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MARINEFF
MARine INfrastructure EFFects

How to get involved

If you are interested in keeping up to date with all current projects, you can subscribe to this newsletter, follow us on Facebook or Twitter or visit the news section of the website. If you are interested in attending a workshop, please contact Jess Bone, Bournemouth University.

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To sign-up to this quarterly newsletter, send an email to: **marineff@ciria.org**

Please note, upon sending an email to this address, you will be automatically signed up to the Marineff mailing list and included in future newsletter communications. Information on how your data is handled can be found at: **https://www.ciria.org/marineff**

Instructions on how to opt out of mailings will be provided in future emails.

Further information

To find out more about the Marineff project, go to:

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The project

Welcome to the first newsletter from the MARine INfrastructure EFFects (Marineff) project.

This will be a quarterly publication, providing general project updates, exploring current industry challenges and then reviewing how the Marineff project seeks to overcome them.

In this issue

- **The team** – who is delivering Marineff?
- **The big picture** – an overview of the key activities in this exciting project.
- **The challenges** – an introduction to the main challenges that the project will aim to address.
- **The story so far** – where we are on the timeline of the Marineff project.
- **The broad view** – how does the project link with other initiatives?
- **The project partners** – introducing the nine multidisciplinary partners collaborating on the Marineff project.

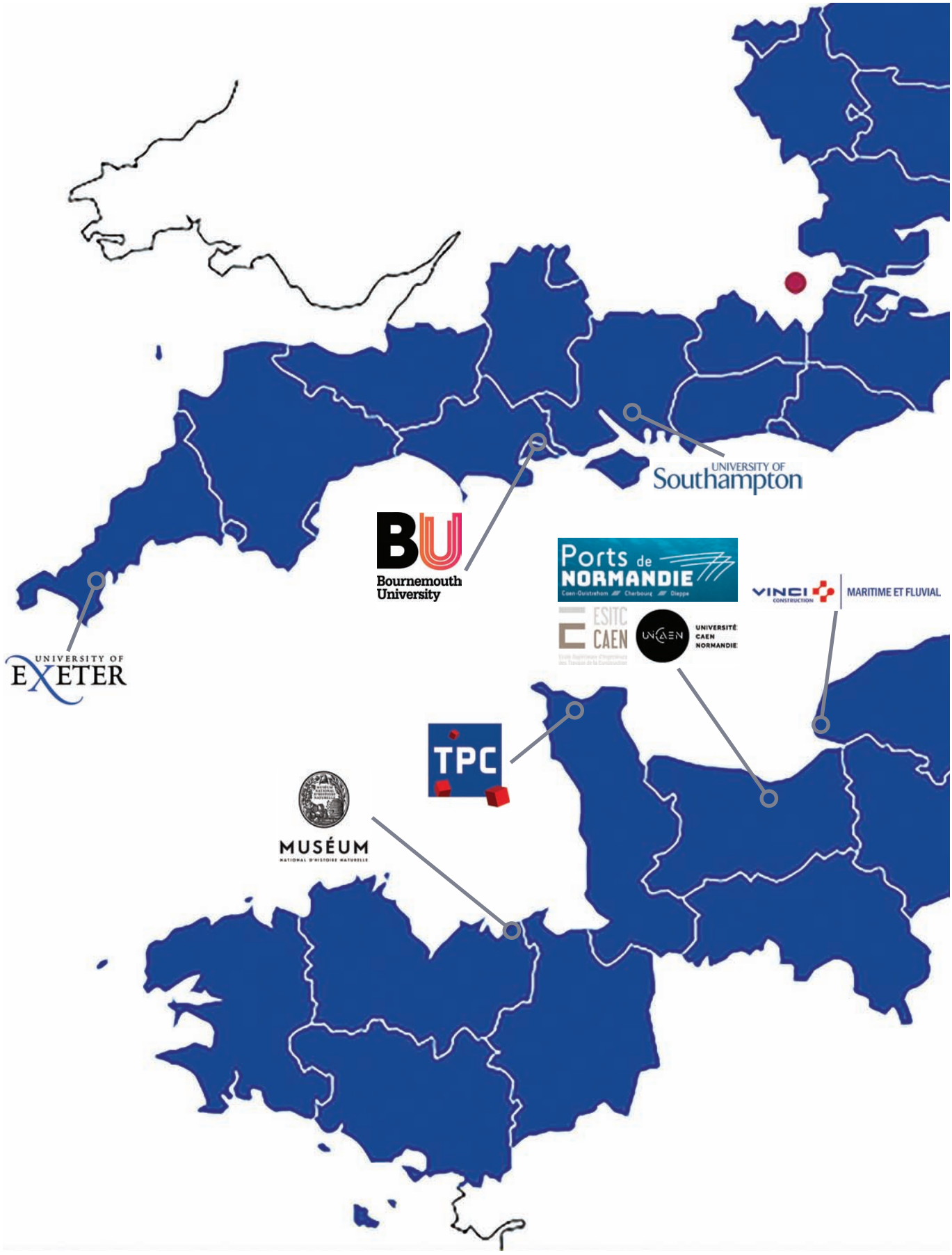
In a nutshell

Welcome to the launch edition of the Marineff project. The Marineff project (MARine INfrastructure EFFects) is an exciting cross-channel multidisciplinary project spanning the UK and France.

The Marineff project's primary goal is to protect and enhance coastal ecosystems in the Channel region by developing ecological enhancement (also referred to as biomimetic marine infrastructure) that will provide habitat opportunities for marine species in areas of coastal infrastructure. It is unique in that it will address issues found by coastal engineers and developers when incorporating eco-engineering by drawing on expertise from multidisciplinary partners and subcontractors. This ranges from testing the robustness of concrete mixes to the optimum arrangement of eco-engineering units for species colonisation. The outcome will be solutions that can easily be incorporated in coastal planning and infrastructure in the future and be readily colonised by marine species. The aims of the Marineff project are consistent with the UK's biodiversity net gain policy, and France's Biodiversity Law 2016. The Marineff project is funded by the European Union's European Regional Development Fund (Interreg).

Dr Ken Collins of University of Southampton with his fieldwork assistant deploying concrete samples in Beaulieu River, UK

The Marineff team

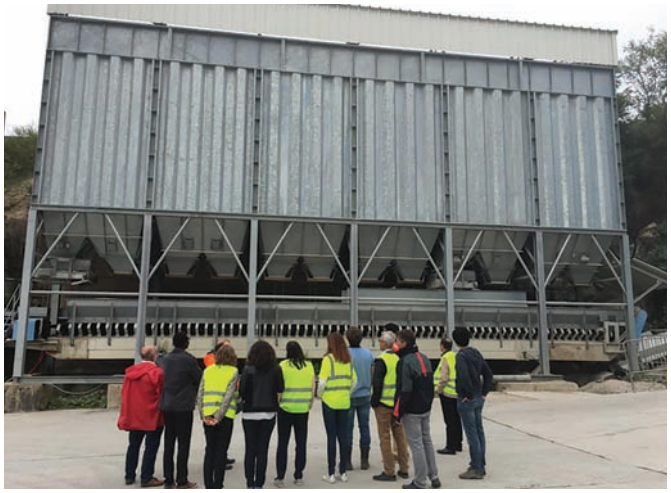


The big picture

Biodiversity loss is occurring at a phenomenal rate on a global scale. By 2100 more than half of the planet's marine species may face extinction without significant changes. Coastal ecosystems are possibly the most threatened of marine systems due to the multitude of pressures focused on the coastal zone. They range from fishing and recreational use to sea-level rise and coastal development. The Marineff project aims to produce solutions for habitat and biodiversity loss in the coastal zone, from design to delivery. These solutions will be proven to be ecologically viable while appealing to the coastal infrastructure industry as feasible, affordable and easy to incorporate.

A unique and collaborative approach

The Marineff project brings together marine biologists and materials scientists with industry experts. The focus is eco-engineering which will incorporate nature's blueprints into human design. The predominant material used in these eco-engineering solutions will be concrete. Before the experimental deployment of eco-engineering units, concrete samples will be tested first for mechanical strength, water porosity and chloride ion (seawater) ingress. The final concrete formulas will then be used to manufacture the Marineff eco-engineering units.



Project partners visiting the production site for the breakwater units at Qualibeton SNC, France

Areas concerned

As a cross-channel project, Marineff spans the south coast of England and the north coast of France (not including the Channel Islands). Three of the nine partners are UK based, including University of Exeter, University of Southampton and Bournemouth University. The remaining six partners are based in France, including the Institute of Civil Engineering and Construction Caen (ESITC Caen), Ports Normandie Association (PNA) and University of Caen-Normandy in Caen, Cotentin Public Works in Cherbourg, VINCI Maritime and Fluvial Construction in Paris, and the National Museum of Natural History's marine centre in Dinard. Potential deployment sites of eco-engineering include the Dorset, Isle of Wight and Normandy.

Key activities

The Marineff project is divided into five work packages (WP) with a designated partner leading each one.

WP M – Project management and administration, led by ESITC Caen and co-led by University of Southampton

The task of day-to-day running of the overall project is managed by ESITC Caen in France and the University of Southampton in the UK. The legal, financial and administrative co-ordination is no small feat, and both organisations ensure progress on technical development and monitoring and enable co-ordination between all partners.

WP C – Communication, led by ESITC Caen and co-led by University of Southampton

The aim of WP C is to spread awareness of the Marineff project and its aims and objectives within the wider community.

WP T1 – Biomimetic eco-engineering for native Oysters, led by University of Southampton

The aim of WP T1 will be to develop eco-engineering to support, protect and increase the native European oysters (*Ostrea edulis*) survival and reproduction in its natural environment. Its transferability will be ensured to promote a long-term oyster bed restoration strategy across the entire Channel area. Following the design phase, a large-scale pilot operation will submerge 26 eco-engineering units in Calshot, UK and four units in Cherbourg and Dinard, France for the settlement of native European oyster larvae.

WP T2 – Biomimetic eco-engineering for coastal infrastructure, led by ESITC Caen and co-led by Bournemouth University

The aim of WP T2 is to develop eco-engineering structures to create new habitat opportunities to compensate habitat loss and to promote colonisation of marine species. Marine ecologists, materials scientists and coastal infrastructure professionals will work synergistically to produce optimised cement-based solutions. These include a harbour breakwater, artificial rockpools, and underwater yacht moorings. These eco-engineering units will be deployed at five sites throughout the Channel.

WP T3 – Professional network development, led by Bournemouth University and co-led by PNA

The aim of WP T3 is to create a stakeholder network with which to consult for the project. The dissemination of milestones and results will be achieved primarily by this newsletter, which is aimed at a professional audience of coastal managers, engineers, planners and ecologists. Workshops and training will be hosted during the project to ensure timely delivery of solutions to market and the continuation of project aims and long-term results beyond its closure.

The challenges

The Marineff project aims to address and provide solutions for issues that occur within the coastal development industries – from improving biodiversity to facilitating greater collaboration between ecologists and engineers.

Improving coastal biodiversity

With nearly half of the planet's human population living along the coast, the number of coastal artificial structures are increasing worldwide. Hard engineering, such as sea defences and shipping infrastructure, has changed over 50 per cent of the coastline in Europe, the USA, Australia and Asia. This reduction in natural coastline coupled with sea level rise leads to a loss in coastal habitat and thus marine biodiversity. To mitigate against biodiversity loss, we must find ways to incorporate habitat opportunities in coastal infrastructure.

Biodiversity opportunities in coastal infrastructure

Coastal infrastructure, such as sea defences (breakwaters, sea walls etc) and boat moorings, present both challenges and opportunities to coastal marine species.

Coastal infrastructure built in soft sediment environments can offer an increase in biodiversity by acting as 'islands' for marine species that prefer harder substrate to colonise. These 'islands' have the capacity to extend the ranges and dispersal of marine species and promote the exchange of genetic diversity by linking up geographically separated populations. However, the usefulness of this benefit is limited by the size of the available habitat and the distance from similar populations that can colonise the coastal infrastructure. It can also provide habitats for fish, which are attracted to structures that occur in soft sediment environments as they present opportunities for shelter, feeding and as nursery habitat for juveniles.

Coastal infrastructure is predominantly finished with smooth, flat surfaces that do not incorporate cracks and crevices to retain water or produce shaded areas. Therefore, they have lower species diversity than natural shores. Eco-engineering aims to disrupt the homogenous surface of coastal defence structures by imitating natural rocky shore habitat, providing habitat complexity and opportunities for colonisation of marine species.

Plain concrete sea wall in Poole Harbour, UK

This allows more species to survive the periodic exposure to air at low tide and reduces the risk of desiccation and death. When the tide returns, these same cracks and crevices provide refuge from predators and wave energy. Greater habitat complexity also increases surface area, enhancing the island effect.

Ecologists and engineers working together

Compared with eco-engineering techniques in the terrestrial environment, coastal and marine eco-engineering is a relatively new area and many trials have been small-scale and academia based. Relevant literature is often published in journal article format which can be less accessible to coastal managers and engineers. This limited access has impeded the incorporation of eco-engineering in coastal development. Documentation and communication of trials need to be formatted in an appropriate and accessible way for practitioners to understand, which would increase the likelihood of eco-engineering application.

Funding is another issue with incorporating eco-engineering into coastal infrastructure. Often eco-engineering is not incorporated within coastal engineering budgets as funding is not available for it. Eco-engineering needs to be marketed to practitioners in a way that highlights the benefits such as community engagement and bioprotection capabilities. For example, the colonisation of barnacles on concrete can reduce the impacts of weathering and erosion.

There is a need for proof that eco-engineering is successful on a larger scale and is scaleable. Many trials have focused on the marine ecology aspect and how eco-engineering has affected habitat provision and biodiversity, without considering the practical aspects of application within the coastal engineering industry, such as how eco-engineering may affect structural integrity. For eco-engineering to be embraced by coastal practitioners, trials should incorporate both ecological and engineering elements to ensure replicable results that are feasible, prescriptive, and low-cost.

Dr Alice Hall from Bournemouth University and Nigel George from Artecology showing a team from Natural England the Vertipools at Boscombe, UK

The dramatic decline of oyster beds – a loss for nature and people

Oysters are unsung marine heroes and crucial ecosystem engineers. Adult oysters have the capacity to filter up to 150 litres of water a day. This filtration improves water clarity and quality by reducing suspended particles such as sediment and algae, providing essential ecosystem services. The UK's native oyster (*Ostrea edulis*), also known as the European flat oyster, is a gregarious species and will form large beds. These beds provide habitat for environmentally and economically valuable species, such as juvenile fish, sponges, and crabs. Oyster beds are one of the most threatened marine habitats on the planet, with 85 per cent of oyster bed habitat lost. In the UK, native oysters have declined by a staggering 95 per cent, following overfishing, disease, pollution and competition with non-native species. The native oyster is now found predominantly in the south-east of the UK and north-east of France. As it is slow growing, its natural recovery has been extremely limited, as native oysters seldom produce larvae until they are at least 50 mm in size. Their recruitment success is also highly variable, meaning survival from spat to adulthood can be sporadic.

The story so far

The Marineff partners meet for their biannual steering committee in Cherbourg, France

The June steering committee was hosted by Marineff project partner Ports Normandie Association in Cherbourg, France. Computer-aided designs of all the eco-engineering modules for the Marineff project were seen for the first time and schedules for their immersion in 2020 were finalised. The range of tests and analyses of the concrete mixes and unit colonisation by the different project partners will improve the validity of project results and pave the way for proving their efficacy to consumers. Following a traditional lunch of locally-sourced seafood, was an afternoon of tours to the breakwater deployment site and a quarry which provides aggregate and cement to the Marineff project. It was exciting to see the progress and realise the effects these eco-engineering units may have within the coastal construction industry and on improving biodiversity.

ESITC Caen and the University of Southampton test concrete mixes for oyster modules

The team at ESITC Caen in France have been testing concrete mixes with CEM II cement (Portland composite cement and 35 per cent of other constituents) and CEM V cement (composite cement comprising Portland cement and combinations of blastfurnace slag and pozzolana or fly ash) and differing shell aggregate ratios. Samples have been tested for water porosity, absolute density, and saltwater ingress with further samples to be tested after being immersed in the sea for three, six and 12 months.

Dr Ken Collins of University of Southampton surveying the seabed and assessing site suitability near Southampton, UK

In May this year, the University of Southampton deployed small (5 cm x 5 cm) concrete sample blocks in several sites near Southampton in Hampshire, UK, to test the receptivity of the concrete for native oyster settlement. Following their removal this August, University of Exeter will assess the biological receptivity of the sample blocks. Once an appropriate concrete mix has been determined, the final oyster restoration modules will be manufactured over winter by project partner TPC for deployment in May 2020 – just in time for the annual native oyster larvae release. The final modules will be deployed in Calshot, UK and Cherbourg and Dinard, France.

Artecology join Bournemouth University to bring their expertise and trademark 'Vertipools'

Artecology will be joining partners Bournemouth University and ESITC Caen in the design and manufacture of eco-engineering units 'Vertipools'. Bournemouth University and Artecology have a history of collaboration and it is exciting to have them onboard with the Marineff project.

Compton style Vertipools on a wooden groyne on the Science Beach at Sandown, UK

The Vertipools are currently in the design phase while Bournemouth University source suitable coastal sites for their deployment in spring 2020, with their manufacture scheduled over the winter. In the meantime, concrete mixes will be tested at ESITC Caen to determine the most appropriate aggregate:cement ratio for deployment.

Sophisticated science to test the productivity of colonised concrete breakwater units

The National Museum of Natural History team, based at the Marine Biology Station in Dinard, France, are employing some sophisticated methods to determine the productivity of the breakwater units. units ('productivity' refers to how rapidly biomass is generated). This will demonstrate their potential capacity to support biodiversity and perform vital ecosystem services such as carbon sequestration. The breakwater units are large concrete blocks that will have a rough textured surface, with gutters, reservoirs, holes and tunnels excavated. Benthic chambers will be used to measure primary production, and pulse amplitude modulation (PAM) will be used to measure chlorophyll and photosynthetic efficiency. Concrete plates installed with the deployment breakwater units will be removed on a quarterly basis for photogrammetry and petrographic characterisation. The results will be shared with readers in a future newsletter.

Turning concrete boat moorings into beds with a unique design

Marineff partners at ESITC Caen and the National Museum of Natural History team at Dinard, France, are working together to design, manufacture and monitor concrete boat moorings as part of WP T2. The modular symmetrical design incorporates differing layers connected with tunnels and concrete 'feet' to allow the unit to be raised off the seabed, providing sheltered habitat for commercially important species such as lobster. Concrete mixes will be tested in a similar way to other Marineff eco-engineering units, with an emphasis on ensuring the boat moorings will be adequately weighted. Following immersion in spring 2020, the colonisation and use of the concrete moorings will be monitored each spring and autumn.

Bournemouth University host a workshop for Natural England

The first Marineff workshop was held at Bournemouth University on Thursday 2 May 2019 with Artecology, and Dr Roger Herbert, Prof. Rick Stafford, Dr Alice Hall and

Jess Bone for British governmental organisation Natural England. Natural England are responsible for promoting conservation and protecting biodiversity within England. The morning was devoted to presentations introducing the Marineff project and Artecology's role, and potential configuration of Vertipool arrays. An open question and answer session was held over lunch, which was followed by a field trip to the Boscombe Vertipools.

The workshop was very successful and was useful to get the perspectives of coastal practitioners on the feasibility of scaling the project up and its compatibility with coastal engineers. Natural England praised the project's multidisciplinary approach, as exploring the effect of Vertipool attachment to coastal defences would be pivotal in persuading developers to incorporate this type of eco-engineering in the future.

ESITC Caen PhD student Marine Georges and researcher Amel Bourguiba with concrete samples to be deployed in Dinard bay, France

Dates for the diary

Over the next three years, the Marineff project will be appearing at a variety of public outreach events, national and international conferences as well as hosting our own Marineff Conference in June 2021. Here follows some of the forthcoming events.

Southampton International Boat Show, 13–22 September 2019

The Southampton International Boat Show is the UK's biggest festival of boating. It promotes the latest accessible, affordable and flexible ways to enjoy boating and watersports with opportunities to get out on the water at the show. Over 600 global marine brands will be present with more than 330 boats to view. University of Southampton will be representing the Marineff Project with a stand at the show.

Conference: Institution of Civil Engineers (ICE) Coastal Management, 24–26 September 2019

ICE Coastal Management 2019 will gather delegates from around the world in La Rochelle, France, to focus on new approaches to coastal engineering that integrate planning and 'place-shaping' to encourage bold adaptation to coastal change, and that balance environmental and community concerns. Bournemouth University will be in attendance presenting a poster about the Marineff project and Vertipools.

Bournemouth Arts by the Sea Festival, 27–29 September 2019

Arts by the Sea in Bournemouth in Dorset, UK, is focused on delivering a packed and fun filled festival celebration, while shining a light on mental health. The weekend will consist of an explosion of art with many fantastic mostly-free events taking place throughout the town which everyone can be involved in. Bournemouth University and Artecology will be in the Green Hub, showcasing the Marineff project and its inclusion of art and design.

The broad view

Tide pool ECOncrete armour at North Portsea

The very first coastal installation of ECOncrete in the UK saw these concrete armour blocks fitted in North Portsea on 29 May 2019 and will be managed by the Eastern Solent Coastal Partnership. Each armour block includes a tide pool with graduated levels, and a grooved surface – great for attracting marine species. It will be exciting to see how these blocks will be colonised over the next few years.

ECOncrete Pools at Portsea, UK (Eastern Solent Coastal Partnership)

Simple, low-cost, effective – eco-engineering at Runswick Bay

The construction of a 180 m long rock armour fillet in Runswick Bay, UK, provided a unique opportunity to explore eco-engineering techniques in rock armour coastal protection. Coastal engineers, managers and ecologists collaborated to create 70 artificial pools in the granite boulders. Through careful orientation, another 20 natural pools were created where the rocks had existing depressions. Habitat complexity was increased further by cutting grooves in the rock face. Biodiversity within the pools had increased in only three months, with 10 more species recorded than the adjacent control rock face. This successful project demonstrated how an easily replicable and low-cost eco-engineering solution can be applied on a large scale when ecologists and engineers collaborate. The Runswick scheme went above and beyond the planning requirements, providing a good example of the biodiversity net gain principle in the UK.

The importance of networking – for people and for oysters

When creating or restoring habitats, it is important to consider their place in a wider network. More habitats close together means more connectivity, which is important for the long-term survival of the species that use those habitats. For restoring the native oyster (*Ostrea edulis*), networking has been at the heart of conservation projects. International networks, eg the Native Oyster Restoration Alliance (NORA), national networks, eg the Native Oyster Network in the UK, and regional networks, eg the Solent Oyster Restoration Project in the south of England, are all interlinked. The connection of these projects is crucial for the dissemination of information and results and sharing of funding opportunities that can benefit the whole network, as well as drawing on expertise from a multidisciplinary pool of stakeholders, such as commercial fisheries and governmental bodies. Recognising that these restoration projects should not occur in isolation and intelligently co-ordinating with similar regional efforts via a network will perpetuate the recovery of the native oyster in the wider geographical area. The results of the oyster units from the Marineff Project will be accessible by the oyster networks.

Rock pools at Runswick Bay, UK

The Marineff project partners

The Marineff project is a collaboration between nine French and English partners, drawing on expertise from a multidisciplinary base of professionals. In addition to this, subcontractors will be contracted to assist with the manufacture and deployment of eco-engineering units and for the dissemination of project outputs.

ESITC Caen is a higher education institute specialising in civil engineering and construction. They will be responsible for the administration and co-ordination of the work packages for the duration of the Marineff project and the development of the marine-adapted concrete materials.

Ports Normandie Association is an alliance of ports in the Normandy region. It will provide maritime industry input to the Marineff project and facilitate operations within its catchment area.

University of Caen-Normandy is a higher education institute and a member of the regional Normandy University group. They will be providing expertise in marine ecology and biology and facilitate the monitoring of eco-engineering units in France.

VINCI Maritime and Fluvial Construction is a leader in maritime and waterway engineering and construction. They will assist with the technical application of the breakwater from WP T2 and ensure regulatory compliance. They will submerge eco-engineering units in Cherbourg and Luc sur Mer in France.

Cotentin Public Works is a subsidiary of VINCI Construction France and specialises in civil engineering, maritime and harbour works and construction. They will design and manufacture eco-engineering units for the Marineff project in France.

National Museum of Natural History will be contributing the expertise of marine ecologists based at their marine research station in Dinard. They will be developing monitoring and evaluation methodology for the eco-engineering units in France.

University of Southampton is a higher education institute that specialises in research with a dedicated marine research facility. Their extensive involvement with shellfish aquaculture and proximity to native oyster beds will facilitate WP T1.

University of Exeter is a higher education institute that will be providing expertise on the mineralogy and microstructure of construction materials used and assessing the changes they undergo during the interaction with sea water and marine species.

Bournemouth University is a higher education institute that will be providing marine ecology expertise and facilitate the monitoring of eco-engineering units in England.