2nd European Seagrass Restoration Workshop

8th-10th April 2025

ARCACHON - FRANCE

Palais des Congrès

THE SEAGRASS CONSORTIUM

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Parc naturel marin
Bassin d'Arcachon

Mairie Arcachon

2nd European Seagrass Restoration Workshop

Arcachon, France, April 8th to April 10th, 2025

Le Parc naturel marin du Bassin d'Arcachon

Président du Conseil de Gestion
Cédric Pain

Directeur-délégué
Franck Mazeas

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Dr Thomas Fauvel

European Seagrass Restoration Alliance

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Dr Nicolas Mayot

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Dr Richard Lilley

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Sarah Lilley

The Seagrass Consortium

De Rijksuniversiteit Groningen
Laura Govers, Richard Lilley, Maite Vogel

L'Office français de la biodiversité
Thomas Fauvel

Project Seagrass
Leanne Cullen-Unsworth, Richard Unsworth

IHCantabria
Bárbara Ondiviela, Inés Mazarrasa Elósegui, Cristina Galván Arbeiza

IMEDEA (UIB-CSIC)
Fiona Tomas Nash, Gema Hernán Martinez, Ryan Mueller

GIPREB
Raphaël Grisel, Nicolas Mayot, Julie Duley

Sea Ranger Service
Wietse van der Werf, Sophie Hankinson

From Competition to Coalition: Towards a European Seagrass Restoration Alliance

The 2025 European Seagrass Restoration Workshop will take place in le Parc naturel marin du Bassin d'Arcachon, France, from April 8th to April 10th, 2025. The theme of the 2nd European Seagrass Restoration Workshop is '***From Competition to Coalition: Towards a European Seagrass Restoration Alliance***'.

Over the previous decades, principally due to a significant lack of biodiversity financing, it has often felt like there has been more of a pressure for our community to compete with each other (for the limited funding), rather than there being the structures and financing in place to enable truly collaborative working – but this kind of competition comes at a cost to everyone.

The rationale for hosting the 2nd European Seagrass Restoration Workshop is based on a desire to help facilitate collaboration and networking withing our community. In Europe we find ourselves at a genuine 'inflection point' when it comes to nature restoration, and so now is the time to come together across species specialisms to speak with one voice for seagrass.

The EU's first continent-wide legislation for the long-term recovery of nature, the EU Nature Restoration Law, came into force on the 18th August 2024. This Regulation sets legally binding restoration targets for a wide range of ecosystems, aiming to restore 20% of the EU's degraded ecosystems by 2030 and all ecosystems in need of restoration by 2050. It is now up to Member States to develop ambitious National Restoration Plans by 1 September 2026.

These plans will detail how each member state plans to meet the Regulation's targets and obligations. These next two years will be crucial for EU Member States to plan strategically and identify opportunities for restoration, where relevant tools, best practices, and lessons learned could offer valuable support.

We know that today's environmental chages are transforming seagrass ecosystems into new configurations, and therefore trying to return to past configurations is often no longer an option. Our challenge as a European seagrass restoration community is to establish a European seagrass 'resource' baseline, and then to protect, restore, and rehabilitate the existing resource.

In order to start to address this challenge we have organised ESRW2 into three themes (one for each of the three days of the programme).

Tuesday 8th April (Day 1) : Past, Present and Future.

Wednesday 9th April (Day 2) : Mechanisms for Change.

Thursday 10th April (Day 3) : Seagrass, Seascape and Society

We recognise that the 2nd European Seagrass Restoration Workshop is, at this stage, only a beginning, and that an effective 'European Seagrass Restoration Alliance' will only become a realty from the subsequent co-creation of a positive, welcoming and inclusive community.

So together let's make this alliance a reality, and let the EU Nature Restoration Law be the catalyst for a new chapter for transnational collaboration for seagrass restoration in Europe.

Dr Richard Lilley

What is Restoration?

*"Restoration means the process of **actively or passively assisting the recovery of an ecosystem** in order to improve its structure and functions, with the aim of conserving or enhancing biodiversity and ecosystem resilience, through improving an area of a habitat type to good condition, re-establishing favourable reference area, and improving a habitat of a species to sufficient quality and quantity."*

EU Nature Restoration Regulation (Article 3)

*"There has never been a more urgent need to **revive damaged ecosystems** than now. Ecosystems support all life on Earth. The healthier our ecosystems are, the healthier the planet - and its people. The UN Decade on Ecosystem Restoration aims to **prevent, halt and reverse the degradation of ecosystems** on every continent and in every ocean. It can help to end poverty, combat climate change and prevent a mass extinction. **It will only succeed if everyone plays a part**."*

UN Decade on Ecosystem Restoration

The 2nd European Seagrass Restoration Workshop is hosted by:

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Bassin d'Arcachon

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The ESRW2 social event is hosted by:

Mairie Arcachon

Keynote Speakers

Dr Isabelle Auby
Ifremer, Station d'Arcachon, France.

“Reflections on three decades of change in the Bassin d’Arcachon”

Dr Isabelle Auby is undoubtedly a local hero of the Bassin d’Arcachon. Isabelle submitted her PhD thesis in 1991; modestly titled *“A contribution to the study of Zostera noltii seagrass in the Arcachon Basin”.* From that point onwards Isabelle has been a prolific contributor to marine science, advancing our understanding in many fields, and particularly within le Parc naturel marin du Bassin d'Arcachon. Isabelle retired from Ifremer in 2022.

Dr. Marieke M. van Katwijk
Radboud Universiteit, The Netherlands.

“Reflections on three decades of change in seagrass restoration.”

There is likely not a person working in seagrass restoration today who hasn’t been inspired by the work of Dr. Marieke M. van Katwijk. Marieke started her pioneering research into seagrass restoration in the Dutch Wadden Sea in 1989, and she has been a cornerstone of the global seagrass restoration community ever since. In 2015 she led a global analysis of seagrass restoration which revealed that the successful regrowth of the foundation seagrass species often requires crossing a minimum threshold of reintroduced individuals, highlighting the importance of large-scale planting efforts.

Invited Speakers – Tuesday 8th April 2025

Marie-Lise Benot

SER Europe, France.

The role of SER-Europe and the EU Nature Restoration Law.

Alison Debney

Zoological Society of London, UK.

Lessons Learned in Building a Successful Restoration 'Alliance'.

Jonathan Sagan

L'Office français de la biodiversité, France.

Life marha: effective and equitable management of marine habitats in France.

Léane Chemineau

L'Office français de la biodiversité, France.

Introducing The Mediterranean Posidonia Network.

Benoit Cajelot

Fugro, France.

Introducing the Marine Ecosystem Restoration (MER) Project.

Marcial Bardolet

Ministry of Agriculture, Environment and Territory of the Balearic Government, Spain.

Seagrass conservation in the Balearic Islands.

Leanne Cullen-Unsworth

Project Seagrass, UK.

The Planetary Role of Seagrass Conservation.

Patrick Astruch

GIS Posidonie, France.

Current and future perspectives – *Posidonia oceanica* seagrass restoration.

Prof. Dr. Fiona Tomas Nash

Imedea (UIB-CSIC), Spain.

Current and future perspectives – *Cymodocea nodosa* seagrass restoration.

Prof. Dr. Laura Govers

Rijksuniversiteit Groningen and NIOZ, The Netherlands.

Current and future perspectives – *Nanozostera noltii* seagrass restoration.

Prof. Dr. Richard Unsworth

Project Seagrass & Swansea University, UK.

Current and future perspectives – *Zostera marina* seagrass restoration.

Day 2 Invited Speakers – Wednesday 9th April 2025

Prof. Dr Laurent Barillé

Nantes Université, France.

Remote sensing as a tool to inform seagrass management and restoration best practice.

Prof. Dr Pierre Gernez

Nantes Université, France.

Remote sensing as a tool to inform seagrass management and restoration best practice.

Prof. Dr. Gabriele Procaccini

Stazione Zoologica Anton Dohrn, Italy.

The genetic component of seagrass restoration.

Dr. Diogo Paulo

Centro de Ciências do Mar do Algarve, Portugal.

Seagrass restoration in Portugal: 2007-2031.

Kirsty Schneeberger MBE

Climate Impact Partners, UK.

Unlocking financing for nature restoration.

Day 3 Invited Speakers – Thursday 10th April 2025

Prof. Dr. Lisa Wedding

Oxford Seascape Ecology Lab, UK.

Five ways Seascape Ecology can help to achieve marine restoration goals.

Prof. Dr. Martin Gullström

Södertörn University, Sweden.

Seascape configuration and connectivity shapes blue carbon stock dynamics in coastal seagrass landscapes.

Prof. Dr. Joanne Preston

University of Portsmouth, UK.

A collective vision of Seascape restoration.

Dr Guillaume Bernard

Ifremer, France.

Seascape recovery in the Bassin d'Arcachon.

Thomas Fauvel

L'Office français de la biodiversité, France.

Le plan de gestion 2017-2032 du Parc naturel marin du Bassin d'Arcachon.

Wietse van der Werf

Sea Ranger Service, The Netherlands.

Social inclusion is the biggest gap the restoration movement is not addressing.

Caroline van Heule

Patagonia Europe, The Netherlands

Madre Mar

Raquel Gaspar

Ocean Alive, Portugal.

Madre Mar

Abstracts are ordered first by Talks, and then Posters, following the 2nd European Seagrass Restoration Workshop programme.

ABSTRACTS FOR TALKS

Thursday 10th April – 09:00 – 12:00

Talk 1 by **Christine Pergent-Martini**
Comparison of *Posidonia oceanica* meadows transplanting protocols and first assessment of their efficiency.

Talk 2 by **Catalina A. Garcia-Escudero**
A path to recovery: Restoration of seagrass *Posidonia oceanica* following cessation of a fish farm in Greece.

Talk 3 by **Fabio Bulleri**
Spatial variation in microbial communities in sediments and on roots of *Posidonia oceanica.*

Talk 4 by **Dimosthenis Traganos**
Identifying high suitability areas for restoration through a novel high-resolution remote sensing framework: The case study of Portocolom Bay, Mallorca.

Talk 5 by **Vasilis Gerakaris**
Seagrass restoration in Greece's coastal lagoons: Reviving *Zostera noltei* meadows.

Talk 6 by **Vítor H. Oliveira**
Zostera noltei as a Nature-based Solution for the restoration of degraded estuarine ecosystems – An overview of project RemediGrass.

Talk 7 by **Nicolas Mayot**
Projet ReHAB: First pressure reduction, then restoration. The foundations for a future seagrass restoration success story in Berre lagoon?

Talk 8 by **Cristiana Maia**
(Halo)phytopthora pathogens: Implications for Seagrass Restoration.

Talk 9 by **Roosmarijn van Zummeren**
Transplantation of *Zostera noltii* sods to establish seagrass meadows on newly nourished sediments as part of coastal development works in Romania.

Talk 10 by **Marlene Jahnke**
Using restoration genomics for sourcing donor material in eelgrass.

Talk 11 by **Jana Willim**
Building Climate-Resilient Seagrass Meadows with Assisted Evolution.

Talk 12 by **Riccardo Pieraccini**
Every seed counts: unlocking the potential of Strigolactones and Gibberellins to improve *Zostera marina* seed germination and growth.

Talk 13 by **Liam Morrison**
Assessing The Ecophysiological Status Of Seagrass Meadows In Ireland Across An Anthropogenic Pressure Gradient.

Talk 14 by **Amelia Newman**
LIFE Funded: UK's Largest *Zostera marina* Restoration Project – A Perspective.

Talk 15 by **Anouska Mendzil**
In-field experimental planting-based methodology trials to inform active restoration practices*: Zostera marina.*

Talk 1

Comparison of *Posidonia oceanica* meadows transplanting protocols and first assessment of their efficiency.

Christine Pergent-Martini[1], Gérard Pergent[1], Pascal Oberti[2], Stefano Acunto[3], Serena André[1], Sebastiano Calvo[4], Ines Castejón-Silvo[5], Jean-Michel Culioli[6], Frederic Leca[2], Heike Molenaar[7], Briac Monnier[1], Alexis Pey[7], Luigi Piazzi[3], Marie-Catherine Santoni[6], Jorge Terrados[5]

[1]*University of Corsica and GIS Posidonie, UMR CNRS SPE 6134, FST Campus Grimaldi, 20250 Corte, France.*
[2]*University of Corsica, UMR CNRS 6240 LISA, Avenue Jean Nicoli, 20250 Corte, Franc.e*
[3]*International School for Scientific Diving, P.le Italia, 279 – 55100 Lucca, Italy.*
[4]*Biosurvey, Viale delle Scienze, Edificio 16 c/o ARCA - Business Incubator, 90128 Palermo, Italy.*
[5]*Instituto Mediterráneo de Estudios Avanzados (CSIC-UIB), Miquel Marqués 21,07190 Esporles, Mallorca, Spain.*
[6]*Office de l'Environnement de la Corse, RNBB, 14 avenue Jean Nicoli, 20250 Corte, France.*
[7]*THALASSA Marine research & Environment awareness, 06690 Tourrette-Levens, France.*

Corresponding author: pergent_c@univ-corse.fr

Abstract
The strengthening of *Posidonia oceanica* meadows was initiated at the end of the 1970s in the Mediterranean. Several techniques (mainly transplanting) have been tested with some success but also many failures, due to the strategy chosen and the slow growth rate of this species. As part of a study carried out in Sant'Amanza Bay (Corsica), initiated in spring 2021, four proven protocols, based on 3 600 cuttings from the same donor meadow and 400 drifting cuttings, were settled and compared in a unique site (900 m^2), where the main impact on the meadow (anchoring) are under controlled. Cuttings were placed on different substrates (dead matte, biodegradable net) using different fixing techniques and planting densities. After three years of yearly monitoring of these experiments, including the reference meadow nearby, significant differences are observed in the cuttings survival rate (66,2 to 98.8 %), but also concerning some other parameters measured (e.g. shoot number, bottom covering). Even it is difficult to identify, after only three years, if a protocol is definitively more successful than the other, an assessment of their efficiency have been realized using a multicriteria analysis (ELECTRE TRI). This analysis allows to propose a preliminary sorting of those.

Acknowledgements
The authors thank the SETEC Foundation and the French Office for Biodiversity and Corsica Environmental Office for funding.

Talk 2

A path to recovery: Restoration of seagrass *Posidonia oceanica* following cessation of a fish farm in Greece.

Catalina A. Garcia-Escudero[1,2], Vasilis Gerakaris[4], Grigorios Skouradakis[3], Elina Gkotsi[2], Emmanouela Vernadou[3], Thanos Dailianis[3] and Eugenia T. Apostolaki[2]

[1] *Department of Biology, University of Crete, Voutes University Campus, 70013, Heraklion, Crete, Greece.*
[2] *Institute of Oceanography, Hellenic Centre for Marine Research, 71003, Heraklion, Crete, Greece.*
[3] *Institute of Marine Biology, Biotechnology and Aquaculture, Hellenic Centre for Marine Research, 71003, Heraklion, Crete, Greece.*
[4] *Institute of Oceanography, Hellenic Centre for Marine Research, 19013, Anavyssos, Attiki, Greece.*

Corresponding author: c.garcia@hcmr.gr

Abstract

Fish farming has severely degraded seagrass meadows, compromising their ecological status and services. Seagrass restoration is essential to reverse this damage and sustain habitat integrity. In Eastern Crete, Greece, a pilot project aims to restore a *Posidonia oceanica* meadow degraded by over two decades of fish farming. The first phase assessed the condition of the degraded meadow and key ecosystem services—blue carbon storage and biodiversity—against a reference state. Using aerial photography and ROV-based ground-truthing, we mapped the area for photomosaic interpretation and classification. The ecological status of the area was evaluated using the national Weighted Posidonia oceanica Index (WePosi). Seagrass and litter were sampled to determine vegetative carbon pools, while sediment samples were used to estimate carbon stocks and accumulation rates using ^{210}Pb and ^{14}C. Biodiversity was measured using transects, quadrats, and corers, while also applying the Ecosystem-based Quality Index (EBQI). The analysis revealed extensive dead matte and sparse, degraded *P. oceanica* patches. Biodiversity was impoverished, with remarkably fewer taxa and differences in species composition, including the proliferation of the non-indigenous seagrass *Halophila stipulacea* over dead matte, illustrating rapid ecological succession. The ongoing phase includes transplantation trials of *P. oceanica* cuttings using peg-based techniques to promote recovery on dead matte, removal of plastic and fish farm debris to improve restoration conditions, scaling up transplantation efforts, and optimizing outcomes through long-term monitoring. The data will serve as the scientific basis for developing a national seagrass restoration roadmap, integrating institutional and legal frameworks alongside Payment for Ecosystem Services (PES) schemes.

Talk 3

Spatial variation in microbial communities in sediments and on roots of *Posidonia oceanica.*

Fabio Bulleri[1], Ezequiel M. Marzinelli[2], Matteo Oliva[3], Paul E. Gribben[4]

[1] *Dipartimento di Biologia Università di Pisa, Pisa, Italy.*
[2] *School of Life and Environmental Sciences, The University of Sydney, Sydney, New South Wales, Australia.*
[3] *Interuniversity Consortium of Marine Biology and Applied Ecology "G. Bacci", Livorno, Italy.*
[4] *Centre for Marine Science and Innovation, School of Biological, Earth and Environmental Sciences, University of New South Wales, Sydney, New South Wales, Australia.*

Corresponding author: fabio.bulleri@unipi.it

Abstract

Below-ground interactions regulate seagrass health and functioning. Nonetheless, little is known about how they vary with environmental conditions and they are rarely considered by restoration strategies. We compared microbial communities between sediments and rhizosphere of roots of *Posidonia oceanica* among sites along a gradient of human activities (i.e., urban, peri-urban and MPAs) in the NW Mediterranean. The sediment microbial community differed among most of the sites, while that associated with roots only differed between plants from the most pristine site and those from some urban and peri-urban sites. PERMDISP analysis showed that among-site variability in microbial community structure was greater in sediments than on roots. Analyses of bacterial ASVs that characterize microbial communities from different sites suggest that plants have limited ability to modify those of sediments. Nonetheless, despite major variations in characteristics of sediments, such as granulometry, nutrient loading and microbial community, plants appear able to maintain a core microbiome on roots. Our results have important implications for the restoration: i) *P. oceanica* may need a very specific rhizosphere microbial community to maintain performance under a wide range of environmental conditions; ii) where restoration is done via plant transplantation rather than seeds, preserving as much as possible the root-associated microbiota may buffer negative effects of sediment microbiota, which vary more and relate to human influences; iii) the microbial community associated to roots could provide more accurate indications of plant health than the sediment microbial community and, hence, it could be included in the monitoring of transplanted plants.

Talk 4

Identifying high suitability areas for restoration through a novel high-resolution remote sensing framework: The case study of Portocolom Bay, Mallorca.

Dimosthenis Traganos[1], Jeremiah J. Nieves[1], Laura Royo[2], Fiona Tomas Nash[2] , Tati B. Tesouro[2]

[1] *Ocean Ledger, 7-9 The Avenue, Eastbourne, East Sussex, United Kingdom, BN21 3YA.*
[2] *MedGardens, Camí des Raiguer, 114, 07320, Santa María del Camí, Balearic Islands, Spain.*

Corresponding author: dimos@ocean-ledger.com

Abstract:
Disparate field data sources and lack of spatio-temporal information impede developing, justifying and tracking restoration activities for coastal ecosystems. These challenges are further amplified by the very high cost and risk of failure of ecosystem restoration in the underwater environment. To solve these challenges, Ocean Ledger, a DLR spinout, has developed new automated and standardized means of combining historical and contemporary remote sensing and field data, tailored to local conditions and behaviors, to identify patterns of habitat change and dynamics, which can assist in targeting restoration areas. We show how such data can then be leveraged to produce estimates of potential restoration effort uplifts for seagrass coverage and carbon sequestration. Ocean Ledger partnered with the MedGardens team at Cleanwave Foundation to apply these granular approaches to guide MedGarden's comprehensive marine restoration plan through the three-year RESHABAY project for the Bay of Portocolom in Mallorca, Spain. This plan aims to reverse the degradation of 27 ha of Mediterranean priority habitats, such as those formed by *Posidonia oceanica* seagrass meadows, ensuring the continuity of their blue carbon sequestration and biodiversity maintenance services. We will present key findings concerning multi-decadal seagrass habitat variability (50cm; 2021-2023), scenario-based ecological forecasting of carbon uplift and natural capital accounting within Portocolom Bay. We will also discuss challenges and next steps in enhancing these approaches and potentially translating them to other coastal ecosystems and scales, including national. Such enhancements and scalability could empower low-risk, cost-effective and precise monitoring and decision-making for coastal resilience activities, within and beyond Europe.

Talk 5

Seagrass restoration in Greece's coastal lagoons: Reviving *Zostera noltei* meadows.

Vasilis Gerakaris[1], Laura Bray[1], Nikolaos Providakis[1], and Sofia Reizopoulou[1]

[1] *Institute of Oceanography, Hellenic Centre for Marine Research, PO Box 712, GR-19013, Anavyssos, Attiki, Greece.*

Corresponding author: vgerakaris@hcmr.gr

Abstract

Seagrass restoration is a critical strategy for enhancing the conservation status of coastal and transitional ecosystems while improving their ability to provide key ecosystem services. This study showcases an ongoing seagrass restoration initiative (LIFE TRANSFER - LIFE19 NAT/IT/000264) in Greece, focusing on small-scale interventions to improve the ecological integrity of coastal lagoons (habitat type 1150) in the Amvrakikos Gulf, Western Greece. The restoration targets degraded *Zostera noltei* meadows in Logarou lagoon, the largest coastal lagoon in the Gulf. High-resolution satellite imagery and aerial photography were used to map the area, providing insights into the presence and variability of *Z. noltei* meadows over recent years. Established transplanting techniques were employed, with sods collected from healthy donor meadows in Mazoma lagoon, a nearby site with similar environmental conditions. Transplanted sods were strategically placed in degraded areas to promote meadow recovery, with efforts to minimize donor site impacts by spreading sod collection across multiple areas and optimizing transplantation success through varied sod placement strategies. After three years of persistent efforts, results are mixed. Promising outcomes include signs of survival and meadow expansion in some areas (up to a few square meters), while high failure rates persist in others, with the underlying causes still being investigated. This study highlights the value of tailored restoration methods and offers insights into selecting site-specific techniques for seagrass rehabilitation. As Greece's first seagrass restoration initiative, the project aims to enhance ecosystem functionality while demonstrating a replicable approach to rehabilitating seagrass habitats in heavily degraded transitional ecosystems, with an emphasis on community engagement and scalability.

Acknowledgements

We would like to thank the financial support of "LIFE TRANSFER" an EU Life Project funded by the European Union's LIFE+ financial instrument (LIFE19 NAT/IT/000264)

Talk 6

Zostera noltei as a Nature-based Solution for the restoration of degraded estuarine ecosystems – An overview of project RemediGrass.

Vítor H. Oliveira [1]; A.I. Sousa [1]; D. Crespo [1,2]; C.L. Mieiro [1]; B.A. Fonte [1]; B. Marques [1]; V. Freitas [2]; J.M. Dias [3]; N. Vaz [3]; D. Matos [1]; A. Carvalhais [1]; F. Costa [4]; R. Faião [2]; E. Figueira [1]; C.B. Lopes [5]; B. Henriques [6]; M. Pacheco [1]; M.E. Pereira [6]; R. Calado [1]; A. I. Lillebø [1]; S. Díez [7]; M. Dolbeth [2]; J.P. Coelho [1]

[1] *CESAM - Centre for Environmental and Marine Studies, Department of Biology, University of Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro, Portugal;*
[2] *CIIMAR - Interdisciplinary Centre of Marine and Environmental Research, Novo Edifício Do Terminal de Cruzeiros Do Porto de Leixões, Avenida General Norton de Matos S/N, 4450-208, Matosinhos, Portugal;*
[3] *CESAM - Centre for Environmental and Marine Studies, Physics Department, University of Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro, Portugal;*
[4] *Centre for Functional Ecology, Department of Life Sciences, University of Coimbra, Calçada Martim de Freitas, 3000-456 Coimbra, Portugal;*
[5] *CICECO, Department of Chemistry, University of Aveiro, Campus de Santiago, 3810-193 Aveiro, Portugal.*
[6] *LAQV-REQUIMTE, Department of Chemistry, University of Aveiro, Campus de Santiago, 3810-193 Aveiro, Portugal.*
[7] *Environmental Chemistry Department, Institute of Environmental Assessment and Water Research, IDAEA-CSIC, E-08034 Barcelona, Spain*

Corresponding author: vitor.hugo.oliveira@ua.pt

Abstract

Active restoration efforts using the seagrass *Zostera noltei* were conducted in a metal-contaminated inner bay of Ria de Aveiro, Portugal. The study aimed to evaluate the potential of *Z. noltei* as an ecological tool for ecosystem restoration. *Z. noltei* demonstrated resistance and adaptability to the contaminated sediments in mesocosm conditions, supporting its suitability for restoration. A pilot transplantation study was then conducted in 2020 in the target area. The transplanted seagrasses adapted well, showing increased coverage and biomass over time. In 2024, spontaneous patches were identified around the transplantation area, indicating a natural recovery process. Within three months of transplantation, *Z. noltei* significantly improved sediment biogeochemistry, reducing mercury bioavailability in the interstitial water of the sediment surface layers by up to 40%. Furthermore, within a year, seagrass presence notably diminished nutrient fluxes into the water column. The restored seagrass meadows also benefited local fauna. Populations of benthic species such as *Scrobicularia plana* and *Hediste diversicolor* experienced reduced physiological stress and bioaccumulation of contaminants in the presence of *Z. noltei*. Improvements in community-derived indicators (total density and biomass, species richness and Shannon-Wiener index) were also observed when compared to adjacent and non-restored areas. Notably, the biomass of the benthic macroinvertebrate community matched levels found in the source meadow from which the seagrasses were collected. These findings highlight the potential of seagrass restoration in contaminated ecosystems to promote ecological recovery and enhance biodiversity.

Acknowledgements

This work was partially funded by project RemediGrass (PTDC/CTA-AMB/29647/2017) funded by FEDER, through COMPETE2020 - Programa Operacional Competitividade e Internacionalização (POCI), and by national funds (OE), through FCT/MCTES (Fundação para a Ciência e Tecnologia and Ministério da Ciência, Tecnologia e Ensino Superior).

Talk 7

Projet ReHAB: First pressure reduction, then restoration. The foundations for a future seagrass restoration success story in Berre lagoon?

Nicolas Mayot[1], Julie Duley[1], Raphaël.Grisel[1]

[1] *GIPREB, 13 Cours Mirabeau. 13130 Berre L'Etang. France.*

Corresponding author: nicolas.mayot@gipreb.fr

Abstract

Berre lagoon (South of France) is a large Mediterranean lagoon which was covered by 6000 ha of Seagrass (mainly *Nanozostera noltei)* at the beginning of the century. After the installation of an hydroelectric powerplant and his the freshwater inputs, the lagoon began eutrophised and seagrass meadows decline up to 1.2 ha in 2009. After different regulation and dryness, the freshwater inputs decline and water transparencies improve. The seagrass meadows began to augment. The last regulation was installed in 2024 with the main objective of an augmentation of the water transparency to permit the development of seagrass meadow. In 2024, Zostera meadow recovered a surface of 59 ha. In this context, the Gipreb decides to accelerate the seagrass recolonization by making seagrass restoration by transplantation. In May 2024, 1000 cores of *Nanozostera noltei* were transplanted in two sites of Berre lagoon from another site in Berre lagoon. After 4 month of monitoring, the results shows a large augmentation of the cores. The mean growth is between 88 cm and 50 cm on the two sites and the respective survival rate are 96% and 70%. The surface was multiplied by 50 in only 4 months. Results should be moderate by the quite short monitoring period and should be confirmed after at least one year. Anyway, this success shows the importance of first identify and reduce the pressure that conduct seagrass regression. This strategy “first reduction, then restoration” is probably the key of the success story of seagrass restoration in Berre lagoon.

Acknowledgements

Thanks to Laura Govers, Richard Lilley and the team from Rijksuniversiteit Groningen, and to Wietse van der Werf , Sophie Hankinson and the Sea Ranger Service for assisting with the restoration operations.

Talk 8

(Halo)phytopthora pathogens: Implications for Seagrass Restoration.

Cristiana Maia[1], Tânia Aires[1], João Brazão[1], Marília Horta Jung[2], Thomas Jung[2], Ester A. Serrão[3], Aschwin H. Engelen[1]

[1] *Marine Microbial Ecology and Biotechnology, Centro de Ciências do Mar, Universidade do Algarve, Campus de Gambelas, 8005-139 Faro, Portugal,*
[2] *Phythopthora Research Centre, Faculty of Forestry and Wood Technology, Mendel University, 613 00 Brno, Czech Republic*
[3] *Centro de Ciências do Mar, Universidade do Algarve, Campus de Gambelas, 8005-139 Faro, Portugal*

Corresponding author: ccmaia@ualg.pt

Abstract
Seagrass meadows are globally declining due to anthropogenic stressors but dramatic declines were already recorded in the 1930s due to widespread disease outbreak. Currently, seagrass restoration efforts are increasing using both transplantations of seeds and/or shoots. For this, the role and importance of the seagrass microbiome gained attention in the last decades, yet pathogens remain poorly understood, despite their historical impact and their potential large implications for restoration.
Here we investigated (*Halo)phytopthora* diversity in European seagrasses, especially in Portugal. We identified and characterized novel and known (*Halo)phytopthora* isolated from baits as well as below and above ground tissues of *Zostera marina*, *Zostera noltei*, *Cymodocea nodosa* and *Ruppia sp.*, to map their distributions and specificity. Isolates were barcoded using the ITS region. Location, bait, and seagrass x tissue combinations yielded different isolates, suggesting some specificities and differentiation among isolates. Laboratory infection experiments on *Z. marina* and *C. nodosa* showed differences in susceptibilities to (*Halo)phytopthora* isolates as well as different levels of pathogenicity among (*Halo)phytopthora* isolates.
Transplanting and nursery activities for seagrass restoration should be very aware of the risk of introducing and dispersing seagrass pathogens and should implement a prescreening and monitoring strategy. In addition, the restoration community should invest in understanding pathogen-seagrass-microbiome interaction to come up with biological solutions to promote seagrass resilience against pathogens.

Acknowledgements
This research is financially supported by FCT under reference number SFRH/BD/136277/2018, RESTORESEAS by Biodiversa+, LIFE-RESTORESEAGRASS2023 Project 101148241-LIFE23-NAT-PT and the Project Phytophthora Research Centre Reg. No. CZ.02.1.01/0.0/0.0/15_003/0000453 co-financed by the Czech Ministry for Education, Youth and Sports and the European Regional Development Fund.

Talk 9

Transplantation of *Zostera noltii* sods to establish seagrass meadows on newly nourished sediments as part of coastal development works in Romania.

Roosmarijn van Zummeren[1], Charlotte Harper[1], Alina Croitoru[2], Wouter van Broekhoven[1]

[1] *Van Oord Dredging and Marine Contractors, Rotterdam, The Netherlands*
[2] *Van Oord Dredging and Marine Contractors – Romania Branch, Constanța, Romania*

Corresponding author: roosmarijn.vanzummeren@vanoord.com

Abstract
A strategy to allow the recovery of *Nanozostera noltii* in the Romanian Black Sea, is integrated alongside a coastal development project by the Romanian Government and industry. Sediment nourishments and breakwaters are constructed to halt coastal erosion, of which the design also requires to generate favourable (abiotic) conditions for N. noltii over 2.8 ha within the project footprint. A numerical model was developed to facilitate suitable conditions of depth, erosion/sedimentation rates, and flow/orbital velocities into the design. Post-construction, site suitability was monitored on sediment stability from January to May 2023 via single-beam surveying. Subsequently, 468 N. noltii sods (totalling 3.7 m2) were collected with 10-cm cores from nearby meadows and transplanted behind the constructed breakwaters at the most morphodynamically stable sites, in May-June 2023. Three different planting patterns were applied: single, clustered, and spaced clustered sods, to explore the effectiveness of clustering and spacing on patch survival and optimal use of donor material for future upscaling. Drone imagery from October 2023 and May 2024 reveals the total restored seagrass area expanded to 181 m2 after the first growing season, with partial loss following a year after planting, but still showing an overall expansion of 126 m2. First results indicate higher seagrass percentage cover in clustered sod plots (69.8%) than in single sod plots (50.4%), one year after planting. These results show that opportunities for seagrass rehabilitation exist within coastal development projects, allowing new financing mechanisms and seagrass rehabilitation to be incorporated as a Nature-based Solution by project developers.

Talk 10

Using restoration genomics for sourcing donor material in eelgrass.

Marlene Jahnke[1], Stefanie Ries[1], Maru Bernal[1], Pierre de Wit[1], Swantje Enge[1], Giannina Hattich[2], Christian Pansch[2] and Jon Havenhand[1]

[1] *Department of Marine Sciences – Tjärnö Marine Laboratory, University of Gothenburg, Strömstad, Sweden*
[2] *Environmental and Marine Biology, Åbo Akademi University, Åbo/Turku;*

Corresponding author: marlene.jahnke@gu.se

Abstract
Identifying the most suitable donor sites for restoration is an important component of successful restoration and for increasing the likelihood that a restoration action is without negative impact on surrounding populations. Restoration genomics generally focusses on the importance of sourcing "the right" donor material for a specific restoration site. Sourcing donor material for eelgrass restoration currently often occurs at small spatial scales—typically within ones to tens of kilometers. It is therefore also the scale of 1s to 10s of kms that needs to be considered in restoration genomics in order to test which local meadow may harbour genetic material that is most likely to be beneficial at a certain restoration site. However, genetic assessments are generally carried out at much larger spatial scales (10s-100s, or even 1000s km), as is the monitoring of environmental parameters that may drive adaptation and restoration success. We carried out a seascape genomic analysis of ten eelgrass meadows on small spatial scales (2-14 km) and also monitored environmental conditions *in situ*. We observed differences in environmental conditions, particularly temperature, as well as genetic differentiation. We found that 9% of the overall genetic variation on this small-scale can be explained by local factors of a meadow (exposure, organic content of the sediment, daily temperature variability), as well as geographic distance and genetic differentiation. We also identified putative adaptive loci associated with environmental variables. The findings of small-scale genetic differentiation associated with environmental differences, suggest that adaptation should be considered during the sourcing of donor material.

Talk 11

Building Climate-Resilient Seagrass Meadows with Assisted Evolution.

Jana Willim[1], Jule Wirries[1], Thorsten B. H. Reusch[1]

[1] *GEOMAR Helmholtz Centre for Ocean Research Kiel, Marine Evolutionary Ecology, Wischhofstr. 1-3, 24148 Kiel, Germany*

Corresponding author: jwillim@geomar.de

Abstract

Marine heat waves are an increasing threat to coastal ecosystems. In seagrasses, vulnerability may vary across life stages but experimental data are sparse. We examined how heat stress affects different stages (6-month-old juveniles, 18-month-olds, and fully grown adults) of Baltic Sea *Zostera marina*, comparing each life stage at 27°C vs. controls at 19°C. Adult plants suffered the highest mortality rates, while both juvenile classes showed greater tolerance, reflected in higher growth rates and photosynthetic activity, suggesting more flexible and heat-resilient metabolism compared to adults. This variation highlights the complexity of temperature responses across life stages in foundation species such as seagrasses. If early-stage heat exposure can create lasting resilience, juvenile plants may be ideal heat-tolerant and strong founders for restoring seagrass meadows. Grown from seeds in nurseries, these genotypes can be preselected or “hardened” through targeted stress exposure, making them robust for planting into the wild. These strategies, part of the "Assisted Evolution" toolbox, offer promising methods for sustainable seagrass restoration in a warming world.

Talk 12

Every seed counts: unlocking the potential of Strigolactones and Gibberellins to improve *Zostera marina* seed germination and growth.

R.Pieraccini[1], L.Picatto[3], N.Koedam[1], T.Van der Stocken[2], A.Vanreusel[1]

[1] *Department of Biology, Marine Biology research group, Ghent University, Belgium*
[2] *Department of Biology, Ecology, Evolution and Genetics (bDIV) research group, Vrije Universiteit Brussel, Belgium*
[3] *JPI Oceans, Brussel, Belgium*

Corresponding author: riccardo.pieraccini@ugent.be

Abstract
Seagrass meadows, such as those formed by *Zostera marina*, are important global carbon sinks, nurseries, and habitats for marine organisms, while also providing effective coastal protection against floods and storms. Despite their importance, these ecosystems are rapidly declining due to human activities and climate change, creating an urgent need for large-scale restoration. As the demand for viable seeds grows, improving nursery propagation methods and maximizing the germination rates of wild-collected seeds are important priorities for successful seagrass restoration programs. A key challenge in these efforts is the poor germination success and seedling survival, which limit the scalability of restoration projects. In this study, we used *in vitro* assays to investigate the potential of Strigolactones (SLs) and Gibberellic Acid (GA_3) as seed priming agents to improve germination rates and accelerate seedling development in *Z. marina*. Wild-collected seeds from two cohorts were treated with SLs and GA_3 at various concentrations. Germination was monitored over 42 days, followed by an additional 31 days of seedling growth assessment. GA_3 demonstrated consistent efficacy across concentrations, while SLs exhibited optimal performance at intermediate levels. Younger cohorts showed greater responsiveness to these treatments, underscoring the role of seed age in germination potential. Our findings reveal that seed priming with phytohormones can significantly improve germination rates, reduce germination time, and synchronize seedling establishment. With this work we would like to provide actionable insights to scale up seagrass restoration efforts and enhance coastal ecosystem resilience.

Acknowledgments
This research was supported by Flanders innovation & entrepreneurship (VLAIO) and the Research Foundation Flanders (FWO). The research leading to results presented in this publication was carried out with infrastructure funded by EMBRC Belgium - FWO international research infrastructure I001621N.
We gratefully thank Dr. Tobias Dolch, the Alfred Wegener Institute, the Landesamt für Umwelt des Landes Schleswig-Holstein (LfU), and Landesbetrieb für Küstenschutz, Nationalpark und the Meeresschutz Schleswig-Holstein, Nationalparkverwaltung for the local guidance, supporting the permit request.

Talk 13

Assessing The Ecophysiological Status Of Seagrass Meadows In Ireland Across An Anthropogenic Pressure Gradient.

Liam Morrison[1], Anagha Amitha[1], Juan Lugilde-Yáñez[1], Teena Thomas[1], Rita Hagan[1], Sara Haro[2], África NG De la Morena[2], Ricardo Bermejo[2]

[1]University of Galway. Earth and Ocean Sciences (EOS), School of Natural Sciences and Ryan Institute, Ireland, H91 TK33.
[2]Universidad de Málaga. Instituto Andaluz de Biotecnología y Desarrollo Azul (IBYDA), Departamento de Ecología y Geología, Campus Universitario de Teatinos s/n, 29071 Málaga, Spain.

Corresponding author: liam.morrison@universityofgalway.ie

Abstract
Seagrasses play a crucial role in sustaining coastal ecosystems providing essential habitats, stabilizing sediments, sequestering carbon, and reducing coastal erosion, etc. Despite their importance, these ecosystems are under significant threat from both natural pressures and human activities. This study aims to explore the distribution of seagrasses in Ireland, highlight their ecological significance, and examine the impacts of human activities on their health and sustainability, focusing on three taxa: *Zostera marina*, *Nanozostera noltei*, and *Zostera marina* var. *angustifolia*.

Using a combination of historical records and recent surveys, this study assessed the effects of anthropogenic pressures such as agricultural runoff and effluents. The impact of nutrients, particularly nitrogen, on various seagrass metrics (shoot density, leaf length, biomass, δ15N) was also evaluated. Analyses were performed using Principal Component Analysis (PCA) and multiple regression models.

The results indicate that most sites selected in Ireland are in moderate to poor ecological condition (EQR), with declines observed in shoot density, biomass, and leaf length. These findings point out the urgent need for restoration efforts and further research to protect these vital ecosystems. The study advocates for enhanced management and conservation strategies to safeguard the health of Ireland's seagrass meadows.

Talk 14

LIFE Funded: UK's Largest *Zostera marina* Restoration Project – A Perspective

Amelia Newman[1,2] Andy Cameron[1], Fiona Crouch[2], Caitlin Napleton[2], Mark Parry[1], Muriel Plaster[2], Hazel Selly[2], Jess Taylor[2], Fiona Tibbet[2].

[1] *Ocean Conservation Trust, Rope Walk, Plymouth, PL3 4HJ, United Kingdom.*
[2] *Natural England*

Corresponding author: amelia.newman@oceanconservationtrust.org

Abstract
Ocean Conservation Trust led the restoration of the UK's largest seagrass restoration project to date. The EU LIFE Recreation ReMEDIES project strived to restore 8 hectares of subtidal seagrass (*Zostera marina*), through trialling a variety of seeding and plantlet techniques. Over a 5 year period two seed dispersal methods were tested, the most successful being the novel Hydro Marine Seeding (HMS) device which is used to deploy seeds into the seabed on mass (hectares at a time). The preliminary trials for this device have provided the highest germination rate of large-scale seed dispersal methods in this region. In addition to seeding, the Ocean Conservation Trust demonstrated proof of concept for Seed Mat Technology (SMT), allowing plantlets grown in a laboratory to be transplanted into the natural environment. We have demonstrated high germination success (>69%) with SMT, as well as promising results for *in situ* growth and bed formation. Here we present the knowledge gained from these cultivation and restoration efforts, which have been accumulated in the ReMEDIES Best Practice Guide for restoring *Z. marina*. We will also highlight key challenges faced during the restoration process and discuss considerations for the broader restoration community.

Talk 15

In-field experimental planting-based methodology trials to inform active restoration practices*: Zostera marina.*

Anouska Mendzil[1,2], Richard Unsworth[1,2],

[1] *Department of Biosciences, Wallace Building, Swansea University Singleton Campus, Swansea, SA2 8PP*
[2] *Project Seagrass, Unit 1 Garth Drive, Brackla Industrial Estate, Bridgend, CF31 2AQ, United Kingdom*

Corresponding author: Anouska Mendzil a.f.mendzil@swansea.ac.uk | anouska@projectseagrass.org

Abstract
In this research, the UK's largest *in-field* seagrass *(Zostera marina)* scientific methodology planting trials, funded by WWF Seagrass Ocean Rescue (SOR), aims to identify and test the most successful and efficient planting methodology to enable increased seed germination and survival for active restoration projects at scale. This research additionally aimed to inform the best practice to act as a local rapid response for seagrass recovery in the event of seagrass loss, of which seagrass is protected feature within the study area.
Five planting methodologies and a control were trialled in 2022 across three locations around the Solent and the Isle of Wight, South England, using four seed-based methodologies and one plant-based methodology. The seagrass planting methodologies trialled in this study included Dispenser Injection Seeding (DIS) (intertidal), hessian bags (intertidal), socks (intertidal), immediate replanting (intertidal), transplants (subtidal). Each planting methodology or plot covered 10 m^2 with a triplicate of each method at each site. In total 18 plots were planted at each site, with a project total of 54 plots covering 0.54 ha across the three study locations. The results indicate varying results at the three study locations, albeit transplants and DIS were found to be the most successful methods and have now been implemented for active restoration in the two of the study areas. Interestingly, following two years since planting, positive results are only now being seen, indicating the importance for funding of monitoring being accounted for in restoration projects long after restoration and/or projects have ceased.

Acknowledgements
This research has been funded with thanks by WWF Seagrass Ocean Rescue and Liz Earle.

ABSTRACTS FOR POSTERS

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Poster 24 by **Andrés Arona**
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Poster 1

Combining dredging techniques with seed-based eelgrass restoration in Loch Craignish, Scotland

Roosmarijn van Zummeren[1], Charlotte Harper[1], Anne-May Alkemade[1], Laura Govers[2]

[1] *Environmental Engineering, Van Oord Dredging and Marine Contractors Rotterdam, The Netherlands;*
[2] *Conservation Ecology Group, Groningen Institute for Evolutionary Life Sciences (GELIFES), University of Groningen, Groningen, The Netherlands*

Corresponding author: roosmarijn.vanzummeren@vanoord.com

Abstract
Governments and project developers increasingly seek Nature-Based Solutions to enhance biodiversity, coastal protection or carbon sequestration. However, the largely manual nature of traditional restoration methodologies poses challenges for large-scale implementation in industry. To advance large-scale seagrass restoration, a collaboration among academia, community initiatives and industry explore the use of dredging techniques for seed-based restoration. A concept is developed whereby seeds are added to a sediment-seawater mixture with targeted release via spray pontoon. This approach aims to integrate seagrass restoration, via industrial methods, in coastal nourishment projects while also stabilizing local sediment conditions through "sand-capping". Laboratory tests demonstrate that low-density mixtures (5–10%) with fine (d50 = 0.17 mm) to medium-coarse (d50 = 0.35 mm) sand promote optimal seed settlement between -1 and -5.5 cm in a 10 cm nourished sand layer. A field trial using proxy seeds (crimson clover) and low-density mixtures (2.5–5%) with fine and medium coarse sand (d50 = 0.25 mm and 0.41 mm, respectively) was conducted using a spreader pontoon mounted on an industrial working vessel in Loch Craignish, Scotland. Sediment samples collected in November 2024 are being analysed to determine seed distribution in the sediment layer. In March 2025, the findings will inform a scaled-up trial with 100,000 *Zostera marina* seeds applied across 1,000 m² sediment nourishment. However, future upscaling depends on developing commercially available seagrass seeds. With this project we demonstrate that collaboration in a multidisciplinary team could unlock more opportunities for seagrass restoration in Europe.

Poster 2

Lessons learnt from a large-scale intertidal restoration project in northwest Wales.

Oliver Thomas[1,2], Bridget Patterson[1,3], Conor Laing[1,3], Stijn den Haan[4], Richard Unsworth[1,3]

[1] *Project Seagrass, Unit 1 Garth Drive, Brackla Industrial Estate, Bridgend, CF31 2AQ, United Kingdom*
[2] *University of Plymouth, Drake Circus, Plymouth PL4 8AA, United Kingdom*
[3] *Swansea University, Department of Biosciences, Wallace Building, Swansea University Singleton Campus, Swansea, SA2 8PP*
[4] *The Field Work Company, Stockholmstraat 2B, 9723 BC Groningen, The Netherlands*

Corresponding author: ollie@projectseagrass.org

Abstract
As part of a multiannual restoration project in North Wales, ~1.31 million *Zostera marina* seeds and ~4300 nursery grown transplants were planted intertidally across two sheltered beaches on the south coast of the Llŷn. Both sites were indicated as suitable by habitat suitability models (Bertelli et al. 2023). In spring 2023 experimental trials were set up at both sites to test the efficacy of two different planting methods: buried hessian bags and directly injected seeds (DIS), with experimental densities of either 80 or 320 seeds m^{-2} in both treatments. Summer monitoring results showed that high density DIS (320 seeds m^{-2}) was the most effective planting method by a significant margin, however, follow up monitoring in autumn showed no surviving shoots from any method: there was strong, but indirect, evidence that overwintering geese had grazed all remaining plants. Further seeds/plants were planted out in early 2024 utilising a variety of methods, high density DIS, mechanised DIS, and transplants. Autumn monitoring showed that all these plantings had failed. Evidence derived from satellite (E.U. Copernicus Marine Service Information 2024a b) and in-situ measurements suggests that this failure was due to a combination of factors: a heatwave and reduced salinity from increased precipitation leading to heightened plant stress; and above average wave heights and irregular prevailing wave direction leading to scour. Conditions were significantly different to the year prior. These results highlight the unpredictable challenges currently faced by temperate intertidal seagrass restoration projects, the limit of habitat suitably models, and best tested planting methods.

Acknowledgements
Thank you to our funders The National Lottery Heritage Fund, to our Seagrass Ocean Rescue North Wales project partners: The World Wildlife Fund for Nature, North Wales Wildlife Trust, Pen Llŷn a'r Sarnau, and Swansea University, and to all the volunteers who have aided in this work.

Poster 3

Towards global-scale prediction of seagrass *Zostera marina* carbon stocks.

Nicola Wilson[1,2], Dr Chris Laing[2], Dr Rudy Arthur[1], Dr Bob Brewin[3]

[1] *Institute of Data Science and AI, University of Exeter, UK*
[2] *Centre of Ecology and Conservation, University of Exeter, UK*
[3] *Centre for Geography and Environmental Sciences, University of Exeter, UK*

Corresponding author: nw431@exeter.ac.uk

Abstract
A key barrier for seagrass restoration projects securing private finance on the voluntary carbon market is the complexity and cost of quantifying and verifying carbon stocks to validate carbon credits. Current methods for carbon accounting in seagrass rely on global or regional averages but due to high variability do not provide enough confidence for the carbon market. The rate of carbon storage in seagrass is highly variable even within species and local areas due to environmental conditions. As credibility and transparency is crucial for the success of blue carbon markets, novel approaches are required for scalable and accurate accounting. This research takes a data-driven approach to predict carbon stocks in the temperate seagrass species, *Zostera marina*. Published in-situ sampled carbon stock data is combined with environmental variables (representing climate, sedimentary environment, flow regime and geography) derived from earth observation data and globally available datasets. From this, a predictive model of carbon stock has been trained using a gradient boosting decision tree algorithm. Approximately 54% of the variability of organic carbon stock in *Zostera marina* beds is explained by 21 variables in the trainset and 40% variability in the test set. The most predictive variables relate to the hydrodynamic environment and land-use. The model is then applied to habitat suitability mapping to spatially map and quantify carbon stocks in south-west UK. This method provides an improvement to predicting carbon stocks at scale and a valuable tool to support local decision makers in restoration efforts and support financing mechanisms.

Acknowledgements
The authors would like to thank the NERC Earth Observation Data Acquisition and Analysis Service (NEODAAS) for processing of Sentinel-2 imagery for this study

Poster 4

Exploring the Role of Microbial Communities in Seagrass Sediments: Impacts on *Zostera marina* Germination and Survival.

Benders P [1], Hodge J, Parry M [2], Newman A [1,2], Daughtery M [2], Cameron A [2], Schindler R[3], Ransome E [1]

[1] *Department of Life Sciences, Imperial College London, South Kensington Campus, London SW7 2AZ, UK*
[2] *Ocean Conservation Trust, Rope Walk, Coxside, Plymouth PL4 0LF , UK*
[3] *School of Geography, Earth and Environmental Sciences, University of Plymouth, Drake Circus, Plymouth PL4 8AA*

Corresponding author: mim.daughtery@oceanconservationtrust.org

Abstract
Terrestrial plant health has been enhanced through the use of plant probiotics, which promote growth by leveraging microorganisms that benefit productivity, immunity, yield, and resilience to biotic and abiotic stresses. However, the application of probiotics in seagrass sediments remains understudied. Research has shown that the absence of natural seagrass microbial communities during transplantation increases mortality, while a root microbiome improves nutrient stress resilience. To address this, an 83-day experiment was conducted at the Ocean Conservation Trust's seagrass nursery facility to investigate how microbial communities in seagrass sediments affect *Zostera marina* germination and survival. For the experiment, non-sterile sand, traditionally used in cultivation, served as a control. Treatments included sediment collected from local seagrass meadows with varying sediment types and microbial communities. Half of the sediments retained intact microbes, while the other half were autoclaved to create microbe-free natural seagrass sediment. Results showed *Z. marina* seeds cultivated in autoclaved natural sediments had reduced mortality and a germination rate of 97.5% of viable seeds, compared to just 20% in non-sterilized sand. Surprisingly, natural sediments with intact microbial communities reduced germination and offered no clear benefits to cultivation or survival. Non-sterile sand had the lowest shoot density and highest mortality rate. These findings highlight potential improvements in *Z. marina* cultivation but underscore the need for a deeper understanding of community coalescence to apply microbial probiotics successfully.

Poster 5

Blue Meadows: Empowering Communities for Seagrass Conservation.

Megan Ross[1], Eden Stevens[1]

[1] *Ocean Conservation Trust, Rope Walk, Coxside, Plymouth PL4 0LF , UK*

Corresponding authors: megan.ross@oceanconservaiontrust.org & eden.stevens@oceanconservationtrust.org

Abstract

As seagrass meadows continue to decline globally, restoration efforts are urgently needed to safeguard their ecological, economic and societal benefits. The Blue Meadows project takes a holistic approach to protect and restore seagrass meadows across the UK while actively involving local communities. This talk will explore the critical role of community engagement in seagrass restoration, highlighting the impact of empowering local populations to connect with and protect their nearby meadows. To support the Blue Meadows vision of "communities along the Southwest Coast connected to seagrass, taking action to support its protection", we developed a Theory of Change (ToC) – a framework that guides the impactful implementation of community involvement within seagrass conservation. This talk will outline the three-year process of developing this ToC, detailing the planning phase, pilot trails and the strategies designed to both raise general awareness and target specific stakeholder groups. These strategies incorporate indirect and direct actions, facilitating behaviour change, alongside plans to adopt citizen science programmes supported by volunteer communities - enhancing community involvement, and connection to seagrass. The Blue Meadows initiative demonstrates the success of community-driven efforts, with a particular focus on engaging diverse audiences across over 200 miles of the South Coast of England, showcasing how local involvement can contribute to the protection and restoration of seagrass ecosystems.

Acknowledgements

A big thank you to the rest of the Blue Meadows team for your hard work and dedication to this project's success. We also appreciate the ongoing support from the Ocean Conservation Trust team. Finally, thanks to all our delivery partners – without you, we couldn't have reached as far or with such detail.

Poster 6

Hydro Marine Seeding – trials to tackle upscaling of restoration in Plymouth Sound.

Leah Pettitt[1], Andrew Cameron[1], Miriam Daughtery[1], Amelia Newman[1, 2], Tadhg O Corcora[1], Lauren Park-McCann[1], Mark Parry[1]

[1] *Ocean Conservation Trust, Rope Walk, Coxside, Plymouth PL4 0LF , UK*
[2] *Imperial College London, South Kensington Campus, London SW7 2AZ, UK*

Corresponding author: leah.pettitt@oceanconservationtrust.org

Abstract
Hydro Marine Seeding (HMS) is a term used to describe the direct seed injection method for the restoration of subtidal *Zostera marina* developed by the Ocean Conservation Trust. Subtidal seagrass restoration faces several challenges to succeed (Unsworth *et al*. 2023). HMS was developed as an alternative method for seed deployment (alongside a transplantation method, Seed Mat Technology) after initial seed bag trials returned very low success rates and were labour-intensive. Following Govers *et al*. 2022, the Ocean Conservation Trust commissioned a local product design team to adapt a device; named OCT'*o*'PUS (Ocean Conservation Trust '*o*' Pressurised Underwater Seeder). The spring-loaded, handheld device is designed for divers to repeatedly use on the seabed. One OCT'*o*'PUS unit can be activated 200 times, to inject ~2,000 seeds, in under 20 minutes. We found it possible for a team of 8 divers to complete approximately 1ha area at this density in one day. As part of the multi partner LIFE Recreation ReMEDIES (LIFE18 NAT/UK/000039) project, in 2023 and 2024, 3.5 hectares of bare sediment were injected at a planting ratio of 8 seeds per square meter using this methodology. Here we present germination success/survival rates for HMS, comparing these with simultaneous out-plantings using Seed Mat Technology and hessian bags. Additional fine scale local experiments allowed for assessment of multiple planting factors (e.g. number of seeds per m^2) and their influence on return of ecosystem services. We outline our experiences of these varied methods of restoration, highlighting successes and failures encountered throughout the project.

Poster 7

Mini Meadows™: A funding model for seagrass restoration and protection.

Guy Hooper[1] Matthew Ashley[1], Tom Mullier[1], Martin Attrill[1], Amelia Sturgeon[2], Zoe Sydenham[3],Lauren Park-McCann[4] Mark Parry[4], Katey Valentine[5], Sian Rees[1]

[1] *School of Biological and Marine Science, University of Plymouth, Drake Circus, Plymouth PL4 8AA, United Kingdom*
[2] *Tamar Estuaries Consultative Forum, Plymouth, Devon, United Kingdom*
[3] *Plymouth City Council, Plymouth, Devon, United Kingdom*
[4] *Ocean Conservation Trust, Rope Walk, Coxside, Plymouth PL4 0LF , UK*
[5] *Finance Earth, London, United Kingdom*

Corresponding author: lauren.park-mccann@oceanconservationtrust.org

Abstract
Seagrass restoration worldwide is an emerging and essential requirement to combat the collapse in our natural world. With the loss of seagrass habitats globally, coastal communities lose crucial ecosystem services that allow life to thrive. To reverse degradation, sustainable long-term finance options need to be developed. Currently, seagrass restoration approaches are viewed as experimental and high risk, in addition regional ecosystem values lack the quantitative data required for formal nature-based solution accreditation. Nature cannot wait, so the Ocean Conservation Trust has developed a donation model to drive support and restoration of Blue Meadows™ Mini Meadows™. The donations fund active restoration and protection on a ratio of 10 ha restored, 100 ha protected. This allows business and individual donors to contribute towards immediate action while also funding the high integrity data collection required by financial markets to provide offsets, biodiversity and net gain credits. Here the Ocean Conservation Trust present the collaborative work funded through the Environment Agency, Natural Environment Infrastructure Readiness Fund that led to the development of Mini Meadows™ and how corporate and private donors can work collaboratively to reverse nature's collapse through seagrass restoration.

Poster 8

Timing matters: Earlier planting leads to increased germination success in *Zostera marina* seeds for active restoration in the UK.

B. Walter[1], H. L. Green [1,2], C. Green [1], E. Yates[1], R. K. F. Unsworth [1,3]

[1] *Project Seagrass, Unit 1, Garth Drive, Brackla Industrial Estate, Bridgend, CF31 2AQ, United Kingdom*
[2] *Department of Earth and Environmental Science, University of Exeter, Cornwall, UK*
[3] *Seagrass Ecosystem Research Group, Swansea University, Swansea, UK*

Corresponding author: hannah@projectseagrass.org

Abstract

Globally seagrass restoration efforts have been increasing in recent years (Orth & Heck 2023). Seed-based restoration is often favoured, as it provides higher genetic diversity and less impact on donor meadows (Reynolds et al., 2012). Restoration success is highly dependent on site-selection, methods and timing. To increase germination rate and the success of seedling establishment for restoration programmes we carried out experiments investigating timing, planting methods and sediment type under semi-controlled conditions in a nursery setup. In December, February and March *Zostera marina* seeds were placed in hessian bags containing different sediment mixes and two different types of sediment, one coming from our donor meadow and one from an unvegetated beach (unvegetated beach sediment). Planting time and sediment had a significant effect on germination. Germination was most successful when planted in December. Rates were lower in unvegetated sediment and decreased with planting time. Sediment type furthermore had a significant effect on the leaf length; 6.4 ± 1.2 (donor meadow sediment SG) to 3.7 ± 0.86 (unvegetated beach sediment) cm in December and 3.79 ± 0.64 (donor meadow sediment) to 3.02 ± 0.82 (unvegetated beach sediment) cm in March. The use of hessian bags decreased germination. For each different sediment mix the highest germination was found in December. Neither timing nor sediment significantly affected the viability of recovered seeds. Our experiment shows that Z. marina seeds from perennial meadows in the UK did not go through winter dormancy. Germination was most successful in early winter. The presented results here could have important implications for success of restorations activities.

Poster 9

Optimising seed selection and germination success of intertidal *Zostera marina* in the Solent, UK.

Uresha Rodrigo[1], Emma Ward[1], Bronwen Paxton[1], Ellie Parker[2], Tim Ferrero[2], John Aldrige[3], Claudia Penketh[1], Max Clare[1], Joanne Preston[1]

[1]*Institute of Marine Sciences, University of Portsmouth, UK*
[2]*Hampshire and Isle of Wight Wildlife Trust, Hampshire, UK*
[3]*Centre for Environment, Fisheries and Aquaculture Science, Weymouth, UK*

Corresponding author: emma.ward@port.ac.uk

Abstract

Several bottlenecks have been identified that impede successful seed-based *Z. marina* seagrass restoration, including low germination rates and knowledge gaps on the life history, seed characteristics and interactions with environmental factors. A three-pronged approach was used to fill knowledge gaps on reproduction, seed selection and germination in intertidal *Z. marina* by assessing; (1) seed quality and sinking velocity, (2) the effect of seed colouration, light quality and freshwater on cotyledon establishment and plant development (3) growth dynamics of reproductive and non-reproductive aboveground biomass in existing intertidal meadows. On average *Z. marina* seeds weighed 6.08 ±2.14 mg, with a sink rate of 4.50 ±1.09 cm s^{-1}. Higher *Z. marina* cotyledon establishment occurred in light seeds (5.9%) versus dark seeds (1.7%). A quality threshold of ~3.5 mg and the use of light-coloured seeds will improve seed selection and germination for seed-based restoration of intertidal *Z. marina*. Light quality (intensity and spectrum) significantly impacted belowground root biomass with implications for site selection and nursery techniques. In natural meadows, environmental driven annual patterns in growth and dieback of *Z. marina* informs timing of seed-based restoration deployment (May) and seed collection (August to September) in this locality.

Poster 10

Geographical Influence on *Zostera marina* Seed Traits.

Amelia Newman[1,2], Dr Chris Yesson[2], Dr Cristina Banks-Leite[1], Dr Emma Ransome[1]

[1] *Department of Life Sciences, Imperial College London*
[2] *Institute of Zoology, Zoological Society of London*

Corresponding author: a.newman24@imperial.ac.uk

Abstract
In the UK, at least 44% of seagrass beds have been lost since 1936. *Zostera marina* is the UKs dominant subtidal species, though it also inhabits the intertidal zone. These beds are under threat from human activities such as trampling, anchor damage, and poor water quality. Across the UK, restoration projects are striving to restore *Zostera marina* beds through various methods, with increasing focus on seed injection. Understanding the geographical influence of the seed donor meadows is therefore critical. For this study, *Z. marina* seeds were collected from two subtidal beds in the South West (St Austell and Looe Bay, Cornwall) and one intertidal bed in the South East (Seasalter, Kent). Each bed exhibited distinct seed traits (length, width, weight, and density). Notably, seeds from the intertidal bed at Seasalter showed significantly higher density compared to those from St Austell and Looe Bay, while significant differences in seed width and weight were also observed between the sites. For all traits, variability was greater between the populations than within them, highlighting the distinct characteristics of each donor meadow. These findings will help refine donor site selection and restoration practices, potentially enhancing the success of seagrass meadow recovery in the UK. Further analysis will examine how microbial interactions influence the health of *Zostera marina* meadows, contributing to a more comprehensive understanding of restoration potential.

Poster 11

Utilizing Probiotics to Enhance Seagrass Restoration Success.

Hannah J. van Duijnhoven[1,2], Mike Lenstra[3], Tânia Aires[1], João Brazão[1], Gerard Muyzer[3], Aschwin H. Engelen[1]

[1] *Department of Marine Microbial Ecology and Biotechnology, Centro de Ciencias do Mar, Universidade do Algarve, Campus de Gambelas, 8005-139 Faro, Portugal, a78807@ualg.pt*
[2] *Marine Plant Ecology, Centro de Ciencias do Mar, Universidade do Algarve, Campus de Gambelas, 8005-139 Faro, Portugal*
[3] *Microbial Systems Ecology, Department of Freshwater and Marine Ecology, University of Amsterdam, 1012 WP Amsterdam, The Nederlands*

Corresponding author: a78807@ualg.pt

Abstract
Seagrass meadows are globally declining due to anthropogenic stressors. Therefore, urgent restoration efforts are required to recover and expand these crucial ecosystems (Cullen-Unsworth & Unsworth, 2016). The role and importance of the seagrass microbiome has gained more attention in the last decades. As soil bacteria have been leveraged to enhance terrestrial crop productivity for many years, growth-promoting bacteria are now proposed as a tool to improve seagrass health and recovery (Gupta & Dikshit, 2010; Ugarelli et al., 2017). This study investigates the microbiome's role in seagrass health, growth, and resilience. We identified and characterized novel and known bacteria isolated from different parts of Portuguese seagrass species, including *Zostera marina*, *Zostera noltii*, *Cymodocea nodosa* and *Ruppia maritima*, to expand the list of putative beneficial microbes associated with seagrasses. Bacterial isolates were identified using comparative analysis of 16S rRNA sequences. Subsequently, whole genome sequencing was performed on selected strains. We annotated the genes and identified potential growth-promoting properties within the genomes. In a laboratory experiment, five bacterial strains were tested for their impact on seagrass seed germination and early development, with *Bacillus* spp. significantly enhancing both. These bacteria may serve as probiotics to facilitate seed viability, stimulate the health and growth of transplanted seagrass shoots, and thus promote the success of seagrass restoration initiatives.

Acknowledgements
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Poster 12

Seagrass transplantation: method-specific effects on the physiology of *Zostera marina* and *Cymodocea nodosa.*

Alizé Deguette[1], Filipe Parreira[1] , Rui Santos[1] , Isabel Barrote[1,2], and João Silva[1]

[1] *Centre of Marine Sciences (CCMAR/CIMAR LA), University of Algarve, Campus of Gambelas, 8005-139 Faro, Portugal*
[2] *Faculty of Science and Technology, University of Algarve, Campus of Gambelas, 8005-139 Faro, Portugal*

Corresponding author: apdeguette@ualg.pt

Abstract
Seagrass restoration efforts have multiplied in the last years, with very diverse success rates, justifying the need for a better understanding of the physiological responses to transplant operations. This study compares the physiological and biochemical responses of *Zostera marina* and *Cymodocea nodosa* to different transplant methods in the Ria Formosa, southern Portugal. *Z. marina* was transplanted in bundles of 5 and 10 shoots, while *C. nodosa* was transplanted within the sediment in trays and as bare segments of at least 3 shoots. Oxidative stress, antioxidant activity, photosynthetic pigment and non-structural carbohydrates (NSC) content in leaves and rhizomes were investigated before transplant and after 4 weeks. Results revealed significant method-specific physiological responses to transplantation. *C. nodosa* transplanted in segments showed radical shifts in NSC storage and lower pigment content whereas tray transplantation further triggered antioxidant activity. Following transplantation, an increase in *Z. marina*'s foliar NSC content was observed, especially in bundles of 5, and antioxidant activity further increased in bundles of 10. Results suggest that transplanting *C. nodosa* in trays is likely to be the most successful strategy for this species whereas *Z. marina* transplanted in bundles of 5 may have an advantage over those transplanted in bundles of 10. This study provides insights into physiological alterations post-transplantation and emphasizes the need for adaptable restoration strategies.

Poster 13

Reintroduction of self-facilitating feedbacks could advance subtidal eelgrass (*Zostera marina*) restoration in the Dutch Wadden Sea.

Katrin Rehlmeyer[1], Oscar Franken[1,2], Tjisse van der Heide[1,2], Sander J. Holthuijsen[2], Kasper J. Meijer[1], Han Olff[1], Wouter Lengkeek[3], Karin Didderen[3] and Laura L. Govers[1,2]

[1] *Conservation Ecology Group, Groningen Institute for Evolutionary Life Sciences, University of Groningen, Groningen, Netherlands,*
[2] *Department of Coastal Systems, Royal Netherlands Institute of Sea Research (NIOZ), Den Hoorn, Netherlands*
[3] *BESE, Waardenburg Ecology, Culemborg, Netherlands*

Corresponding author: k.rehlmeyer@rug.nl

Abstract
Extensive subtidal eelgrass (Zostera marina) meadows (~150 km²) once thrived in the Dutch Wadden Sea but vanished in the 1930s. Understanding bottlenecks for eelgrass survival is essential for reintroduction. As ecosystem engineers, seagrasses create self-facilitating feedbacks that alleviate stressful conditions, making their reintroduction challenging once lost. We conducted a field experiment at two sites in the Dutch Wadden Sea to test whether 1) sediment stabilization and 2) hydrodynamic stress relief could enhance eelgrass survival. We used biodegradable root-mimicking structures (BESE-elements) and sandbag barriers to induce feedbacks. Root mimics increased short-term survival by +67%, while sandbag barriers unexpectedly decreased it by -26%, likely due to hydrodynamic turbulence at barrier edges, causing erosion (-14 cm). Site selection proved critical; short-term survival was entirely negated at one site after five weeks due to floating and epiphytic macroalgae loads. At the other site, all plants died two weeks later, resulting in no long-term survival. Overall, sediment stabilization using root mimics was promising, but manipulating hydrodynamic forces with barriers was counterproductive. For successful restoration in the Wadden Sea, careful consideration must be given to 1) introducing positive feedbacks with restoration tools, 2) selecting donor populations and timing transplantation, and 3) choosing sites based on local biotic and abiotic conditions. Optimizing these factors may reduce stress to levels that allow long-term survival.

Poster 14

ZoRRO, a successful citizen-lead project to reintroduce eelgrass into the Berre lagoon.

Damien Bonnet[1], Pascal Bazile[1], Laure Jaurès[1]

[1]8 Vies pour la planète, 15 Chemin d'Embarben, 13250 Saint-Chamas, France.

Corresponding author: damien@8vies.fr

Abstract

By 2005, no eelgrass (*Zostera marina*) had been recorded in the Berre lagoon for around 30 years, and dwarf eelgrass *Nanozostera noltii*) had nearly disappeared. Concurrently wastewater treatments were improving and a hydroelectric power plant, which had been discharging large amounts of freshwater into the lagoon since 1966, was forced to reduce its discharges (2004). Subsequently, the remaining Dwarf eelgrass in the lagoon started growing again, and by 2015 a few larger meadows existed, and patches could be seen around the perimeter. From 2017 onwards, citizens attempted eelgrass cuttings using "wrack" rhizomes (plagiothropic fragments) from a nearby 'Camargue' meadow (~30 km away). A few were successful, and subsequnetly administrative authorization was granted to our NGO ´8 Vies pour la planète' in 2021 for the deployment of two methods: rhizome transplants from "wrack" and seeding. To scale the restoration efforts a volunteering programme was created. The rhizome fragment method has been deployed since 2021, but is limited by the number and quality of the rhizomes found. Around 15 spots (surface > 0.25 m²) and at least as many starts (surface < 0.25 m²) from this method have survived, on 3 sites. The seed method was started in 2023, after construction of two small seed maturation and storage units. By the spring of 2024, the method had succeeded with a dozen seedlings recorded at one site. Around one hundred volunteers have participated across the 4 campaigns (2021-2024) of the project, which is will continue for another 6 years. Natural recovery is now being seen in the lagoon.

Poster 15

Insights on Seed Abrasion and Planting Depth to Inform A Novel Approach For Large Scale Seagrass Restoration.

Charlotte Harper[1], Roosmarijn van Zummeren[1], Jesper Elzinga[1], Nadia Hijner[2], Laura Govers[2]

[1] *Environmental Engineering Department, Van Oord, Rotterdam, The Netherlands*
[2]*Conservation Ecology Group, Groningen Institute for Evolutionary Life Sciences (GELIFES), University of Groningen, Groningen, The Netherlands*

Corresponding author: charlotte.harper@vanoord.com

Abstract
Seagrasses have faced significant global decline in the last century, prompting the development of numerous restoration attempts and techniques. However, seagrass restoration remains challenging, and success rates are generally low, particularly when conducted on small scales or in unsuitable restoration sites. To enhance the suitability of muddy, hypoxic restoration sites, a thin layer of sand can be placed (sand-capping) prior to implantation to reduce resuspension, increase light availability, and facilitate seagrass restoration. To enhance the success and scalability of seagrass restoration, a novel method that integrates seagrass seeds into sand-nourishments is under development. A key challenge of this approach is maximizing germination rates by identifying optimal planting parameters. In this study, we research the impact of the developed sand-capping method with regards to abrasion time (i.e. seed damage) and planting depth on the germination of multiple populations of *Zostera marina, Zostera noltii,* and *Ruppia maritima* under laboratory conditions. Our results show that abrasion time significantly influenced germination rates, with varying sensitivity depending on species and population type (subtidal vs intertidal). In some species, moderate abrasion actually increased germination rates compared to the control. For the planting depths tested (1, 2 and 4.5 cm) no significant effect on germination rates was observed (with the exception of one population). These findings provide valuable insights into the sensitivities of seagrass seeds with respect to the proposed technique, setting the stage for subsequent investigations, and ultimately contributing to the development of a novel method for large-scale seagrass restoration.

Poster 16

Where we are for seagrass restoration monitoring: from the birds' eye view.

Dimitris Poursanidis[1], Bede Ffinian Rowe Davies[2], Simon Oiry[2], Pierre Gernez[2], Vasillis Papathanasiou[3], Laurent Barillé[2]

[1] Foundation for Research and Technology Hellas, Institute of Applied and Computational Mathematics, 100 N. Plastira Str., Vassilika Vouton, Heraklion 70013, Greece
[2] Nantes Université, Institut des Substances et Organismes de la Mer, ISOMer, UR2160, Nantes F-44000, France
[3] Fisheries Research Institute (ELGO-DIMITRA), Nea Peramos, Kavala, Greece

Corresponding author:

Abstract
While the Regulation on Nature Restoration (Nature Restoration Law) came into effect in August 2024, efforts to restore seagrass ecosystems in Europe have been underway for years, aiming to reverse decades of accelerating loss. These efforts often involve "boots in the mud" and divers planting seeds and transferring seagrass by hand, guided by historical knowledge and logistical considerations such as ease of access and proximity to research institutions. In the absence of comprehensive and reliable seagrass distribution maps, restoration initiatives heavily depend on local ecological knowledge to inform decisions. However, there is a significant gap in understanding the baseline status of the seascapes targeted for restoration. This knowledge gap can now be addressed with cutting-edge technology, which is increasingly accessible and cost-effective. Tools such as drones equipped with RGB or multispectral sensors, satellite observations, and affordable hydroacoustic and camera systems offer scalable solutions for mapping and monitoring seagrass ecosystems. Despite these advancements, there is an urgent need for a consistent, comparable, and coordinated approach to fully harness the potential of these technologies. In this paper, we present a roadmap for adopting a holistic strategy to monitor seagrass restoration sites, establish baseline conditions before interventions, and address the limitations—both technological and legal—of current tools. Given the complexity of data generated by these advanced technologies and the lack of consensus in peer-reviewed literature on optimal data processing methods, we propose a framework guided by the FAIR principles: Findable, Accessible, Interoperable, and Reusable. Additionally, recognizing that restoration initiatives are often led by marine ecologists and environmental scientists with varying levels of expertise in data analysis, we emphasize the importance of collaboration across disciplines. By integrating technology, engineering, and ecology, restoration projects can achieve greater success. This approach will not only enhance our understanding of the strengths and limitations of drones and satellites for seagrass restoration but will also promote the development of transdisciplinary projects. In doing so, it will lay the foundation for more effective and scalable restoration efforts across Europe and beyond.

Acknowledgements
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Poster 17

Evaluating seed size effects on *Posidonia oceanica* seedling development under control and heat stress conditions: implications for seagrass restoration.

Provera I.[1*], D'anna G.[2] , Giacalone V.M. [3], Badalamenti F. [1,4,6], Marín-Guirao L.[1,5], Procaccini G.[1,6]

[1] *Department of Integrative Marine Ecology, Stazione Zoologica Anton Dohrn, 80121, Naples, Italy,*
[2] *CNR-IAS, via Giovanni da Verrazzano 17, 91014 Castellammare del Golfo, Italy*
[3] *CNR-IAS, Via del Mare 3, 91021 Torretta Granitola, Italy CNR-IAS, Lungomare Cristoforo Colombo 4521, 90149, Palermo, Italy*
[4] *CNR-IAS, Lungomare Cristoforo Colombo 4521, 90149, Palermo, Italy*
[5] *Centro Oceanográfico de Murcia (IEO-CSIC), Varadero 1, 30740 San Pedro del Pinatar, Spain*
[6] *National Biodiversity Future Centre (NBFC), Palermo, Italy*

Corresponding author: isabella.provera@szn.it

Abstract

In plants, variation in seed size reflects a trade-off between promoting seedling establishment and maximizing the ability to colonise new areas. This size-dependent strategy reflects plants adaptation to varying environmental conditions. This study focuses on investigating whether seed size of *Posidonia oceanica* may have important ecological consequences that could improve strategies for future seedling transplanting activities. Collected beach-cast seeds were categorized into two groups based on their individual weight (Small < 33 percentile and Large > 66 percentile), and the influence of seed size on seedlings performance was evaluated with reference to: (i) seed viability, (ii) seedling growth and vigor under control condition, (iii) seedlings development and resilience under heat stress. Changes in morphometry, leaf growth rate, biomass and in the photo-physiological response were examined. The results suggest that, under natural temperature conditions, larger seeds facilitate the production of larger seedlings in a shorter timeframe, thereby enhancing the potential success of restoration efforts by reducing the critical period of vulnerability during the early life stage of the species. Although no apparent advantage conferred by seed size was observed in seedlings exposed to heat stress, given the short duration of the experiment relative to the life cycle of the plant, it is possible that survival advantages emerge later in life, as happen in many long–lived organisms. The presentation provides valuable insights for seagrass transplantation and marks an initial effort to explore the impact of seed size on seed-based restoration of *P. oceanica.*

Poster 18

Sustainable seagrass reforestation using naturally detached *Posidonia oceanica* cuttings and small stakes: A key initiative in the 'A Sea Forest to Save the Planet' campaign.

Francesca Frau[1], Luigi Piazzi[1], M.Francesca Cinti[1], Nicoletta Cadoni[2], Maria Leonor Garcia Gutierrez[2], Lara Carosso[2], Ivan Guala[1], Michela Congiu[1], Alan Deidun[3], Alessio Marrone[3]

[1] *MEDSEA - Mediterranean Sea and Coast Foundation, Via Piemonte n°33, 09127 Cagliari, Italy.*
[2] *Marine Protected Area Capo Carbonara, Municipality of Villasimius, Piazza Gramsci, 1, Villasimius, Italy*
[3] *UM - Department of Geosciences of the University of Malta*

Corresponding author: francescafrau@medseafoundation.org

Abstract

Mediterranean seagrass meadows have suffered significant regression in recent decades, highlighting the need for effective restoration initiatives. The "*A Sea Forest to Save the Planet*" campaign aligns directly with European seagrass restoration goals, combining active interventions and passive protection to address critical challenges to halt the regression of *Posidonia oceanica* meadows. This campaign focuses on restoring the priority habitat 1120* *Posidonia oceanica* meadows through sustainable methods. Transplantation efforts were conducted in two Marine Protected Areas (MPAs) in Sardinia (2022 and 2024) and a Site of Community Importance (SCI) in Malta (2024). Naturally detached *P. oceanica* cuttings were transplanted onto dead matte areas using small stakes. In Sardinia, approximately 1200 m² of dead matte were restored at a density of about 12 cuttings per m², involving 14,000 cuttings, while 130 m² were restored in Malta using the same technique. Key parameters such as shoot density, number of shoots per cutting, and leaf length were assessed during monitoring surveys.The first results from Sardinia revealed an 80% survival rate for transplanted cuttings, and similar outcomes are expected in Malta. The high survival rates underscore the feasibility of this cost-effective method for large-scale projects. The removal of stakes post-rooting or their degradation ensures a substrate free of artificial materials, further enhancing the sustainability of the approach. The campaign's dual approach relies on active restoration and regulated protection within MPAs and SCIs to safeguard habitats. Future projects in Turkey, Greece, and additional Sardinian MPAs are planned for 2025, further expanding the campaign's impact across the Mediterranean.

Poster 19

Exploring techniques to enhance seagrass (*Cymodocea nodosa*) seed germination and seedling development: Ex situ approaches for restoration.

Reynés, X[1], Marín-Guirao, L[2], Mueller, R.S.[3], Hernan, G[1], Muñoz, S.[2], Ramos, A.[2], Ruiz JM[2] and Tomas, F[1].

[1] *Department of Marine Ecology – Instituto Mediterráneo de estudios avanzados (IMEDEA)*
[2] *Department of Marine Ecosystems – Centro Oceanográfico de Murcia (IEO)*
[3] *Department of Microbiology – Oregon State University (OSU)*

Corresponding author: xreynes@imedea.uib-csic.es

Abstract
Seagrass meadows are a fundamental coastal habitat that is undergoing degradation and loss worldwide, prompting an increased interest in the development of restoration projects. *Cymodocea nodosa* is widely distributed in the Mediterranean and adjacent Atlantic coasts, but, in part because of its relatively fast growth rates, studies on restoration of this species have received much less attention than other Mediterranean species (e.g., *Posidonia oceanica*). A key approach being explored for restoration is the use of seeds and seedling, prior to which a good understanding of factors influencing successful seed germination and seedling development is key. Previous studies indicate that germination is influenced by environmental conditions and that it is possible to induce the germination of *C. nodosa* under controlled conditions (Caye & Meinesz 1986, 1992). In this study, we explored different *ex situ* germination techniques to improve germination rates of *C. nodosa* and to obtain seedlings for *in situ* restoration projects. Specifically, we applied hyposalinity treatments (10, 14 18 and 37 psu) and different temperatures before (4 or 20 ºC) and after (16, 20 and 22 ºC) the hyposaline shock, during different seasons of the year (winter, autumn and spring). Our results show that *C. nodosa* seeds experience a dormancy period and the season of seeds collection plays an important role in their germination success and further development. Even so, germination can be enhanced at any time by reducing salinity. The intensity and duration of the hyposaline shock are key to the success of germination.

Poster 20

Assessing High-Latitude Seagrass Meadows for Restoration Using Remote Sensing: Decline of a *Nanozostera noltei* Intertidal Meadow in Southwest Ireland.

Sara Haro[1], África N.G. De la Morena[1], Juan Lugilde-Yáñez[2], Liam Morrison[2] and Ricardo Bermejo[1].

[1] *Department of Ecology and Geology, University of Malaga, Instituto Andaluz de Biotecnología y Desarrollo Azul (IBYDA), Bulevar Pasteur, 31, s/n, 29071 Málaga, Spain*
[2] *Department of Earth and Ocean Sciences (EOS), University of Galway, School of Natural Sciences and Ryan Institute, Ireland, H91 TK33*

Corresponding author: africa.nunez.garcia@gmail.com

Abstract
Seagrass restoration requires the identification of suitable donor and recipient locations, understanding site-specific environmental conditions, and selecting appropriate planting techniques and timing. In this study, a *Nanozostera noltei* meadow in northern Tralee Bay, Ireland, located at a high latitude (52°N) and recognized as one of the healthiest in the region, was monitored to assess its potential as a donor meadow or for testing transplant techniques. The spatiotemporal dynamics of the meadow were analysed using Sentinel-2 imagery from 2018 to 2024. The Normalized Difference Vegetation Index (NDVI), with values >0.15 indicating seagrass presence, was used to monitor cover, NDVI, and growth rates (μNDVI). Generalized Additive Models (GAM) revealed that 77% of the temporal variability in average NDVI was explained by monthly and annual factors, with peaks around August-September and minima in April. A significant decline in average NDVI and cover was observed from 2021 onward. Cover decreased by 67% (from 7.5 to 2.5 ha annually), while biomass declined by 38% (from average annual NDVI 0.4 to 0.25) over the past seven years. Maximum growth rates were recorded in June (0.007 d^{-1}), while minimum rates occurred in November (-0.01 d^{-1}). Two main conclusions were drawn: (1) transplanting in high-latitude regions should occur in months preceding June, as corroborated by *in situ* transplants; and (2) despite the recent decline observed via remote sensing, the meadow remains a viable option for experimental purposes with appropriate precautions. This study highlights the value of remote sensing tools for seagrass restoration, offering a scalable approach for monitoring efforts.

Poster 21

Potential of *Posidonia oceanica* blue carbon eco-mooring projects to avoid anchoring-related CO_2 emissions.

Fernando Ruiz Iglesias[1], Thomas Binet[2], Briac Monnier[3], Oscar Serrano[4], Eduard Serrano[4], Karina Inostroza[5], Maelle Tabaste[6], Timothée Cook[2], Miguel Ángel Mateo[4]

[1] *Institute of Environmental Science and Technology, Universitat Autonòma de Barcelona, Carrer de les Columnes s/n, Campus UAB, Edifici ICTA-ICP, 08193 Cerdanyola del Vallès, Barcelona, Spain*
[2] *BlueSeeds, Darwin Eco-système, 87 quai des Queyries, 33100 Bordeaux, France*
[3] *Department of Biology, Università di Corsica Pasquale Paoli, CNRS UMR SPE 6134 / UAR STELLA MARE 3514*
[4] *Centre d'Estudis Avançats deBlanes-Consejo Superior deInvestigaciones Científicas (CEAB-CSIC), Blanes, Spain*
[5] *BIOSFERA, Associació d'Educació Ambiental, 1 Carrer Anselm Clavé, 08902, L'Hospitalet de Llobregat, Spain*
[6] *Aix-Marseille Université, 58 boulevard Charles Livon, Marseille, France*

Corresponding author: timotheecook@blueseeds.org

Abstract

Blue carbon offers a nature-based solution to climate change, drawing interest from diverse stakeholders who call for robust, science-based methodologies that can confidently offset emissions, and meet net-zero goals. There is a focus on the endemic Mediterranean seagrass, *Posidonia oceanica*, because it is the ecosystem with one of the highest organic carbon stocks. One approach is to develop blue carbon financing mechanisms to fund sustainable eco-moorings, avoid destructive anchoring, and restore degraded meadows. Obstacles to such mechanisms are technical and systemic. In this work, the multifaceted considerations for selecting adequate sites for *P. oceanica* blue carbon projects are demonstrated with the case study of the Cap de Creus Natural Park in Catalonia, Spain. In the bay of Guillola, both inorganic and organic carbon stocks in the first 30-cm of sediment were found to vary significantly according to depth and benthic habitat. Accordingly, the bay was stratified into homogeneous areas based on depth and habitats to estimate total organic carbon stock. From this estimate, a preliminary result for the net organic carbon loss resulting from anchoring was determined using a novel modelling approach. Results indicate a blue carbon financing eco-mooring project in the bay of Guillola could be feasible in terms of emissions reduction potential and conservation outcomes but is unlikely to be financially viable in the current blue carbon certification landscape. Lastly, results and existing literature are used to critically analyse the potential for *P. oceanica* blue carbon projects in terms of blue carbon financing and climate change mitigation.

Poster 22

Evaluating Techniques for Active Restoration of *Cymodocea nodosa* in the Alboran Sea, Southern Spain.

África N.G. De la Morena[1], Sara Haro[1], Ignacio Moreu[1], Antonio Avilés[1], Juan Lugilde-Yáñez[2], Nathalie Korbee[1], Liam Morrison[2] and Ricardo Bermejo[1].

[1]Department of Ecology and Geology, University of Malaga, Instituto Andaluz de Biotecnología y Desarrollo Azul (IBYDA), Bulevar Pasteur, 31, s/n, 29071 Málaga, Spain
[2]Department of Earth and Ocean Sciences (EOS), University of Galway, School of Natural Sciences and Ryan Institute, Ireland, H91 TK33

Corresponding author: africa.nunez.garcia@gmail.com

Abstract
Seagrass meadows in southern Spain have declined severely since the early 2000s, leading to near extinction in most Alboran Sea coastal areas. These meadows are vital in ecosystem functioning and providing highly valuable services. Although environmental management strategies have effectively reduced anthropogenic pressures that lead to seagrass loss, natural recovery has not been observed. Therefore, developing effective and scalable restoration techniques is necessary to recover them. This study assessed three transplantation techniques – plug cores (donor site only), ballast, and frame – for adult *Cymodocea nodosa* plants in subtidal areas. Experiments were developed at Aguadulce (donor meadow, 6m depth) and Maro Cerro-Gordo (recipient site, 6m and 12m depth). The recipient site, located 114km away on an open coast, hosted one of the largest seagrass meadows in the region fifteen years ago. Time and cost analyses revealed that the frame method was the quickest and cheapest (36±4 minutes per square meter), while the core was the most time-consuming (57±6 minutes per square meter). Survival assessment showed the ballast rhizome technique to be the most effective, while the core method was the least effective. Over six months, all techniques resulted in high shoot survival, but the core technique did not increase the initial number of shoots or expand the transplanted area. At the recipient site's 6m depth, significant shoot loss was caused by boat anchoring. The core method achieved 73% survival without growth, whereas ballast and frame techniques increased shoot numbers by 128% on average and expanded the restored area by 20%.

Poster 23

Comparison of anchoring techniques for active restoration from naturally detached *Posidonia oceanica* fragments.

Laura Royo[1], Gema Hernan[2], Tatí Benjumea[1], José Escaño[1], Fiona Tomas[2]

[1] *Cleanwave Foundation. MedGardens Initiative, Camí des Raiguer, 114, 07320, Santa María del Camí, Balearic Islands, Spain.*
[2] *IMEDEA (CSIC-UIB), C/ Miquel Marques 21, Esporles, Spain*

Corresponding author: laura@medgardens.org

Abstract
Considering widespread degradation of seagrass ecosystems and within the context of the UN Decades on Ecosystem Restoration and Ocean Sciences for Ocean Development, EU Nature Restoration Law and the EU Mission Restore our Oceans and Waters there is an increasing interest in seagrass restoration, and many initiatives have been developed worldwide. Nevertheless, appropriate methods for many species have not been tested, obtained or contrasted, but such comparisons are needed to provide the most useful and efficient active restoration techniques. In the Mediterranean Sea, active restoration has focused on *Posidonia oceanica*, being the transplant of plagiothropic fragments, a widely-accepted method. Surprisingly though, while several techniques have been proposed, there is a lack of studies that compare efficiencies and costs of those techniques and that consider context-dependency. Here we provide an in situ comparison of three different anchoring techniques, two already accepted and used by the scientific and the NGO communities (bee-waxed-covered iron staples and bamboo sticks) and a third one developed by our team (garden stakes) across two sites in Mallorca, Balearic Islands. This work highlights the importance of providing useful comparable assessments that consider multiple aspects of seagrass restoration in order to optimize success.

Poster 24

Development and establishment success of transplanted pseudoviviparous plantlets and seedlings of *Posidonia oceanica*.

Andrés Arona[1], Xesca Reynés[1], Emmanuela Orero[1], Gema Hernán[1], Julia Máñez-Crespo[1], Balma Albalat[1], Lucia Loubet[1] and Fiona Tomas[1]

[1] *Mediterranean Institute for Advanced Studies, C/ Miquel Marques 21, Esporles, Spain*

Corresponding author: andresarona100@gmail.com

Abstract

In 2022, the Western Mediterranean experienced one of the most intense marine heatwaves recorded in last decades. Following this event, *Posidonia oceanica* meadows around Mallorca (Balearic Islands) exhibited mass flowering as well as the rare reproductive strategy of pseudovivipary. Unlike sexual reproduction, in pseudovivipary, the inflorescence head is replaced by clonal propagules of the maternal plant, instead of producing fruits. To understand differences in the success of offspring resulting from pseudovivipary (plantlets) vs. sexual reproduction (seedlings), and their potential use in restoration efforts, germinated seedlings and pseudoviviparous plantlets were collected in situ and transplanted onto dead matte (plantlets were also planted in meadow habitat). Establishment and leaf development were monitored over 18 months and hydrodynamics data were obtained to assess the potential influence of environmental factors on development and establishment. By the end of the experiment, establishment success on dead matte was similar for seedlings and plantlets (~30%), whereas the seagrass meadow was unsuitable for plantlets, which disappeared within three months of planting. Plantlets started from a more advanced developmental state, with a total leaf area eight times greater than seedlings, with seedlings exhibiting higher leaf growth rates. Plantlets appeared to be more susceptible to hydrodynamic conditions than seedlings, as main losses were observed after storms. This is the first work to ever provide insights into the development of pseudoviviparous plantlets in P. oceanica and to identify differences between seedlings and plantlets as potential mechanisms for natural recovery and restoration.

Poster 25

Effects of European green crabs (*Carcinus maenas*) on transplanted eelgrass (*Zostera marina*): potential protective measures.

Tim Petersen[1,*], Sebastian Bagger Gransten[1,*], Freja Elbrønd[1,*], Cecilie Anker Johnstad-Møller[1,*], Caroline Vigsbo Christensen[1], Kasper Elgetti Brodersen[1,]

[1] Environmental Dynamics Section, Department of Science and Environment, Roskilde University, Universitetsvej 1, 4000 Roskilde, Denmark [*]These authors share first authorship

Corresponding author: carolinev@ruc.dk

Abstract

The global decline of seagrass raises concerns over the loss of important coastal ecosystem services. Consequently, restoration projects have gained traction among scientists and local coastal communities. However, key challenges must be addressed for restoration to be successful. One of the known threats against transplanted eelgrass (*Zostera marina*) is the European green crab (*Carcinus maenas*). In this study, we investigated four potential protective measures for eelgrass transplants against the European green crab: cages, BESE elements, stone anchors, and mussel banks. The efficiency of each protective measure was observed over 11 days in indoor aquatic mesocosms, in which meristem cuts and shoot uprooting were measured variables. The most efficient protective measure was the cage treatment, with an eelgrass survival of 90% after 11 days, compared to the unprotected control treatment which showed a survival of only 37%. The second and third most effective protective measures were mussel banks and BESE elements with 60% and 57% survival after 11 days, respectively. Additionally, an investigation into the feeding behavior of the green crab revealed that seeds were the most preferred part of the eelgrass plant, with 48% being consumed after 6 days. Furthermore, a cost-benefit analysis of the protective measures was conducted to determine which technique is most suitable for large-scale transplantations, depending on cost, labor, and time. Our results highlight the potential for protective measures to mitigate disturbances from biological entities in eelgrass transplantation sites, thereby enhancing the success rate of eelgrass transplantation attempts.

Poster 26

Restoring Seagrass Meadows For Climate Resilience In Atlantic Coasts: The CLIMAREST Project.

Juan Lugilde-Yáñez[1], África NG De la Morena[2], Sara Haro[2], Ricardo Bermejo[2], Liam Morrison[1]

[1] University of Galway. Earth and Ocean Sciences (EOS), School of Natural Sciences and Ryan Institute, Ireland, H91 TK33.
[2] Universidad de Málaga. Instituto Andaluz de Biotecnología y Desarrollo Azul (IBYDA), Departamento de Ecología y Geología, Campus Universitario de Teatinos s/n, 29071 Málaga, Spain.

Corresponding author: juan.yanez@universityofgalway.ie

Abstract
The CLIMAREST project focuses on the restoration and monitoring of Atlantic coastal ecosystems, including seagrass meadows in Ireland and southern Spain. In Ireland, the project targets the species *Zostera marina* and *Nanozostera noltei*, selecting four estuaries each one including a donor and a recipient site based on their historical presence and ecological suitability. Our research includes small-scale experimental trials to identify optimal restoration areas, refine effective techniques, and assess the impact of restoration efforts on ecosystem services. After one year, transplant survival rates in demonstration sites in Ireland have exceeded 100% survival rate using the rhizome method (with and without ballast) for *Z. marina* at shallow subtidal and the sediment plug-core transplantation method for *N. noltei*, at the intertidal. Early results from six-month trials at both locations show exponential growth in shoot numbers, highlighting the potential for scalable restoration success. Restoration efforts at other demonstration sites using the same techniques were unsuccessful, highlighting the significant influence of site-specific factors on seagrass restoration outcomes. The project also investigates how seasonality affects restoration success, with trials conducted in all four seasons, showing that spring is the most favourable for *N. noltei* and winter for *Z. marina*. Additionally, the project is assessing organic matter content and carbon sequestration in transplanted meadows. Preliminary results after one year show a more than 20 and 50% increase in organic matter content in *Z. marina* and *N. noltei* respectively in transplanted areas. These findings will provide valuable insights for future conservation and restoration efforts.

Poster 27

Microbiome matters: How transplantation methods and donor origins shape the successful restoration of the seagrass *Posidonia oceanica.*

Arnaud Boulenger[1,2], Tânia Aires[3], Aschwin H. Engelen[3], Gerard Muyzer[4], Michel Marengo[2], Sylvie Gobert[1,2]

[1] *Laboratory of Oceanology, MARE Centre, UR FOCUS, University of Liege, 11 allée du six août, 4000, Liege, Belgium*
[2] *STAtion de REcherche Sous-marines et Océanographiques (STARESO), 20260 Calvi, France*
[3] *Centro de Ciências do Mar (CCMAR), Centro de Investigação Marinha e Ambiental (CIMAR), Universidade do Algarve, Faro, Portugal*
[4] *Microbial Systems Ecology, Department of Freshwater and Marine Ecology, Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam, Amsterdam, Netherlands*

Corresponding author: arnaud.boulenger@doct.uliege.be

Abstract

Posidonia oceanica forms extensive seagrass meadows in the Mediterranean Sea, providing key ecosystem services. However, these meadows decline due to anthropogenic pressures like anchoring and coastal development. Transplantation-based restoration has been explored for decades, yet the role of the plant-associated microbiome in restoration success remains largely unknown. 16S rRNA gene amplicon sequencing was used to investigate how different transplantation methods and donor origins influence the bacterial communities of P. oceanica cuttings two years post-transplantation. We tested three transplantation methods — iron staples, coconut fiber mats, and BESE elements — and compared them with control meadows and donor populations from two different origins : naturally uprooted storm-fragments and intermatte cuttings manually harvested from established meadows. Our results show that transplantation methods strongly shape bacterial communities in seagrass roots. Iron staples promoted bacterial assemblages like those in control meadows, likely due to direct sediment interaction contact facilitating efficient microbial recruitment. In contrast, the physical separation from the sediment imposed by coconut fiber mats and BESE elements delayed microbial stabilization. Donor populations also influenced the bacterial dynamics; intermatte cuttings showed higher abundances of Candidatus Thiodiazotropha - a genus associated with sulfur oxidation and nitrogen fixation. Despite initial differences, transplants progressively recruited microbiomes resembling those of the control meadows, demonstrating the potential for long-term microbial stabilization. These findings underscore the need to integrate microbiome considerations into *Posidonia oceanica* restoration practices to enhance restoration success and improve ecosystem function recovery.

Poster 28

Nanozostera noltii transplants - restoration or relocation?

Emma Fox[1], Emily Yates[2], Richard K.F. Unsworth[3]

[1] *Project Seagrass, Unit 1 Garth Dr, Brackla Industrial Estate, Bridgend CF31 2AQ*

Corresponding author: emma@projectseagrass.org

Abstract

Higher success rates are needed to scale up seagrass restoration to ensure the level of ocean recovery required. An increasingly used method across the Northwest Atlantic has been the transplantation of *Nanozostera noltii* cores, resulting in varied success. This method relies upon the use of natural beds as donor material. Therefore, it is crucial to understand the impact of core removal on the natural beds in deciding whether this is a suitable restoration method when scaling up. To increase knowledge and develop best practices, recovery of the donor meadow was looked at across sites in Essex, South Wales and Scotland. This poster will present data from these sites, examining the length of time for the natural bed to recover and the variation in recovery rates. Initial results demonstrate beds with sandy sediment are less susceptible to lasting damage, with significant regrowth of the transplanted cores within 3 months. However, meadows with more muddy sediment have seen significant variation in recovery, with one site in Scotland demonstrating little to no recovery from the same transplantation method. This research has implications for beds selected as donor material and, subsequently, has led to the development of trials using *N. noltii* from the Project Seagrass Nursery.

Poster 29

Blue carbon and nitrogen sequestration in restored seagrass meadows increases over time but has not reached natural levels after 10 years.

Ángela Herrero-Fernández[1,2], Carmen B. de los Santos[1], Márcio Martins[1], Tânia Aires[1], Ester Serrão[1,3], Fátima Abrantes[4], Rui Santos[1,5]

[1] Centre of Marine Sciences (CCMAR), University of Algarve, Faro, Portugal
[2] OCEAN ALIVE Cooperativa para a educação criativa marinha CRL, Setúbal, Portugal
[3] Research Centre on Biodiversity and Genetic Resources (CIBIO-INBIO), Portugal
[4] Portuguese Institute of Sea and Atmosphere (IPMA) Lisbon, Portugal
[5] BlueZ C Institute, , Faro, Portugal

Corresponding author: angela.herrero.fernandez@gmail.com

Abstract

Seagrass ecosystems are well-acknowledged as a nature-based solution to solve water quality challenges like high nutrient loads and to mitigate climate change since, in the long-term, they sequester and store high amounts of nitrogen and carbon in their sediments. However, this carbon and nitrogen sequestration capacity has been lost in many coastal areas following the deterioration or loss of seagrass meadows due to human impacts. Seagrass restoration emerges as a strategy to restore these ecosystem services, yet information about the effectiveness of these projects on C and N sequestration service recovery is still needed. Here, we investigated the sedimentary carbon and nitrogen storage and sequestration capacity of two *Zostera marina* meadows in the Arrábida Natural Park (Portugal) restored 3 and 10 years ago, compared to nearby natural meadows and the meadow that acted as the donor for the restoration. The comparison between meadows revealed that the sedimentary OC and TN stocks slightly increased through time in the restored meadows, although they did not reach the values of the nearby meadow after 3 and 10 years after transplanting. The source of the sedimentary organic matter was investigated using eDNA metabarcoding revealing the main macrophytes contributing to the restored organic matter in the sediment. Our results demonstrated that the service of carbon and nitrogen storage is recovered, yet further monitoring of the restored meadows is necessary to understand the time required to equal the service provided by the nearby meadows.

Poster 30

Innovative Approaches to Zostera Seagrass Meadow Restoration in the Arcachon Basin: Biomimetic Solutions for Hydrodynamic Control.

Mathis Cognat[1], Joffrey Capet[1], Rodrigue Rey[1], Lucas Tertereau[1], Thomas Fauvel[2], Julien Dalle[1]

[1] *Seaboost, 889 Rue de la Vieille Poste, 34 000 Montpellier*
[2] *Parc Naturel Marin du Bassin d'Arcachon, 4 Rue Copernic, 33 470 Le Teich*

Corresponding author: mathis.cognat@seaboost.fr

Abstract
Seagrass meadows, especially those formed by Zostera species, are critical for coastal ecosystems, providing habitat, enhancing water quality, and stabilizing sediments. However, these meadows have dramatically declined in the Arcachon Basin since 1989, primaly due to rising temperature. Then a positive feedback loop leads to a global decline as identified by Ifremer studies, which hinder their natural recovery. In response, our project aims to restore these valuable ecosystems by creating hydrodynamic conditions favorable to Zostera seagrass regrowth. We developed a flexible, biomimetic structure designed to mimic the physical properties of seagrass leaves. This solution reduces current velocities and bottom shear stress, similar to natural seagrass meadows. Initial design and calibration were performed on a small scale, testing various configurations of "leaves" on the field with in-situ monitoring, to determine the optimal size, density and position in the water column for effective hydrodynamic control. Numerical modeling further refined the design, predicting system performance across various environmental conditions.Pilot installations at larger scales in the Arcachon Basin have shown promising results. Early field data indicate a significant reduction in current speed and bottom shear stress around the structures. Additionally, the altered hydrodynamic environment has already begun showing signs of improved sediment stability and enhanced suitability for Zostera transplantation. These findings suggest that our biomimetic approach could serve as a scalable and effective tool for the ecological restoration of seagrass meadows, offering a new pathway to enhance coastal resilience and biodiversity.

Poster 31

Priming as an Innovative Strategy to Enhance Stress Resilience in Seagrass Restoration.

Jessica Pazzaglia[1,2], Lázaro Marín-Guirao[1,3], Gabriele Procaccini[1,2]

[1] *Department of Integrative Marine Ecology, Stazione Zoologica Anton Dohrn, Naples, Italy;*
[2] *National Biodiversity Future Center, Palermo, Italy;*
[3] *Centro Oceanográfico de Murcia, Instituto Español de Oceanografía (IEO, CSIC), Murcia, Spain*

Corresponding author: jessica.pazzaglia@szn.it

Abstract
Seagrasses play a pivotal role in coastal ecosystems, yet their restoration is often hindered by their limited resilience to environmental stresses. Priming emerges as a promising strategy to enhance stress tolerance, offering potential applications in seagrass restoration. Thermo-priming was already demonstrated to enhance thermal tolerance in *Posidonia oceanica* seedlings, leading to improved growth and the activation of molecular stress-memory signatures that likely regulate stress response machinery for future thermal challenges. We extended this approach to *Cymodocea nodosa*, a fast-growing species adapted to dynamic environments such as lagoons. Given that seagrasses predominantly reproduce through clonal propagation, we exposed *Cymodocea* rhizomes to thermal priming to investigate the potential transmission of stress tolerance through vegetative growth. By comparing responses in older and younger shoots from primed and non-primed plants, we identified molecular signatures, including DNA methylation patterns, indicating that stress-response mechanisms could be passed to new shoots. These findings highlight the potential of priming not only to enhance stress resilience in individual plants but also to improve the success of seagrass restoration efforts by increasing the robustness of transplants in challenging environments. However, further exploration of various priming strategies is needed to develop clear, effective protocols that can be incorporated into restoration plans.

Acknowledgements
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Poster 32

SEACOVERY: Biotechnological tools for assisting seagrass natural recovery in the Mediterranean Sea.

Fabio Blanco-Murillo[1], Isabella Provera[1], Irene Olive[1], Emanuela Dattolo[1], Jessica Pazzaglia[1], Maurizio Simeone[2], Lázaro Marín-Guirao[3] and Gabriele Procaccini[1]

[1] Department of Integrative Marine Ecology – Stazione Zoologica Anton Dohrn, Naples, Italy
[2] Centro dei Studi Interdisciplinari Gaiola – Naples, Italy
[3] Seagrass Ecology Group – Spanish Institute of Oceanography, San Pedro del Pinatar, Spain

Corresponding author: isabella.provera@szn.it

Abstract
Current degradation of seagrass meadows, worsen by global change processes, have triggered scientific and public awareness for environmental conservation. Even though seagrass restoration might be locally helpful with some species, these actions may not be enough to reverse the strong decline observed, as for the slow-growing species *Posidonia oceanica*. Thus, there is an increasing scientific interest in active strategies that increase seagrass adaptation to present and future environmental conditions. These strategies are commonly known as *assisted evolution*. The SEACOVERY project, funded by Marie Sklodowska-Curie Actions, will investigate different assisted evolution approaches on disturbed *P. oceanica* meadows like: (1) genetic migration, with the potential to improve the existing genetic basis of natural populations; (2) priming strategies which can increase stress tolerance and physiological performance against stressors such as anomalous temperature increments; and (3) assisted ecological succession through multi-species transplants with *Cymodocea nodosa* to improve seedling viability. The project will assess the effectiveness of these techniques to increase the success of restoration actions. The project will start on January 2026, and it will be executed through the international collaboration with Stazione Zoologica Anton Dohrn (G. Procaccini) and the Spanish Institute of Oceanography (L. Marín-Guirao), aiming to expand its outreach and applications through the Italian and Spanish coasts. SEACOVERY will contribute to the urgently needed knowledge on assisted natural recovery of *P. oceanica* meadows, with the potential of being a cost-effective climate change mitigation strategy.

Poster 33

A new approach to financing & delivering large scale seagrass restoration in Scotland.

Katherine Knight[1]

[1]*Scottish Marine Environmental Enhancement Fund (SMEEF),*

Corresponding author: Grants@smeef.scot

Abstract

The Scottish Marine Environmental Enhancement Fund (SMEEF) is an innovative nature finance vehicle that facilitates investment in marine and coastal enhancement in Scotland. Through SMEEF, users of Scottish waters voluntarily re-invest in the health and biodiversity of our seas. The fund, which is managed by a Steering Group comprised of representatives from the Scottish Government's Marine Directorate, Crown Estate Scotland and NatureScot, provides exceptional insight and assures robust governance and transparency. SMEEF has so far secured and distributed more than £3.8m to around 54[1] restoration and enhancement projects in Scottish coasts and seas. SMEEF is applying this finance model to embark on Scotland's most ambitious seagrass planting project. Planting 14ha of Z.marina around Scotland's coast by 2028, supported by SSEN Distribution. The funding model is not the only part of this project which is novel. The project will facilitate a joined-up approach to restoration not previously seen in Scotland. Participating projects, selected from a competitive grants process, will share learning and resources to collectively achieve a restoration goal which is more than the sum of its parts. The poster will detail the governance structure and diligence processes of SMEEF which provides confidence for both investors and funding recipients. It will give an overview of the sources of finance to date and detail how this approach to funding large scale seagrass restoration will be bring additional benefits to communities as well expand our knowledge of seagrass restoration practices.

Poster 34

The Sea Ranger Service: Enabling the next generation to make nature and people futureproof.

Sophie Hankinson[1], Elise Chalcraft[1] and Nathalie de Bruin[1].

[1] *Sea Ranger Service, Kattenburgerstraat 5, 1018 JA Amsterdam, the Netherlands*

Corresponding author: sophie@searangers.org

Abstract

The Sea Ranger Service is a social enterprise on a mission to enable the next generation to make nature and people futureproof. Working with government agencies, industry partners and local authorities, we offer unique training and employment opportunities to young people as a stepping stone into a maritime career, whilst managing and restoring oceans.In 2022, order to implement large-scale seagrass restoration in support of the UN Decade On Ecosystem Restoration (2021-2030) the Sea Ranger Service cofounded The Seagrass Consortium.Focus is on accelerating and developing both the scientific and logistical methods and standards to enable seagrass restoration at scale. An additional aim is to create unique employment for young people in deprived coastal communities to carry out restoration work, achieving a simultaneous social impact. Since 2023 restoration has been underway in the Oosterschelde, Netherlands, and in the Bassin d'Arcachon and Étang de Berre in France. Partners in the consortium include Project Seagrass, University of Groningen, L'Office Français de la Biodiversité (OFB), Institute of Environmental Hydraulics of Cantabria (IHCantabria), The Mediterranean Institute for Advanced Studies (IMEDEA-CSIC-UIB), GIPREB and the Sea Ranger Service.

Poster 35

Mariculture for Ria de Aveiro subtidal seagrass rewilding – The LIFE SeagrassRIAwild Project.

J.P. Coelho [1]; A. I. Sousa [1]; A. I. Lillebø [1]; H. Teixeira[1]; M. Dolbeth [2]; F. Martinho [3]; D. Fonseca [4]; Thorsten Reusch [5]; Emílio Fernandez [6]; R. Gaspar [7];

[1] *CESAM - Centre for Environmental and Marine Studies, Department of Biology, University of Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro, Portugal;*
[2] *CIIMAR - Interdisciplinary Centre of Marine and Environmental Research, Novo Edifício Do Terminal de Cruzeiros Do Porto de Leixões, Avenida General Norton de Matos S/N, 4450-208, Matosinhos, Portugal;*
[3] *Centre for Functional Ecology, Department of Life Sciences, University of Coimbra, Calçada Martim de Freitas, 3000-456 Coimbra, Portugal;*
[4] *HAEDES PORTUGAL LDA, Casais Do Arrocho Sn, Azoia De Cima 2025 452, PortugalCICECO, Department ofChemistry, University of Aveiro, Campus de Santiago, 3810-193 Aveiro, Portugal.*
[5] *GEOMAR Helmholtz Centre for Ocean Research Kiel, Marine Evolutionary Ecology, Kiel, Germany*
[6] *Centro de Investigación Marina. Universidade de Vigo, Vigo, 36310, Spain*
[7] *OCEAN ALIVE, Cooperativa Para A Educacao Criativa Marinha, CRL, Bombel Casal 32, Vendas Novas 7080-303, Portugal*

Corresponding author: jpcoelho@ua.pt

Abstract

Subtidal seagrass beds are critically endangered at the European Atlantic Coast, and in urgent need of restoration. *Zostera marina* is presently the most endangered seagrass species in Portugal, facing extinction if protection measures are not taken to assure the last remaining populations. In the Ria de Aveiro, its presence was not recorded for 10 years, but recently resurged in small patches, making this the momentum for active restoration measures implementation. LIFE SeagrassRIAwild therefore aims to reverse the conservation status of *Z. marina* in Ria de Aveiro through the co-development of cost-efficient and policy relevant NbS (Nature-based Solutions). The project proposes a large-scale restoration program with negligible effects on existing natural meadows, through the development of seagrass mariculture to support the plant and seed needs for rewilding. It follows a transdisciplinary approach involving academia, authorities, management agencies, local administration, end-user associations and citizens in the co-design, prioritization and implementation of restoration actions, at a large scale and using targeted and adaptable Citizen Science initiatives and synergies with other national and EU initiatives. LIFE SeagrassRIAwild will further explore innovative NbS to potentiate synergistic effects of seagrass conservation efforts and system management needs which, if proven effective, have the potential to become an innovative management service/product for port authorities, private marinas and management agencies. These NbS will potentiate the sustainability of the project, supported by tailor-made capacity building actions and the infrastructure legacy, which will perdure in time and be made available for national restoration programmes, with the supervision of the national competent authorities.

Acknowledgements

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Poster 36

Lessons learned in a pilot study to replant *Posidonia oceanica* shoots uprooted by storms.

Andreu Dalmau[1]; Dani San Román[1]; Carlos de Juan[1]; Jordi Sanchez[1]

[1] *SUBMON, Carrer d'Ortigosa, 14, Ciutat Vella, 08003 Barcelona, Spain*

Corresponding author: andreudalmau@submon.org

Abstract

The pilot study was conducted in 2023 in the Natura 2000 site of L'Albera (NW Mediterranean). It consisted of replanting Neptune seagrass shoots to restore a very shallow meadow previously affected by illegal mooring systems historically installed in the area. The replanting followed a non-destructive methodology, using shoots naturally uprooted by storms and biodegradable material to fix them into dead *matte*. The collaboration of citizens and the fishing sector was crucial, as all shoots replanted were recovered by the local community and temporarily preserved in tanks installed at the fishing harbour. Information talks were organized throughout the project to engage the local community and encourage their participation. A total of 236 shoots were replanted, with a survival rate of approximately 75% after two years of monitoring. The study showed the short-term effectiveness of a small-scale active Neptune seagrass meadow restoration using recovered shoots. Beyond that, it highlighted the importance of involving local communities in restoration initiatives and it showed the potential of these initiatives to raise awareness of the importance of seagrass meadows. Building on this experience, a three-year study will be carried out in the area within the BLUE CONNECT project, allowing us to test different replanting methodologies and to continue monitoring the replanted shoots. This new initiative will follow the same approach as the previous one: only using recovered shoots, involving the local community and using its context to raise awareness.

Acknowledgements

To the local community of L'Albera to make this active restoration initiative possible.

Poster 37

Call for Seagrass Restoration Data: Creation of an International Meta-Analysis.

Bridget Patterson[1,2], Richard Unsworth[1,2]

[1] *Project Seagrass, Unit 1, Garth Drive, Brackla Industrial Estate, Bridgend, CF31 2AQ, United Kingdom*
[2] *Seagrass Ecosystem Research Group, Swansea University, Swansea, UK*

Corresponding author: bridget@projectseagrass.org

Abstract
Active planting of seagrass is an important element of seagrass restoration projects. Planting efforts, however, range in their effectiveness. Reasons for individual successes and failures in seagrass restoration are often highly localised, driven by site specific forces. A broader approach is required to draw conclusions around best practices. Global meta-analyses have focused on biological reasons for success, rather than environmental ones (van Katwijk et al. 2016). In the past 10 years, seagrass restoration efforts have grown in scale and technicality, with increased trailing of novel methods (Gräfnings et al. 2022; Xu et al. 2023). Additionally, the availability of consistent, satellite-derived environmental data opens new opportunities to test planting outcomes. Project Seagrass are opening a call for additional data on restoration efforts, both successes and failures, for an international meta-analysis of seagrass restoration. Gathering data broadly from different regions and methodologies, including from our own UK-based projects, will help us to draw high-resolution conclusions, and identify common trends in why projects fail and succeed. It will also allow us to see how seagrass restoration has grown in the decade since the last major meta-analysis. Our initial data demonstrates that methodology and timing of planting play a large role in determining restoration success over environmental variables. To add your averaged data or to learn more about the meta-analysis, please email bridget@projectseagrass.org or visit our poster.

Acknowledgements:
Thank you to Climate Impact Partners and Deloitte for their support.

Poster 38

Where, when, and how: progress and setbacks in implementing large-scale eelgrass restoration in Norway.

Karine Gagnon[1], Kristina Øie Kvile[2]

[1] *Institute of Marine Research Norway, Flødevigen Research Station, His, Norway*
[2] *Norwegian Institute for Water Research, Section for Marine Biology, Grimstad, Norway*

Corresponding author: karine.gagnon@hi.no

Abstract
Eelgrass (*Zostera marina*) is widely distributed in shallow areas across the entire Norwegian coast, covering temperate to subpolar latitudes, and large gradients in salinity, temperature, and exposure. However, research on eelgrass has been relatively limited in Norway until recently. Here, we outline the current status of eelgrass research in Norway, and the steps taken towards conservation and restoration of this critical habitat. Using a century-long dataset of eelgrass cover along with historical aerial photography, we found that eelgrass populations in much of the coastal Skagerrak have expanded. In contrast, the extent and condition of eelgrass meadows in the Oslofjord have declined in recent decades, likely due to a combination of eutrophication, coastal darkening, overfishing, urban development and temperature increase. Three test sites in the Oslofjord where eelgrass has likely disappeared were selected for restoration pilot trials in 2022, with some localised success in the following years. However, expanded large-scale restoration has been on hold due to the discovery of potential pathogens (*Phytophthora and Halophytophthora* oomycetes) in donor meadows. The temporal and spatial variation in oomycete distribution is currently being mapped to understand their natural prevalence. These projects highlight the importance of considering not only current status, but also future threats, in restoration planning.

Poster 39

Pilot trials of *Posidonia oceanica* transplantation techniques in Greek Natura 2000 sites: Lessons from the Aegean Sea.

Vasilis Gerakaris[1], Yiannis Issaris[1], Polytimi-Ioli Lardi[1], and Maria Salomidi[1]

[1] *Institute of Oceanography, Hellenic Centre for Marine Research, PO Box 712, GR-19013, Anavyssos, Attiki, Greece.*

Corresponding author: **vgerakaris@hcmr.gr**

Abstract

Seagrass restoration is essential for enhancing coastal ecosystem resilience in the Mediterranean, where endemic *Posidonia oceanica* meadows face significant anthropogenic threats. This study presents findings from two distinct restoration approaches implemented in Greek Natura 2000 sites impacted by boat anchoring. Case 1 (Gyaros Island) tested *P. oceanica* cuttings attached to biodegradable mats, while Case 2 (Sounion bay) involved laboratory-cultivated seedlings transplanted with and without herbivore protection. Both trials were conducted on dead matte substrate using standardized monitoring protocols. In Case 1, cuttings showed 90.7% survival after two years, decreasing to 82.7% after three years with continued shoot development. In Case 2, seedlings displayed 100% survival after two months, followed by winter/spring decline resulting in 46% overall survival after 12 months. The cutting method demonstrated high long-term viability with sustained shoot growth, while the seed-based approach showed strong initial establishment followed by seasonal vulnerability, despite a slight benefit from herbivore protection. These trials provide valuable insights for developing effective restoration protocols for this keystone Mediterranean species, expanding the rehabilitation toolkit for degraded seagrass habitats.

Poster 40

VISECAN – A Pioneering Experimental Nursery to Conserve and Restore *Cymodocea nodosa* Seagrass Meadows in the Canary Islands.

Marta González[1], **Silvia Oliva**[1], Diego Garrido[1], Daniel Hernández[1] Juan Manuel Ruiz[2], Lázaro Marín-Guirao[2] & Eduardo Almansa[1]

[1] *Oceanographic Center of the Canary Islands, Spanish Institute of Oceanography, Spanish National Research Council, COC-IEO-CSIC, Canary Islands, Spain.*
[2] *Oceanographic Center of Murcia, Spanish Institute of Oceanography, Spanish National Research Council, COMU-IEO-CSIC, Region of Murcia, Spain.*

Corresponding authors: marta.gonzalez@ieo.csic.es & silvia.oliva@ieo.csic.es

Abstract

Cymodocea nodosa seagrass meadows are essential for the ecological and socio-economic equilibrium of the Canary Islands. These ecosystems support a plethora of key ecological functions, including coastal protection, biodiversity enhancement, or acting as carbon sinks. However, anthropogenic pressures threaten their survival and the ecosystem services they provide, potentially transforming them into emitters of greenhouse gases or releasers of other pollutants from the underlying sediments. In this context, in order to decode pertinent knowledge gaps on the ecology of *C. nodosa* to support its conservation and to generate insights applicable in restoration actions, we are working towards developing the VISECAN project, which aims to establish an experimental *C. nodosa* nursery in Tenerife, one of the major islands of the archipelago. This infrastructure will enable (i) preserving the genetic diversity of *C. nodosa*, (ii) developing pioneering culturing, seeding and transplanting methods, and (iii) laying the groundwork for future restoration efforts, being the first of its kind for this species. Aligned with the European Nature Restoration Law and regional conservation strategies, VISECAN will galvanize global marine ecosystem restoration endeavours under the UN Decade on Ecosystem Restoration (2021-2030) for this species. Amongst the expected outcomes stand out envisioning a panoply of adaptation strategies to different forcing scenarios through environmental tolerance trials and yielding innovative marine restoration techniques. Further, beyond the patent positive ecological impacts, the project will foster economic opportunities and job diversification within the areas of marine biotechnology, environmental education, and citizen science, ultimately benefitting local communities.

Poster 41

Restoring *Nanozostera noltii* in Ria de Aveiro (Portugal): A Citizen Science Approach to foster Blue Carbon Storage and Coastal Resilience.

Mariana Pinto[1], J. Pedro Coelho[1], Nerea Piñeiro-Juncal[1,2], João Oliveira-Silva[1], Vítor Oliveira[1], Ana I. Lillebø[1], Ana I. Sousa[1*]

[1] ECOMARE, CESAM - Centre for Environmental and Marine Studies, Department of Biology, University of Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro, Portugal
[2] Centro de Investigacions Mariñas da Universidade de Vigo. Departamento de Xeocencias Mariñas e Ordenación do Territorio, Facultade de Ciencias do Mar, Campus Lagoas Marcosende, Universidad de Vigo, Vigo, Spain

Corresponding author: anaisousa@ua.pt

Abstract
Seagrass ecosystems are essential for blue carbon sequestration and storage, coastal protection, and biodiversity support, playing a key role in maintaining ecosystem health and sustainability. Despite their importance, these habitats have experienced a global decline for decades due to human-induced pressures, natural stressors, and climate change, jeopardizing the functions and ecosystem services they provide. Recognizing the urgency of restoring these vital ecosystems, this study aligns with the objectives of the UN Decade on Ecosystem Restoration (2021–2030) and the Nature Restoration Law. It focuses on the restoration of *Nanozostera noltii (Zostera noltei*) seagrass in the Ria de Aveiro coastal lagoon (Portugal), as a socio-ecological ecosystem, and its contribution to carbon storage and climate regulation. Using a citizen science approach, *N. noltii* restoration was carried out at multiple intertidal sites through a former validated sod transplant technique. The role of seagrass in blue carbon sequestration was assessed by analyzing carbon stocks across donor meadows, bare sediment, and restored areas in different locations. Engaging scientists, stakeholders, and local communities in the restoration process is key to upscaling efforts, ensuring long-term sustainability, and fostering a sense of stewardship among coastal populations. By integrating restoration actions with international sustainability goals, this study reinforces the potential of seagrass ecosystems as a nature-based solution (NbS), supporting climate resilience and enhancing the stability of socio-ecological coastal systems.

Poster 42

Reintroducing seagrass in a heavily modified lake.

Lea Hahn[1], Nadia Hijner[1], Lisa Bruil[1], Konstantina Bairaktari[1], Annemieke Borsch[1], Isabelle Dubois[1], Stijn den Haan[3], Jannes Heusinkveld[3], Michelle Marijt[4], Lennart Turlings[5], Cas van Bemmelen[5], Marloes van der Kamp[5], Thomas van der Stegen[3], Steven Weisscher[5], Mandy Dil[5], Britas Klemens Eriksson[1], Laura L. Govers[1,2]

[1] *Conservation Ecology Group, Groningen Institute for Evolutionary Life Sciences, University of Groningen, P.O. Box 11103, 9700 CC Groningen, the Netherlands*
[2.] *NIOZ Royal Netherlands Institute for Sea Research, Department of Coastal Systems, Utrecht University, PO Box 59, 1790 AB Den Burg, the Netherlands*
[3] *The Fieldwork Company, Stockholmstraat 2B, 9723 BC Groningen*
[4.] *Altenburg&Wymenga Ecologisch onderzoek, Suderwei 2, 9269TZ, Feanwalden, the Netherlands*
[5.] *Witteveen+Bos Raadgevende ingenieurs B.V. | Deventer , Daalsesingel 51c, Postbus 24087, 3502 MB Utrecht, The Netherlands*

Corresponding author: l.hahn@rug.nl

Abstract
Extensive seagrass (*Zostera marina*) meadows once covered 4600 hectares of Lake Grevelingen, the Netherlands. However, human-induced coastline changes led to extreme salinity shifts, causing eelgrass to disappear in the 1990s. With no natural recolonization possible, we are developing a knowledge base for large-scale subtidal eelgrass restoration using an iterative, experimental approach. Previous research (2017-2021) highlighted major challenges, including site selection, long-term survival, method scalability, and biotic bottlenecks from food web alterations. Since 2022, we have focused on upscaling restoration to meet policy targets (~5 ha restored) using combined modeling and field-based experiments. Our aims are to 1) identify suitable locations for survival and expansion, 2) compare planting methods (cores vs. shoot-based transplant units), and 3) optimize transplant design by testing scale and density-dependency. Recent experiments show promising results. In 2024, 71% of planted locations in Lake Grevelingen showed successful establishment, with shoot densities increasing by 100-150% within three months. Long-term monitoring reveals even greater gains, with 200-500% shoot increases sustained from 2022 plantings. Despite these successes, key questions remain. Next steps focus on scaling up and long-term monitoring, investigating environmental and biological interactions, assessing biodiversity trends, and unraveling ecosystem complexity. This work provides crucial insights into overcoming ecological and logistical challenges in restoring seagrass meadows in highly altered coastal ecosystems.

Poster 43

Annual *Zostera marina* populations occur worldwide.

M.M. van Katwijk[1], B.I. van Tussenbroek[2]

[1] *Department of Environmental Science, Radboud Institute of Biological and Environmental Sciences, Radboud University, Heyendaalseweg 135, 6525AJ Nijmegen, The Netherlands.*
[2] *Institute of Ocean Sciences and Limnology, Universidad Nacional Autónoma de México, Puerto Morelos 77580, Mexico.*

Corresponding authors: marieke.vankatwijk@ru.nl & vantuss@cmarl.unam.mx

Abstract

Plant species usually have either annual or perennial life cycles, but *Zostera marina* is a facultative annual species: it has annual or perennial populations depending on their environment. In terrestrial angiosperms, facultative annual species are rare, with wild rice being one of the few examples. There are 5 more seagrass species that are facultative annual apart from *Z. marina*: *Z. japonica, Halophila decipiens, H. beccarii, Ruppia maritima,* and *R. spiralis*. Populations of seagrasses are commonly perennial, however, annual population occur when exposed to desiccation, anoxia-related factors, shading, or heat stress. A system-wide 'experiment' (closure of two out of three connected estuaries for large-scale coastal protection works) showed that the initial annual *Z. marina* population could shift to a perennial life cycle within 5 years, depending on environmental circumstances. The differential life cycles could have an (epi-) genetic basis or may rise from low P/R ratios experienced in the seedling. This remains to be investigated, and may have implications for plant culture. Further exploration of flexible life histories in plant species, and seagrasses in particular, may aid in answering questions about trade-offs between vegetative and sexual reproduction, preprogrammed senescence, and donor population choice.

Poster 44

Habitat Suitability Modelling for Restoration of *Nanozostera noltii*: A Case Study from the Greater Thames Estuary, UK.

Morwenna Grigg[1], Anna Cucknell[1], Kerry Marten[2], Thea Cox[1], Chris Yesson[3]

[1] *Conservation and Policy Department, Zoological Society of London (ZSL), UK*
[2] *HR Wallingford, UK*
[3] *Institute of Zoology, Zoological Society of London (ZSL), UK*

Corresponding author: thea.cox@zsl.org

Abstract

The extent of seagrass meadows has drastically decreased around the UK coastline, with estimates that at least 44% of the UK's seagrasses have been lost since 1936 (Green *et al*., 2021). As such, restoration efforts for *Nanozostera noltii* and *Zostera marina* are increasing. Habitat suitability modelling is a valuable tool for mapping and can be applied by practitioners at a local scale to identify suitable restoration sites. In the UK, habitat suitability models (HSMs) have previously been applied to *Z. marina*, however, due to constraints in marine and remotely sensed environmental data, creating HSMs that are intertidal-specific poses challenges to *N. noltii* restoration projects. Here, an example of a Maximum Entropy (maxent) HSM is presented to identify areas with high *N. noltii* suitability within the intertidal waters of the Thames, Medway and Swale estuaries, UK (Grigg *et al*., 2025). The model was predominately built on open source, easily derived environmental variables to meet the needs of restoration practitioners. Since its creation, areas of high suitability have been ground-truthed, with locations of previously unmapped seagrass found, thus improving knowledge of current distribution as well as supporting the identification of potentially suitable restoration sites. HSMs can be limited by the availability, resolution and extent of important environmental variables, and require careful ground truthing to ensure the selection of suitable restoration sites. Nonetheless, it has proved a valuable tool for ZSL restoration practitioners in the initial stages of site selection, and will help inform future recovery of the Greater Thames Estuary seascape.

Poster 45

SeaStore: Protection and restoration of seagrass meadows in the southern Baltic Sea.

Kesy, K.[1] and Kreuzburg, M.[2]

[1] *University of Greifswald, Institute of Microbiology, Felix-Hausdorff-Strasse 8, 17489 Greifswald*
[2] *Leibniz Institute for Baltic Sea Research Warnemuende (IOW), Biogeochemistry Environmental Gases, Seestraße 15, 18119 Rostock*

Corresponding author: katharina.kesy@uni-greifswald.de & matthias.kreuzburg@io-warnemuende.de

Abstract
Seagrass meadows are vital coastal ecosystems that enhance biodiversity, sequester carbon, and stabilize sediments, contributing to coastal protection and climate regulation. However, they are also among the fastest-declining marine biomes due to anthropogenic disturbances and climate change. Eutrophication and other human activities, along with climate-driven stressors have led to significant seagrass loss in the German Baltic Sea. Scientifically guided restoration efforts are needed to counteract these trends. In SeaStore we test and enhance restoration protocols for *Zostera marina* in the southern Baltic Sea to develop a Decision Support Tool (DST) that integrates ecological, biogeochemical, and physical factors to identify optimal restoration sites, methods, and management practices. Simulation models support spatial and temporal predictions of seagrass recovery, determining site-specific requirements and the potential need for technical interventions. Remote sensing and long-term monitoring protocols are developed to assess the ecological functions of restored seagrass meadows. By working closely with authorities and stakeholders, the DST will be tailored for practical application, facilitating large-scale restoration efforts and contributing to natural climate protection. Understanding when a restored seagrass meadow fully resembles a natural one requires focusing on seagrass-microbiome interactions and their role in nutrient and carbon cycling. Field and laboratory studies will investigate how microbiome composition influences greenhouse gas dynamics in natural and restored seagrass meadows and bare sediments. Deploying in situ lander systems and using closed chamber measurements, we monitor oxygen dynamics, nutrient exchange, and greenhouse gas emissions. The results will inform the DST and support monitoring and management strategies for seagrass meadows.

Poster 46

Advancing Dwarf eelgrass (*Zostera noltii*) restoration methods.

Lisa Bruil[1,2] Nadia Hijner[1] Yannick Hill[1] Elisa Coccorese[1] Jannes Heusinkveld[3] Stijn den Haan[3] Thomas van der Stegen[3] Michelle Marijt[4] Lennart Turlings[5] Marloes van der Kamp[5] Cas van Bemmelen[5] Britas Klemens Eriksson[1] Laura L. Govers[1,6]

[1] *Groningen Institute for Evolutionary Life Sciences (GELIFES), University of Groningen, The Netherlands*
[2] *The Fieldwork Company, Groningen, The Netherlands*
[3] *Altenburg & Wymenga Ecological research B.V, Feanwâlden, The Netherlands*
[4] *Witteveen+Bos B.V., Deventer, The Netherlands*
[4] *Royal Netherlands Institute for Sea Research (NIOZ), Den Burg, The Netherlands*

Corresponding author: L. Bruil l.bruil@rug.nl

Abstract

Over the course of the twentieth century, dwarf eelgrass (*Zostera noltii*) has drastically declined in the Dutch Wadden Sea and natural recovery has been limited. Active restoration is therefore required to restore dwarf eelgrass in this area. During a four-year restoration project, we aim to 1) gain insight into the factors driving restoration site suitability and 2) optimize techniques for the local and global upscaling of dwarf eelgrass restoration, using an experimental approach. By comparing seed-based and transplant-based restoration methods (dispenser injection seeding (DIS) and cores) across different locations, we found that method suitability highly depends on local environmental conditions. In addition, we found that natural seed germination of dwarf eelgrass restoration is relatively low compared to intertidal common eelgrass (*Zostera marina*). Combined with high seed collection efforts, this challenges the scalability of seed-based methods for dwarf eelgrass restoration. However, through several experiments, we are now developing methods to enhance seed germination and DIS efficiency, which will allow us to use seeds more efficiently. The optimization of seed-based and transplant-based methods can greatly contribute to the upscaling of seagrass restoration in both the Wadden Sea and worldwide.

Poster 47

Transplant Away! – Insights Of Site Selection Through Small-Scale *Nanozostera noltii* Transplantations In The Eastern Scheldt, Netherlands.

Maite L. Vogel[1], Sophie Hankinson[2], Wietse van der Werf[2], Thomas Fauvel[3], Richard J. Lilley[1], Esther Thompson[4], Gemma Hernan[5], Fiona Tomas Nash[5], Barbara Ondiviela Eizaguirre[6], Christina Galvan Arbeiza[6], Freya Watkins[7], David Gold[7], Marieke van Katwijk[8], Dick de Jong[9], Britas Klemens Eriksson[1], Laura L. Govers[1]

[1] *Groningen Institute for Evolutionary Life Sciences (GELIFES), University of Groningen, The Netherlands*
[2] *Sea Ranger Service, Kattenburgerstraat 5, 1018 JA Amsterdam, The Netherlands*
[3] *L'Office français de la biodiversité, Parc naturel marin du Bassin d'Arcachon, 4 Rue Copernic, 33470 Le Teich, France*
[4] *Project Seagrass, Unit 1, Garth Drive, Brackla Industrial Estate, Bridgend, CF31 2AQ, United Kingdom*
[5] *IMEDEA (CSIC-UIB), C/ Miquel Marques 21, Esporles, Spain*
[6] *IH Cantabria. C/ Isabel Torres, 15 (PCTCAN). 39011 Santander, Spain*
[7] *CGG Satellite Mapping, Crockham Park. Edenbridge, TN8 6SR, United Kingdom*
[8] *Radboud University, Houtlaan 4, 6525 XZ Nijmegen, The Netherlands*
[9] *Rijkswaterstaat Rijksinstituut voor Kust en Zee (RWS-RIKZ), The Netherlands*
[10] *Department of Coastal Science, Royal Netherlands Institute for Sea Research (NIOZ), Landsdiep 4 1797 SZ 't Horntje (Texel), The Netherlands.*

Corresponding author: m.l.vogel@rug.nl

Abstract

To counteract global seagrass losses, active seagrass restoration is currently considered a viable management tool with increasingly better outcomes. However, despite recent advancement, local seagrass restoration remains challenging. Current restoration methods are laborious, influencing upscaling capacity. As the Seagrass Consortium, we aim to develop the knowledgebase for a more standardized approach to European seagrass restoration using 4 demonstrator sites across Europe. Furthermore, we are training young people in marine conservation through the involvement of the Sea Rangers. The poster will highlight the first steps that have been taken to kickstart restoration of dwarf eelgrass (*Nanozostera noltii*) in the highly modified Eastern Scheldt lagoon (NL). Transplanting cores across 13 sites followed by extensive monitoring not only identified current bottlenecks to seagrass survival, but also suitable locations to upscale future restoration attempts. Additionally, first seeding trials of intertidal annual eelgrass (*Zostera marina*) show promising results for strengthening severely degraded meadows. The end goal is to develop a toolkit that links both general knowledge and site-specific restoration practice while building restoration capacity.

Poster 48

Integrating genomics and experimental approaches for adaptive eelgrass (*Zostera marina*) restoration.

Maru Bernal-Gómez[1], Camille Rumberger[2], Katie Lotterhos[2] and Marlene Jahnke[1]

[1] *Tjärnö Marine Laboratory, Department of Marine Sciences, University of Gothenburg, Sweden.*
[2] *Department of Marine and Environmental Sciences, Northeastern University, United States.*

Corresponding author: mru.bernal@gmail.com

Abstract
Increasing meadow size and recovering ecosystem services are important milestones in seagrass restoration. Additionally, as climate change accelerates, it is also crucial that restored meadows are resilient to changing environments to ensure long-term persistence. One approach to achieve this is by designing restoration plans that enhance the genetic variation needed to respond to environmental change, known as "adaptive potential". Amongst the various "adaptive restoration" strategies that have been proposed, it is still debatable whether restoration plans should prioritize: (1) adaptation to the local environment, by transplanting individuals from nearby meadows; (2) increasing genetic diversity, by introducing genotypes from more distant meadows; or (3) adaptation to a wide environmental range, by using transplants from both local and more distant meadows. Despite widespread discussion of these strategies, empirical tests to determine if they are effective and under which conditions remain scarce. To address this gap, we outline a plan that integrates genomic data with common-garden mesocosm experiments and in-situ reciprocal transplants to evaluate these three adaptive restoration approaches in eelgrass (*Zostera marina*) meadows. We use the steep environmental gradient along the Swedish coast as a case study, incorporating meadows with varying levels of genetic diversity, clonality and exposure to different salinities and temperatures. With the findings of this experimental approach, we aim to aid in the development of adaptive restoration and genetic risk assessments to support the ongoing seagrass restoration efforts in Europe.

Poster 49

Predicting suitable restoration Sites for *Zostera marina* in the German Baltic Sea using Species Distribution Modelling.

Lattuada, M.[1], Schröder, B.[1]

[1] *Plant ecology, Institute of Ecology, Technische Universität Berlin, Rothenburgstraße 12, 12165 Berlin*

Corresponding author: m.lattuada@tu-berlin.de

Abstract

Seagrass meadows of *Zostera marina* play a crucial role in marine ecosystems, providing essential ecosystem services such as carbon storage. However, these habitats have significantly declined in the German Baltic Sea. As a first step for supporting restoration efforts, we used Species Distribution Modelling (SDM) to identify suitable restoration sites along the German coast. Presence-absence data were obtained from the HELCOM dataset, while environmental predictors included high-resolution bathymetric data from the Bundesamt für Seeschifffahrt und Hydrographie (BSH). We derived additional terrain attributes from this data to enhance model precision. Furthermore, we generated 24 ecologically relevant variables related to water quality, temperature, and hydrodynamics, using Baltic Sea models hosted on the Copernicus platform. To account for potential human impacts, we also included two anthropogenic stressor variables: distance from the coast and distance from river mouths. Using this dataset, we developed a Random Forest modelling workflow for predicting habitat suitability. The Random Forest produced strong predictive performance (AUC > 0.85) and identified key drivers such as water depth and water quality. Beyond habitat suitability modelling, we also attempted to predict seagrass biomass using data provided by MariLim Aquatic Research GmbH, applying the same environmental variables. Additionally, we assessed model uncertainty for both habitat suitability and biomass predictions. These findings provide a data-driven framework for guiding restoration efforts in the Baltic Sea. Further validation through field trials and higher spatiotemporal resolution environmental data is recommended to refine model predictions.

Poster 50

REPIC program, planting drifting cuttings to restore *Posidonia oceanica* meadows impacted by anchors.

Deter Julie[1], Delaruelle Gwenaelle[1,2], Schies Jo-Ann[1], Descamp Pierre[1] and Holon Florian[1]

[1] *Andromède océanologie, 7 place cassan – Carnon plage, 34130 Mauguio, France*
[2] *L'œil d'Andromède, 7 place cassan – Carnon plage, 34130 Mauguio, France*

Corresponding author: julie.deter@andromede-ocean.com

Abstract
Tens years of anchoring whithout any regulation have largely impacted the meadows built by *Posidonia oceanica*, a protected species endemic to Mediterranean. Since 2019, maritime regulation was reinforced (arrêté n°123/2019) and anchoring was efficiently forbiden within the seagrass beds for boats larger than 24 m (Bockel et al, 2023). Numerous wreck fragments are still found in seawater during the summer, especially in the French côte d'Azur because of small boats anchoring and/or natural causes. Since 2019, REPIC program consists in collecting cuttings among those drifting on the sea bottom and planting them in different shallow areas protected from anchoring. In three sites (Golfe Juan, Beaulieu sur Mer and Villefranche sur Mer) of the French Côte d'Azur, 273 500 cuttings have been planted (attached to metal staples) between 1.5 and 30 m deep with several densities i. e. more than 3900 m² replanted (watch the method in video at https://www.youtube.com/watch?v=gCMqYBNX1Lc). Each year, a scientific monitoring is conducted with measurements of survival, photogrammetry, carbohydrate reserve measurements and temperature sensor readings. Survival is 80 % in mean.The use of wreck material presents the advantage to not impact healthy meadow and potentially increase the genetic variability (with the multiple origin of cuttings) of the replanted patches. Even though we are aware that restoring the ecosystem and all its functions will take a long time, our approach involves a dynamic of restoration (reinforcement of populations) of these seagrass beds. By 2026, we aim to have planted 5000 m².

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Development and Trial of a Core Plug Transplantation Technique for *Cymodocea nodosa* Restoration in the Canary Islands.

Sophie Jehin[1], Karima G. López[1]

[1] *Innoceana, Calle El Picón 47, 38687, Santa Cruz de Tenerife, Canary Islands, Spain.*

Corresponding authors: sophie.jehin@innoceana.org and karima.lopez@innoceana.org

Abstract

Seagrass meadows are vital coastal ecosystems that provide essential ecological functions, yet they are declining globally due to anthropogenic pressures. In the Canary Islands, over half of the *Cymodocea nodosa* meadows have been lost in the past two decades, primarily due to declining water quality and unsustainable coastal development (Fabbri et al. 2015). Despite this, restoration efforts remain scarce. This pilot project tested the transplantation of core plugs—mature plants with underground organs and surrounding sediment—into degraded areas along the southwestern coast of Tenerife. An innovative technique was developed to transport core plugs while preserving sediment cohesion, minimizing disturbance to the underground ecosystem.

Seagrass patches were collected from healthy donor meadows in southeastern Tenerife and transplanted using a sliding box system during two campaigns (October 2023, July 2024). Monitoring continued until January 2025, assessing shoot density, leaf length, associated fauna, and abiotic factors (temperature, light intensity). Reference sticks and photographic analysis were used to track meadow recovery at the donor site.

Preliminary findings underscore the challenges of long-term transplant success. The first transplant exhibited 35% survival at four months but declined within a year, while the second showed 25% survival at six months. Low light availability, high sediment mobility, and burial depth influenced survival. A targeted method to reduce herbivory was effective. These findings highlight the importance of site selection and contribute to refining the best practices for seagrass restoration.

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