NORA 3 Online

3rd Conference
4th – 5th November 2020

ABSTRACTS

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Photo: Bureau Waardenburg Ecology & Landscape Floor Driessen

Day 1 / Wednesday, November 4th, 2020

10:00	**Welcome to NORA 3 Online** Hein Sas
10:10	**Technical Introdcution** Chair: Alison Debney
10:15	**Keynote** **Genetics and Genomics of *Ostrea edulis*** Pierre Boudry
10:30	**Questions & Comments** Chair: Alison Debney
10:40	**Launch NORA/NON Biosecurity Guidelines** Philine zu Ermgassen
10:50	**Questions & Comments** Chair: Alison Debney
11:00	**Launch UK-Ireland NON Oyster Restoration Managers Guide** Joanne Preston
11:10	**Questions & Comments** Alison Debney
11:20	**Break**
11:30	**Update on the NON/NORA Oyster Restoraton Monitoring Guidelines** Alison Debney
11:40	**Questions & Comments** Chair: Bernadette Pogoda
11:50	**Presentations of New Projects** Celine Gamble **Introducing the Wild Oysters Project: Firth of Clyde, Conwy Bay & Tyne & Wear** Nancy Nevejan **UNITED Project – The Flat Oyster Restoration Envisaged in the Belgian Pilot** Eve Galimany **Evaluating the Role of Flat Oysters for Bioremediation Strategies in Mar Menor, a Degraded Lagoon in the Western Mediterranean Sea** Ken Collins **MARINEFF Solent Oyster Enhancement Reefs** Alec Reid **Galway Bay Native Oyster Restoration Project** Jesper Elzinga **Making use of Offshore Windfarms for Native Oyster Rehabilitation: A Case Study for Borssele OWF** Renate Olie **Towards a Reliable Supply Chain of Bonamia-Free Flat Oysters**
12:30	**Closing Statement** Boze Hancock
12:40	**End of Session**

Day 2 / Thursday November 5th, 2020

10:00	**Welcome** Hein Sas
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10:25	**Questions & Comments** Chair: Bill Sanderson
10:35	**Working Group Updates** Ruth Thurstan, Corina Peter, Anna Hughes, Åsa Strand
10:55	**Questions & Comments** Chair: Bill Sanderson
11:05	**Break**
11:15	**Presentations of Important Results from Existing Projects** Matt Uttley **Essex Native Oyster Restoration Initiative Pilot Results and Scale up Plans** Stèphane Pouvreau **Which Concrete Substrate Suits You?** ***Ostrea edulis* Larval Preferences and Implications for Shellfish Restoration in Europe** Tom Cameron **Active Sea Bed Management for Native Oyster Restoration in High Sediment Load Estuaries** Emilie Reuchlin **Recruitment for First Actively Restored Oyster Reef in Offshore North Sea and Successful Near- and Offshore Outplacement of Oyster Spat** Verena Merk ***Ostrea edulis* Pilot Reef in Natura 2000 Site Borkum Reefground**
11:45	**Questions & Comments** Chair: Karel van de Wijngaard
11:55	**OSPAR Assessment Overview** Bernadette Pogoda
12:00	**NORA 2: Special Issue of Aquatic Conservation** Bill Sanderson
12:05	**NORA Perspectives** Philine zu Ermgassen
12:15	**Calls for Collaboration**
12:30	**Closing Statement** Henning von Nordheim
12:40	**Closing of the Conference**

Genetics and Genomics of *Ostrea edulis*: Progress and Prospects to Contribute to the Restoration of Wild Populations, Sustainable Aquaculture Production and Fisheries

P. Boudry

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Over the past 50 years, studies dedicated to population genetics of *Ostrea edulis* have aimed to document spatial and temporal differences and to identify major driving evolutionary forces, such as genetic drift, local adaptation or impact of stock translocations, while a second major area of research has been to identify stocks with higher resistance to bonamiosis, mass or family-based selective breeding and disease testing. The impact of this research on farmed and wild populations has remained limited until now, due to low or short-term investments and/or limited commercial interest. This is, however, changing. Recent efforts to counter the decline of this species in Europe, as illustrated by the engagement of the NORA community, have resulted in new initiatives and progress in breeding, genetics and genomics. This recent progress will be reviewed in the light of increasing demand for disease-free or disease-resistant seed to restore populations and reviving aquaculture production and fisheries. Concerns about effective population size of hatchery-propagated seed, genetic impact of transfer of wild seed between evolutionary significant units will be addressed in view of the potential gains and of emerging genome-based selective breeding programs.

Key Words: population genetics, selective breeding, effective population size, genomics.

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Introducing the Wild Oysters Project: Firth of Clyde, Conwy Bay & Tyne & Wear

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The Wild Oysters Project is a UK oyster restoration project launched in June 2020, developed as part of a new collaboration between the Zoological Society of London (ZSL), Blue Marine Foundation (BLUE) and British Marine.

The Wild Oysters Project is working together to restore marine life, inspire ocean stewardship and achieve system change required to recover our seas. This new project will be using seabed restoration expertise gained by ZSL and partners as part of the Essex Native Oyster Restoration Initiative (ENORI), and caged oyster systems suspended under marinas developed by BLUE and University of Portsmouth with the Solent Oyster Restoration Project, combining the two elements for the first time at scale in the UK.

Wild Oysters will be establishing and developing oyster rehabilitation hubs in the Firth of Clyde (Scotland), Conwy Bay (Wales) and Tyne & Wear (England). At each new oyster rehabilitation hub, we will be working with local stakeholders to install oyster nurseries from marina pontoons, carrying out oyster seabed restoration and delivering an extensive public outreach and biological sciences education programme to both primary and secondary students.

The Wild Oysters project is adopting an innovative approach to build capacity for ocean recovery, by collaborating with our industry partner British Marine and facilitating the l local coastal partnerships. We look forward to introducing Wild Oysters to the NORA 3 online conference.

Key Words: native oyster, UK, innovative partnership, rehabilitation hub

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UNITED Project
The Flat Oyster Restoration Envisaged in the Belgian Pilot

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UNITED is a research project co-funded by the EU-Horizon2020 programme and runs from 2020 to 2023. The acronym UNITED stands for multi-Use offshore platforms demoNstrators for boostIng cost-effecTive and Eco-friendly proDuction in sustainable marine activities. Marine production and the provision of marine services can be optimised if private and public actors cooperate to share marine space.This is what UNITED aims by installing specific test setups at five different marine sites in five European countries.The Belgian pilot focuses on flat oyster restoration and aquaculture, and co-cultivation with seaweed in offshore wind farms. This will be tested in two phases and two locations:

1. At the nearshore site of the Belgian part of the North Sea (BPNS), different types of nature-inclusive scour protection, accommodated in a restoration table designed by Jan De Nul and installed by Brevisco, will be tested for flat oyster settlement. The best performing scour material will be selected and applied at the offshore site. Additionally, the aquaculture potential of the nearshore site will be evaluated.

2. The offshore site is situated in the BPNS in an offshore wind farm operated by Parkwind. Because it is closed for fisheries, this area might offer a unique environment for both flat oyster aquaculture and restoration. The hard material used as scour protection around the wind turbine foundations might serve as a suitable substrate for oyster settlement. Recruitment from the aquaculture individuals can initiate and sustain natural oyster reef development on this scour protection, and as such restore a lost ecosystem in the BPNS.

Key Words: multi-use, flat oyster restoration, flat oyster and seaweed aquaculture, UNITED

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Evaluating the Role of Flat Oysters for Bioremediation Strategies in Mar Menor, a Degraded Lagoon in the Western Mediterranean Sea

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Mar Menor is one of the largest hypersaline coastal lagoons in Europe with an extension of 135 km^2 and an average depth of 3.6 m. The lagoon has been strongly affected by human activities (agriculture, tourism, mining) during decades, which finally caused a massive phytoplankton bloom in the summer of 2015, a repetitive event with almost an annual frequency. During the 80s and 90s, an abundant population of flat oysters (*Ostrea edulis*) inhabited the lagoon, with an estimate of 135 million of individuals in 1992. However, overharvesting, habitat deterioration, and eutrophication, which degraded the water quality of the lagoon, severely diminished the population, most likely, to a few hundreds.

The use of flat oysters to restore Mar Menor has been proposed as one of the several management tools to improve water quality, but some issues need to be solved to ensure a successful bioextraction action. Therefore, the oyster project includes,

i. assessment of the current status of the oyster population in the lagoon (abundance, density, physiology, anatomy, genetics, and pathology),

ii. construction of a pilot oyster hatchery to study the viability of reproduction and spat production of the local oysters and alternatives,

iii. determination of the oyster clearance as a function of the phytoplankton bloom cycle and the oyster lifecycle,

iv. development of a model to predict the efficiency of flat oysters on sustaining the water quality,

v. integration of the Mar Menor community in the oyster restoration project,

vi. assessment of the oyster quality for human consumption.

Key Words: mar menor, eutrophication, bioextraction, flat oyster

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MARINEFF Solent Oyster Enhancement Reefs

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MARINEFF is a €5million project, 2018 - 2022 to enhance and protect coastal and transitional water ecosystems in cross-border Channel regions. The MARINEFF project was selected under the European cross-border cooperation Programme INTERREG VA France (Channel) – England co-funded by the ERDF and involves 9 French and British partners. Today, marine structures (seawalls, quays, piers, groynes and moorings) ubiquitous on our coasts, do not incorporate the enhancement of coastal ecosystems in their design and during construction. The project aims to demonstrate new biomimetic marine structures to improve the ecological status of inshore waters, as well as to involve professionals and stakeholders in the project. Specifically Southampton will be supporting the current Solent oyster restoration project with specially designed oyster settlement structures recently deployed in the Solent. Building on the findings of its predecessor RECIF, the MARINEFF project has developed a robust, biologically attractive waste shell concrete. It is hoped that the 26 triangular structures, 1 metre across, will attract the settlement of native oyster larvae/spat and kick start self-sustaining oyster reefs, which will thrive without further intervention.

marineff-project.eu/en/
recif.esitc-caen.fr/recif_project.html
www.southampton.ac.uk/oes/research/projects/marineff.page/
www.bluemarinefoundation.com/project/solent/

Key Words: enhancement biomimetic marine structures

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Galway Bay Native Oyster Restoration Project

Alec Reid

Cuan Beo

The Galway Bay Native Oyster Restoration Project is a community, state and scientific institution led initiative that aims to restore the native oyster (*Ostrea edulis*) populations that once existed in huge quantities in Galway bay. Our goals are to restore native oyster habitats through strategic cultch deployment to promote larval settlement, to identify distribution of critical habitat for native oyster including modelling of temperature and salinity, develop spatial management of fisheries that will include closed areas for oyster reef development, to gain a more in-depth knowledge of native oyster habitat restoration through practical research, to monitor prevalence of Bonamia and to improve coastal water quality in Galway Bay by fostering a community understanding that land based activities have an immediate impact on coastal water quality. The project is funded by the EMFF Biodiversity Scheme.

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Making use of Offshore Windfarms for Native Oyster Rehabilitation: A Case Study for Borssele OWF

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The vision to include the potential for increased biodiversity in Offshore Wind Farms (OWF) construction is endorsed by windfarm developer Blauwwind and The Rich North Sea programme. Blauwwind constructs the Borssele III&IV wind park. The Rich North Sea aims to make nature enhancement standard practice in offshore windfarms. These two parties will jointly conduct field experiments for ecosystem enforcement within the Borssele OWF area, aimed at establishing native oyster reefs and increasing biodiversity.

The Borssele OWF works for nature enhancement will consist of the placement of clean shell material on top of the scour protection around eight wind turbines. The shell material is expected to provide suitable substrate for oyster larvae settlement. At four of these locations, an oyster broodstock cage will be placed, containing approximately 600 adult European flat oysters each, to stimulate oyster reef development. The other four locations are for control measurements.

The development of marine ecology in general and the establishment of oysters in particular will be monitored 1, 3 and 8 years after installation. Multiple methods will be used, including a ROV photo and video survey, measurements on oyster broodstock, sampling of eDNA and larval concentrations in the seawater and settlement observations using spat collectors.

Experiences of the installation and T0 monitoring works in October 2020 will be shared during the presentation.

Key Words: flat oyster, offshore wind parks, nature enhancement, biodiversity

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Towards a Reliable Supply Chain of Bonamia-Free Flat Oysters

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The Rich North Sea programme aims to enhance nature within offshore wind farms in the North Sea by facilitating or placing reef building species, which in turn attract reef associated and reef benefitting species. European flat oysters can greatly contribute to marine biodiversity, but are almost absent from the North Sea. Good quality and quantity of source material is essential but difficult to obtain due to the presence of diseases, invasive species and ambiguous regulations.

To create oyster reefs in offshore windfarms, spat-on-shell is economically and ecologically the most interesting option. A unique group of eight Dutch organisations (including research institutes, companies, an NGO, a university and The Rich North Sea) are combining efforts to create a reliable and affordable production of *Bonamia*-free flat oyster spat-on-shell at three locations. The purpose of this production is purely for nature enhancement and the gained knowledge will be made publicly available.

In close cooperation, the 8 organisations will investigate the conditions under which healthy, *Bonamia*-free spat-on-shell can be produced. The project will continue for the next three years, in which timing of outplacement and the functioning of outplacement structures will be addressed as well. Risks such as the unforeseen introduction of alien species will be mitigated in both hatcheries and spatting ponds. Furthermore, research into resistance to bonamiosis will continue and if successful, this will play an important role in selecting the oysters for outplacement in the North Sea.

Key Words: breeding, *bonamia*-free, optimal conditions, sharing knowledge

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Merging Science and Community to Achieve Shellfish Restoration and Management

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Scientists and restoration practitioners recognize that development, implementation, and adaptation of oyster restoration and management plans must be informed by the best available science as well as stakeholder input. Stakeholder participation from the outset and through all stages of the process ensures development of a community vetted and readily implementable plan. Community involvement in restoration and management decisions can be challenging, time consuming and viewed as an obstacle to getting on with the "important" work. In practice, it is rewarding and necessary. Actively engaged community stakeholders offer real-life experiences, local knowledge, unique ideas and solutions. Inclusion of a diversity of community stakeholders often results in them becoming the best champions of and influencers for our work.

An example is the Oyster Ecosystem-Based Fisheries Management (EBFM) Plan project that is under development in the Pensacola Bay System of Florida, USA. A key science element for a successful EBFM Plan is a Habitat Suitability Model (HSM), which is comprised of seven biological, physical and chemical factors individually rated for suitability, and spatially characterized. The HSM sets the foundation for the plan. A draft HSM was developed by project scientists and presented to the project's community stakeholders working group for review. The working group, comprised of oyster fishers and aquaculture farmers, planners, developers, community and economic organizations, scientists and resource managers, recommended several valuable improvements to the HSM. Acceptance of the HSM and, by extension the Oyster EBFM Plan, would be difficult without working group input and participation in the process.

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Essex Native Oyster Restoration Initiative Pilot Results and Scale up Plans

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In 2019, the Essex Native Oyster Restoration Initiative (ENORI) deployed over 400 tonnes of cultch and 11,500 mature oysters into the Blackwater Restoration Box in order to trial spat settlement substrates, whilst improving larval and substrate budgets. The objective of this trial was to compare settlement on untouched ground, cultch and cleaned ground. Throughout the trial, spat collectors acted as a control to detect spat in the water column. We will present the preliminary results of the settlement seen on the spat collectors, overwinter mortality rates and the 2019 trial plots sampling. We will present how, based on these 2019 results we are continuing to shape our restoration strategy within our 2 km² Restoration Box.

We will also present some innovative outreach activities that we have developed in partnership with specialist outdoor educators that will enable children with special educational needs and disabilities to have an outdoor learning experience and access to nature, which they would not usually have the opportunity to experience.

Key Words: essex, pilot, results, outreach

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Which Concrete Substrate Suits You? *Ostrea edulis* Larval Preferences and Implications for Shellfish Restoration in Europe

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The European flat oyster, *Ostrea edulis*, is an important ecosystem engineer that has been progressively disappearing from European coasts over the last century mainly due to overexploitation, habitat degradation and disease. Protecting and managing the remaining populations has become a nature conservation priority because this species is able to build biogenic reefs, very specific habitats that provide many ecosystem functions and services. It is now the subject of many conservation and restoration programs throughout Europe, including the Flat Oyster REcoVERy (FOREVER) project in France.

The availability of suitable hard substrates for larval fixation is a critical factor during this reef-building process. The present study was carried out to improve artificial reef design focusing on the impact of concrete formulation and surface texture on larval settlement in the field. Nine bio-sourced concrete formulations and ten surface textures were evaluated. The number of settled larvae counted on each concrete substrate reflected their preferences, and results demonstrated that microscale surface texture has a greater impact on recruitment than concrete formulation itself, with larvae preferring to settle in depressions on a rough rock-like texture and avoiding flat, horizontal and exposed areas. These results could be helpful for artificial reef-building especially in terms of materials and surface texture that should be used.

Key Words: *ostrea edulis*, larval recruitment, artificial reef, restoration

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Active Sea Bed Management for Native Oyster Restoration in High Sediment Load Estuaries

Tom C. Cameron, Graham Baker, Jim Pullen & Alice Lown

Several studies have been undertaken to determine the role of active interventions and bed management on the recruitment of bivalve spat to the seabed. Of these studies some have been inconclusive or undertaken at reduced spatial or temporal scale. The best of these previous studies has shown that bed interventions, or harrowing, has not improved oyster spat settlement. Here we present the analysis of a several order for the on bed mariculture on European oysters occupying 185 four hectare plots in the highly sedimented Blackwater estuary in Essex, UK. We determined significant and positive effects of on bed disturbance (effort in 2015 - 2018) on juvenile oyster recruitment by 2018, and this effect persists once spatial autocorrelation with adult abundance is taken into account. The contribution of effort in any one year to recruitment in 2018 is not uniform, suggesting that the intervention success may be influenced by environmental variation. We discuss these results in light of local ecological knowledge and conservation success as well as site specific decision on management in marine environments with high sediment loads.

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Recruitment for First Actively Restored Oyster Reef in Offshore North Sea and Successful Near- and Offshore Outplacement of Oyster Spat

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In April 2019 we placed two batches of spat-on-shell near the naturally occurring shellfish reef in the Voordelta (Netherlands) at ca. 4 m depth, to monitor survival, growth and movement. From settlement in a hatchery, spat on shell aged 58 days was translocated to two plots of 240 m^2 and subplots of 1 m^2 to monitor development and movement of 50 spat-shells and 50 empty shells respectively. For retrieval, in each plot 8 oyster chains were placed: 4 with spat-shells and 4 with empty shells. Survival after 112 - 132 days measured 29 - 33 %, growth measured 381 - 451 % and growth was higher at lower spat-density per shell. After 363 days survival measured at least 5.8% and growth measured 280 - 640 %. Single spats were found separated from shell and alive on the seabed and 93% of shells moved out of the subplots.

In May 2018 we pioneered with introducing approximately 10000 - 15000 individuals of European flat oysters from Norway near two monopiles in Gemini wind farm location Buitengaats at approximately 29 m depth. After two months we observed high survival, good oyster condition, and gonad development. In April 2019 we placed another 500 kilos at one of the monopiles. In July 2019 we detected flat oyster larvae In Gemini and halfway between Gemini and Borkum Stones oysterreef.

In May 2018 we also actively restored an oyster reef in the offshore North Sea for the first time, introducing 40.000 - 80.000 individuals of Norwegian oysters on the Borkum Reef Ground (25 m depth), nine 3D-printed sandstone reefstructures and 4 research cages containing oysters. Since, we reported survival, growth and reproduction. In April 2019 we added oysterspat. In September 2019 we observed recruitment (2018 recruits sized 5,7 - 7,2 cm) and settlement as well as survival and growth of 2019 spat. Flat oyster survival in research racks was 40 – 73% 16 months after placement; larger oysters showing higher survival. Live oysters on the seabed grew and survived; 92% survival, 8% recorded mortality. 42 species were observed associated with the oyster reef, among which sand mason worm (*Lanice conchilega*) and queen scallop (*Aequipecten opercularis*), solitary individuals of ross worm (*Sabellaria spinulosa*), nudibranchs and anemones. On 3D reefs we found mobile species including fivebeard rockling and goldsinny wrasse and sessile species including plumose anemone and cold-water coral dead-man's finger.

Through our presentation we would like to discuss with you what promise the latest results from our field-projects hold for active restoration of oyster reefs to restore marine biodiversity using both mature native oysters and spat on shell in near- and offshore areas of the North Sea.

Key Words: spat-on-shell, *ostrea edulis*, marine biodiversity, artificial reefs

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Ostrea edulis Pilot Reef in Natura 2000 Site Borkum Reefground

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[2] German Federal Agency for Nature Conservation (BfN), Vilm, Germany

The German Federal Agency for Nature Conservation (BfN) and the Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI) have successfully set up a pilot reef for the restoration of *Ostrea edulis* in a sublittoral environment. The presentation will provide a short photo documentation about the pilot reef construction in summer 2020.

A research area and no take zone were established in the western part of the 625 km² MPA Borkum Reefground. There, at a depth of about 30 meters, limestone rockbeds have been deployed as a solid substrate, following the experience of US and Australian examples. On the rockbeds and on the surrounding sandy bottom, oysters of different size classes have been deployed.

The focus of the project is

- to develop large-scale substrate and oyster deployment while minimizing the ecological footprint: We used biodegradable jute nets for spat on shell, organic cotton nets for single seeds and sandstone reef blocks seeded with spat.
- to assess growth and condition of the oysters and the reef structure: We implemented oyster trays to allow for scientifically appropriate sampling.
- to assess biodiversity over the course of 5 years: We will investigate associated species in the sampled trays and via underwater visual census.

Further areas will be created as part of the official management measures for the Natura 2000 site in due course, taking into account the results of the pilot reef.

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