to the rest of the workshop at the end

Subtidal Case Study 1 – Floating pontoons



Subtidal Case Study 2 – Long Groyne

Subtidal Case Study 3 – Cowes

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Subtidal Case Study 4 – Wind farm

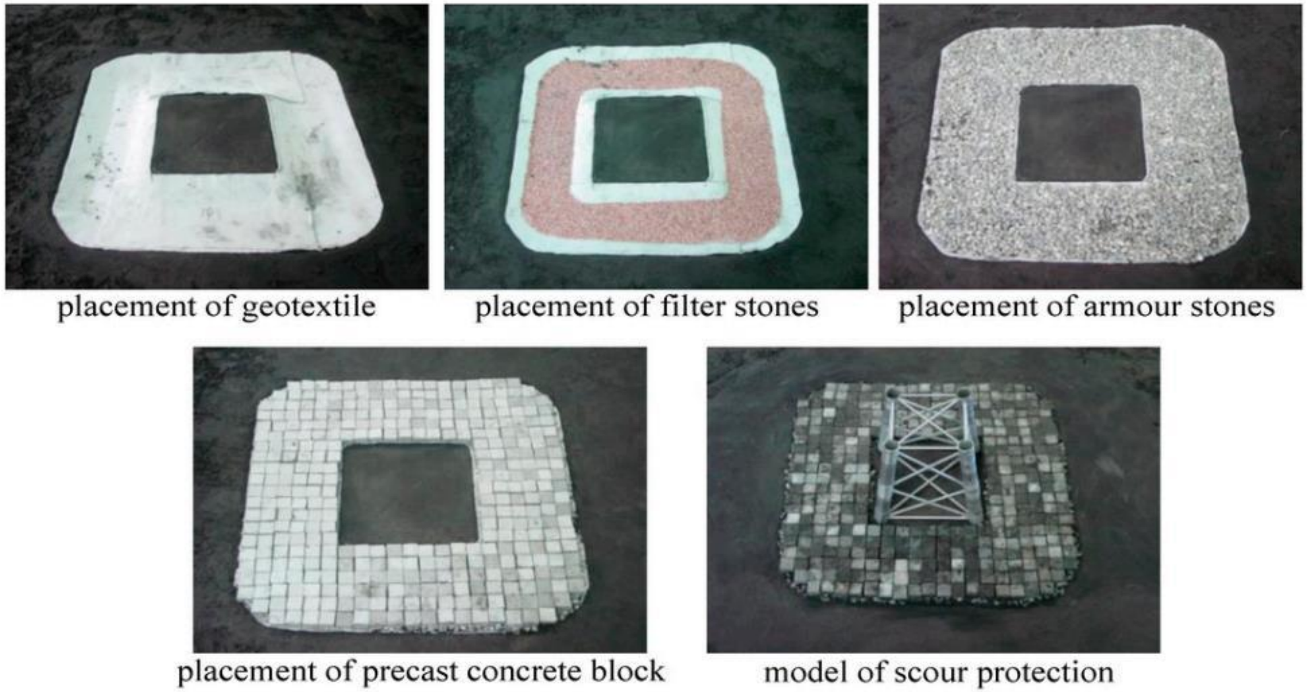

Figure 5. Different scour protection systems. Reproduced from Chen, H. et al. 2014 with permission

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Panel Discussion

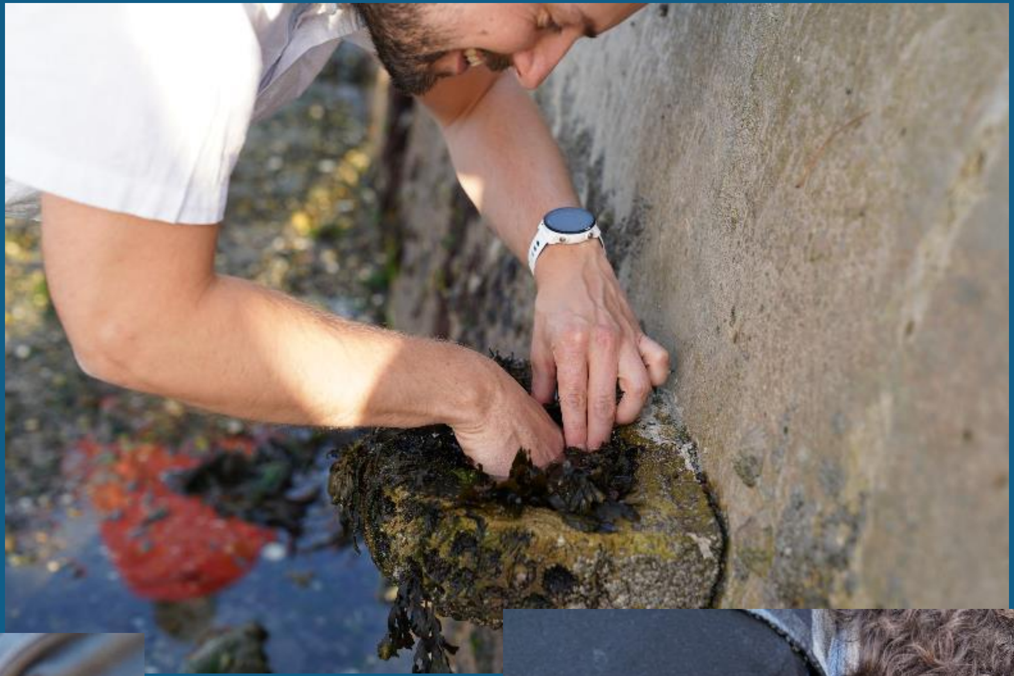
Jess Bone – Marineff Project

Sam Greenhill – 3DPARE Project

David Miko – SARCC Project

Joe Ironside – Ecostructure Project

Fieldtrip to Poole Harbour Marineff rockpools



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Photos from the workshop