European Commission

Blue carbon

for biodiversity and climate action

A PROJECTS INFO PACK BY CORDIS

Research and Innovation

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FOREWORD

"Nature is our greatest ally against climate change and it is imperative that we safeguard it!"

Marc Lemaître
Director-General,
Directorate-General for Research and Innovation, European Commission

Carbon naturally stored by coastal, oceanic and marine ecosystems plays a crucial role in mitigating climate change by capturing atmospheric carbon and storing it as natural carbon sinks, helping to reduce greenhouse gas levels. Additionally, blue carbon ecosystems support a rich variety of microbes and wildlife, including fish, birds and invertebrates. They filter pollutants and excess nutrients, improve water quality in coastal areas, act as natural buffers, shield coastlines from erosion, provide protection and resilience against storm surges, and contribute to the livelihoods of coastal communities, supporting fishing industries and tourism. Blue carbon ecosystems are critical not only for combating climate change but also for offering a range of ecosystem services that are vital for both people and the planet. Blue carbon's potential as a nature-based solution will depend on societal actions. By prioritising the protection, conservation and restoration of these ecosystems and their biodiversity, a key focus of the UN Decade on Ecosystem Restoration (2021–2030), we can ensure their continued effectiveness in carbon sequestration and environmental preservation.

Around 20 % of the countries that signed up to the Paris Agreement on climate change refer to blue carbon in their national climate plans. Blue carbon management has the potential to reduce emissions while providing habitat for wildlife. However, shallow coastal ecosystems are extremely vulnerable to climate impacts, including increasing water temperature, ocean acidification, deoxygenation, sea level rise and other types of human-caused degradation.

The EU, through its research and innovation Framework Programmes Horizon 2020 and Horizon Europe, has supported with over 140 projects representing a budget of over EUR 750 million for research contributing to the protection, restoration and ecosystem-based management of marine and coastal biodiversity and its ecosystem functioning. Over 30 projects with a budget of EUR 197 million specifically address the carbon cycle and carbon-rich ecosystems and research the potential effectiveness, benefits and risks of boosting blue carbon stores, as a nature-based solution for mitigating and adapting to climate change. The EU Mission 'Restore our Ocean and Waters by 2030' also plays an important role in this respect.

In this Projects Info Pack, you will discover 15 projects on blue carbon research and innovation that are contributing to closing critical research gaps in observing, valuing, estimating, managing and rolling out blue carbon solutions.

EDITORIAL

Blue carbon for biodiversity and climate action

Blue carbon describes the way in which carbon is captured, stored and released through ecosystems in the ocean, coastlines, rivers and wetlands. Incorporating the management of blue carbon ecosystems into climate and biodiversity frameworks is essential to meeting Europe's climate and biodiversity goals. This Projects Info Pack highlights 15 EU-funded research projects closing important gaps in understanding, observing, modelling and predicting the natural blue carbon component of ecosystem services.

The EU contains 1.3 million km of river habitat and over 100 000 km of coastline across five major maritime zones, from the Arctic to the subtropical region – overseas territories not included. These ocean and coastal ecosystems and habitats, from cold water coral beds to alpine marshlands, play a significant role in the global carbon cycle, representing Europe's largest long-term carbon sink, as well as acting as biodiversity hotspots.

Over the past decade, there has been a marked increase in research efforts to understand the ocean and blue carbon sinks and explore their potential in climate mitigation frameworks. Evaluating and quantifying the broad range of benefits provided by coastal and marine ecosystems should strengthen the ability to account for them in nationally determined contributions and national adaptation plans.

Yet many of Europe's riverine and maritime habitats are under threat. Fisheries have been overexploited, shellfish beds damaged by bottom trawling, invasive alien species, and habitat loss, and coastal areas damaged by pollution and anthropogenic pressure, such as built infrastructures. On land, wetlands have been drained for agricultural and urban development, and rivers dammed and buried. If degraded or lost, these ecosystems are likely to release most of their carbon back into the atmosphere.

While the potential climatic benefits of blue carbon ecosystems can only be a modest addition to rapid reduction of greenhouse gas emissions, blue carbon ecosystems can help reduce the risks and impacts of climate change, with multiple co-benefits.

Two mutually supporting management approaches are possible. The first is to maintain the integrity of natural carbon stores in healthy ecosystems, decreasing their potential release of greenhouse gases. The second is the century-scale restoration of

their potential to capture and sequester carbon, through actions that restore the functioning of those degraded marine ecosystems.

In both cases, the healthy functioning of these ecosystems is highly dependent on maintaining a healthy biodiversity, which also fulfils the EU objectives of halting and reversing biodiversity loss.

The projects highlighted in this Pack are dedicated to improving our understanding of blue carbon processes and advancing research in this essential field of study. The work is divided into three chapters. The first explores how carbon moves through ocean ecosystems, and the impacts that human activity and climate change are having on these processes. The second explores new solutions, tools and techniques, from robotic sampling vehicles to environmental DNA analysis. The final chapter examines how to value blue carbon ecosystem services, placing them at the heart of socioeconomic and environmental policymaking.

Together, they highlight the need to understand – and protect – Europe's aquatic habitats, laying a path for a holistic approach to climate change mitigation efforts, the benefits of which will be felt far beyond Europe's riverbanks and coastlines.

A blue path to green goals

The European Green Deal sets out a number of policy goals and strategies that underpin Europe's ambition for its economy and society to transition to sustainability, become climate-neutral and live in harmony with nature by 2050. The projects featured in this Pack support via research and innovation the implementation of the EU Biodiversity Strategy for 2030, the EU Strategy for Climate Adaptation, the integrated EU policy for the Arctic, the Kunming-Montreal Global Biodiversity Framework, the European Nature Restoration Law, and more. They provide actionable science and recommendations for policy, socio-economic, legal and regulatory pathways for the European Green Deal. They also make substantive contributions to global scientific assessments such as the Intergovernmental Panel on Climate Change (IPCC) and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), as well as other major regional and global initiatives. The work also addresses the Sustainable Development Goals (SDGs) of the United Nations and the UNFCCC Paris Agreement.

EU-funded research, development and implementation is supporting the long-term vision for a sustainable, greener, fairer, more resilient society, ensuring that no person or place is left behind.

CARBON IN MARINE AND COASTAL ECOSYSTEMS

"We want our findings to be not only relevant, but also actionable across various European climates."

Myron Peck, ACTNOW project coordinator

PROJECT ID CARD

Full name:	Advancing understanding of Cumulative Impacts on European marine biodiversity, ecosystem functions and services for human wellbeing
Project dates:	1 March 2023 – 28 February 2027
Coordinated by:	Foundation for Dutch Scientific Research Institutes in the Netherlands
Funded under:	Horizon Europe – Food, Bioeconomy Natural Resources, Agriculture and Environment
CORDIS factsheet:	cordis.europa.eu/project/id/101060072
Project website:	actnow-project.eu
Total budget:	EUR 10 632 000
EU contribution:	EUR 10 632 000

ACTNOW

Scientists act to protect marine ecosystems across 16 European regions

As human activities continue to reshape ocean ecosystems, ACTNOW is setting the stage for sustainable management of Europe's diverse coastal zones.

How do you advance fundamental research on environmental stressors impacting marine habitats and ecosystems, while collaborating with regional policymakers to ensure this knowledge actually leads to concrete action?

This complex but vital question is at the heart of the EU-funded ACTNOW project. It is developing workable solutions across 16 regional case studies to help preserve European seas and coastal zones.

Across the wide landscape of EU projects striving for marine ecosystem preservation, ACTNOW differentiates itself through a unique, participative approach. "Instead of delivering results exclusively for the scientific community, we work directly with regional stakeholders," explains Myron Peck, project coordinator on behalf of the University of Hamburg in Germany. "We want our findings to be not only relevant, but also actionable across various European climates, from eutrophication in the icy waters of Norway to bio-invasions near the warm shores of Türkiye."

Part of these efforts will focus on data standardisation, clustering information into comprehensive databases to facilitate broad, transnational analyses that are crucial for understanding and combating the multifaceted effects of climate change on marine life. Ultimately, the project team expects to deliver models able to make projections of the impacts of multiple stressors on marine life.

But there's more to it, according to Peck. "We're developing close relations with stakeholders involved with environmental policy and management. We organise workshops, questionnaires and stakeholder meetings to help shape practical strategies local and regional authorities can implement. This means clarifying the needs for specific research, providing science-based advice and making sure that our results are understandable to all kinds of audiences."

With three years of research still ahead of them and fieldwork in full swing, the project team's integrated strategies and regional focus look poised to make a lasting impact on marine conservation efforts across Europe.

"Sediment cores allow us to look at how marine biodiversity has changed over the last 100 years."

Colomban de Vargas, BIOcean5D scientific director

PROJECT ID CARD

Full name:	Marine biodiversity assessment and prediction across spatial, temporal and human scales
Project dates:	1 December 2022 – 30 November 2026
Coordinated by:	European Molecular Biology Laboratory in Germany
Funded under:	Horizon Europe – Food, Bioeconomy Natural Resources, Agriculture and Environment
CORDIS factsheet:	cordis.europa.eu/project/id/101059915
Project website:	biocean5d.org
Total budget:	EUR 15 449 903
EU contribution:	EUR 15 449 903

BIOcean5D

Exploring our oceans in five dimensions

The ocean is vast, and much of it remains unexplored. BIOcean5D is on a mission to investigate marine biodiversity, from tiny viruses to the largest mammals.

Marine biodiversity and ecosystems undergo constant change and are doing so at a faster pace than their terrestrial counterparts. The EU-funded BIOcean5D project aims to revolutionise ocean exploration and provide a holistic understanding of its ecosystems.

"We want to explore, set standards and attempt a planetary-scale sampling of biodiversity – from viruses to mammals," says the project's scientific director Colomban de Vargas, research director at the French National Centre for Scientific Research. "This will help unveil the drivers of biodiversity changes, stability and resilience in marine ecosystem health."

Their ultimate objective is to lay the groundwork for a comprehensive '5D' map of the world's oceans. The number refers to three unique dimensions across space, plus time and human impact. This data will provide critical insights for new theories and accurate ocean modelling, while identifying vulnerable marine habitats and potential conservation areas.

At the heart of the project is a consortium of 31 partners from 11 countries. The BIOcean5D team comprises specialists from different disciplines, including molecular cell biology, marine biology, sequencing, theoretical ecology, econometrics and social sciences. This collaborative approach helps the study of marine life from many different angles and timescales.

"One of the key components of BIOcean5D is time," adds de Vargas. "We go back in time using sediment cores that allow us to look at how marine biodiversity has changed over the last 100 years."

The initiative is also teaming up with the TREC expedition, which spans 21 European coastal countries and 45 marine stations and institutes, to evaluate the effects of human activity and climate change on ocean health. To achieve this, it is using a variety of technologies both in and away from the field, including remote sensing, genetic sequencing and a range of models and protocols.

Exploring across a critical range of dimensions, BIOcean5D hopes to gather sufficient comprehensive information on marine ecosystem behaviour to empower future ocean models and inform policy decisions.

"We hope to monitor and map the spatio-temporal variation of biodiversity and its drivers in coastal systems."

Glenn J. Dunshea, DiverSea project co-coordinator

PROJECT ID CARD

Full name:	Integrated Observation, Monitoring and Prediction Architecture for Functional Biodiversity of Coastal Seas
Project dates:	1 September 2023 – 31 August 2027
Coordinated by:	Norwegian University of Science and Technology in Norway
Funded under:	Horizon Europe – Food, Bioeconomy Natural Resources, Agriculture and Environment
CORDIS factsheet:	cordis.europa.eu/project/id/101082004
Project website:	ntnu.edu/diversea/diversea
Total budget:	EUR 9 688 013
EU contribution:	EUR 9 688 013

DiverSea

DNA-based tech for better marine preservation policy

Innovative DNA technologies and habitat mapping are setting new standards for understanding and preserving our oceans.

The EU-funded DiverSea project could revolutionise how we approach marine biodiversity. DNA collected from environmental samples (eDNA) has been widely used to better understand the state of our planet's biodiversity in recent years, but its full potential is still untapped.

In an effort to deepen our understanding of marine biodiversity, DiverSea is using eDNA to offer unprecedented insights into ocean ecosystems and help shape effective conservation strategies. "By integrating emerging molecular techniques such as eDNA with existing technologies such as satellites and autonomous systems, we hope to monitor and map the spatio-temporal variation of biodiversity and its drivers in coastal systems," explains Glenn J. Dunshea, project co-coordinator on behalf of the Norwegian University of Science and Technology with biogeochemist Murat V. Ardelan.

At the heart of DiverSea's innovative approach is the 'DNAmark' method, a technique that simplifies the collection of genetic data. This method, which uses low-coverage genome sequencing combined with efficient computational strategies, can significantly reduce the time and cost of marine biodiversity assessments. As Dunshea puts it: "Such advancement in DNA and RNA identification and interpretation promises to enhance our understanding of marine life in ways previously thought impractical due to cost and technological constraints."

Beyond gathering information on the state of coastal regions' biodiversity, DiverSea will help in understanding the physical, chemical and biological drivers of biodiversity decline while mapping habitats in coastal marine environments. Traditional mapping methods face significant challenges due to the sheer scale and inaccessibility of underwater habitats, but the project will overcome these obstacles by merging molecular data with robotic technologies.

By the end of the project's lifetime in August 2027, consortium members hope to have created a platform allowing non-experts and policymakers to understand and manage marine biodiversity more effectively. The tool will forecast the long-term impacts of different management strategies on marine ecosystems, thereby supporting informed policy decisions.

Understanding the direct drivers of biodiversity loss in different habitats is crucial for effective conservation efforts. Launched in September 2023, DiverSea's results promise to be instrumental in these efforts.

"We are keen that the data we generate isn't just useful for scientists, but also for policymakers."

Nicolas Pade, MARCO-BOLO project coordinator

PROJECT ID CARD

Full name:	MARine COastal BiOdiversity Long-term Observations
Project dates:	1 December 2022 – 30 November 2026
Coordinated by:	European Marine Biological Resource Centre in France
Funded under:	Horizon Europe – Food, Bioeconomy Natural Resources, Agriculture and Environment
CORDIS factsheet:	cordis.europa.eu/project/id/101082021
Project website:	marcobolo-project.eu
Total budget:	EUR 7 255 038
EU contribution:	EUR 7 255 037

MARCO-BOLO

A unified approach to observing our ocean

The health of our ocean is increasingly under threat. Understanding marine biodiversity has never been more critical.

Despite various efforts directed towards evaluating coastal health and the effects of human activity on marine ecosystems, a lack of cohesive approaches has hindered progress. The EU-funded MARCO-BOLO project aims to transform how we monitor and manage marine biodiversity. It will implement standardised research methods and develop technologies to map and monitor biodiversity, including remote sensing, robotics, and environmental DNA sampling and analysis.

Nicolas Pade, executive director of the European Marine Biological Resource Centre in France and project coordinator of MARCO-BOLO, explains: "We need good data to effectively protect and restore biodiversity. At the simplest level, MARCO-BOLO is about creating our ability to systematically study ocean life. Measuring the same thing, in the exact same way, every single time."

With 21 partners across EU countries, including universities, research institutes and infrastructures and authorities, MARCO-BOLO is structured around key work packages focused on enhancing understanding of biodiversity decline, facilitating the development of affordable, efficient and precise observation technologies, and improving the dissemination of observations to stakeholders.

The initiative is examining the relationship between land and sea ecosystems in coastal areas. Pollution and land-use activities can have profound impacts on marine life, so a key focus of the project is to explore this delicate balance and develop strategies for mitigating human-induced impacts.

Combining scientific expertise, technological innovation and stakeholder engagement, MARCO-BOLO's collaborative approach aims to bridge the gap between science and policy, translating research into tangible actions, supporting evidence-based policy through improved data sharing. "We are keen that the data we generate isn't just useful for scientists, but also for policymakers," says Pade.

By closely collaborating with policymakers, MARCO-BOLO hopes to ensure that the project's outputs will create lasting, positive changes in European seas – aligning them with global efforts to rehabilitate ocean health.

"Managing marine resources has to be done within a policy context, but decisions should always be based on best available knowledge."

Jacob Carstensen, OBAMA-NEXT project coordinator

PROJECT ID CARD

Full name:	Observing and mapping marine ecosystems – next generation tools
Project dates:	1 December 2022 – 30 November 2026
Coordinated by:	Aarhus University in Denmark
Funded under:	Horizon Europe – Food, Bioeconomy Natural Resources, Agriculture and Environment
CORDIS factsheet:	cordis.europa.eu/project/id/101081642
Project website:	obama-next.eu
Total budget:	EUR 8 612 070
EU contribution:	EUR 8 612 068

OBAMA-NEXT

Developing innovative tools to monitor marine ecosystems

A new system of tools will help scientists to generate a clearer picture of the world below the ocean surface.

Managing our oceans sustainably over the long term requires reliable observations of the biological ocean.

To this end, the EU-funded OBAMA-NEXT project is developing a suite of tools to generate accurate and precise information on marine ecosystem functioning and biodiversity. The project will develop marine information products and the tools needed to support them.

"The main output from the project will be 'information products', which are typically distribution maps of habitats, species, communities and so on," explains project coordinator Jacob Carstensen, a professor in the Department of Ecoscience at Aarhus University in Denmark. "To produce these maps, we will develop certain tools – based on statistical models and AI – which can be used by specialists," he adds.

The algorithms developed in the project will support future marine monitoring programmes, for example identifying areas where restoration and protection of blue carbon habitats should be prioritised. The team will assess various emerging technologies that can provide new sources of data, drawing from recent advances in environmental DNA analysis, novel optical instruments and citizen science. This assessment will address the reliability of the tools, the general applicability to the project goals, and the quality of the information gathered.

After developing the tools further, the team will then test them in 12 chosen 'Learning Sites', which represent diverse ecosystems across four European seas. These tests will provide further information about the robustness of the algorithms and the new techniques, and, importantly, provide feedback to researchers developing the methods.

"Often, methods are developed with data from a specific site, and proposed to be generally applicable," notes Carstensen. "By testing developed methods across many different sites, we will examine the robustness of the method and the general applicability, or alternatively, the limitations of its use."

The project will enhance the information available to support marine managers, by providing more precise and specific information that can be applied in models and decision support tools. "Managing marine resources has to be done within a policy context, but decisions should always be based on best available knowledge," says Carstensen.

"We will create exploitation scenarios for ocean resource extraction, linked to the Shared Socioeconomic Pathways, outlining the impact of human processes on ocean carbon cycling."

Richard Sanders, OceanICU project coordinator

PROJECT ID CARD

Full name:	Ocean-ICU Improving Carbon Understanding
Project dates:	1 November 2022 – 31 October 2027
Coordinated by:	NORCE Norwegian Research Centre in Norway
Funded under:	Horizon Europe – Food, Bioeconomy Natural Resources, Agriculture and Environment
CORDIS factsheet:	cordis.europa.eu/project/id/101083922
Project website:	ocean-icu.eu
Total budget:	EUR 13 102 053
EU contribution:	EUR 13 094 052

OceanICU

Quantifying the human impact on oceanic carbon storage

Oceanic carbon storage is crucial to slowing climate change. OceanICU's simulations will help quantify the impacts of various resource extraction scenarios.

The ocean absorbs about 25 % of all carbon dioxide emitted into the atmosphere. "While this buys us time to develop climate change mitigation and adaptation measures, it increases ocean acidification, disrupting food cycles," says Richard Sanders from NORCE, coordinator of the EU-funded OceanICU project. "Studying how biological processes, including feeding and excretion, contribute to the biological carbon pump is frontier research."

Due to high variability in carbon fluxes across time and location, accurate quantification of net oceanic carbon uptake requires large amounts of data. "Unfortunately, the data and modelling about ocean CO_2 uptake simply don't agree," explains Sanders. OceanICU will help resolve these inconsistencies.

OceanICU will measure how the carbon cycle will likely develop in a changing climate, focusing on the influence of large-scale extraction of fish and mineral resources. The data will be used to inform AI-driven decision support tools to help policymakers sustainably manage the trade-offs needed to guide future investment, especially for the green transition.

Oceanic carbon cycles include exchanges at the sea surface, propelled by a variety of processes such as cooling and biological carbon uptake driven by photosynthetic organisms. "Activities such as fishing, energy and mineral extraction likely affect biological fluxes," notes Sanders.

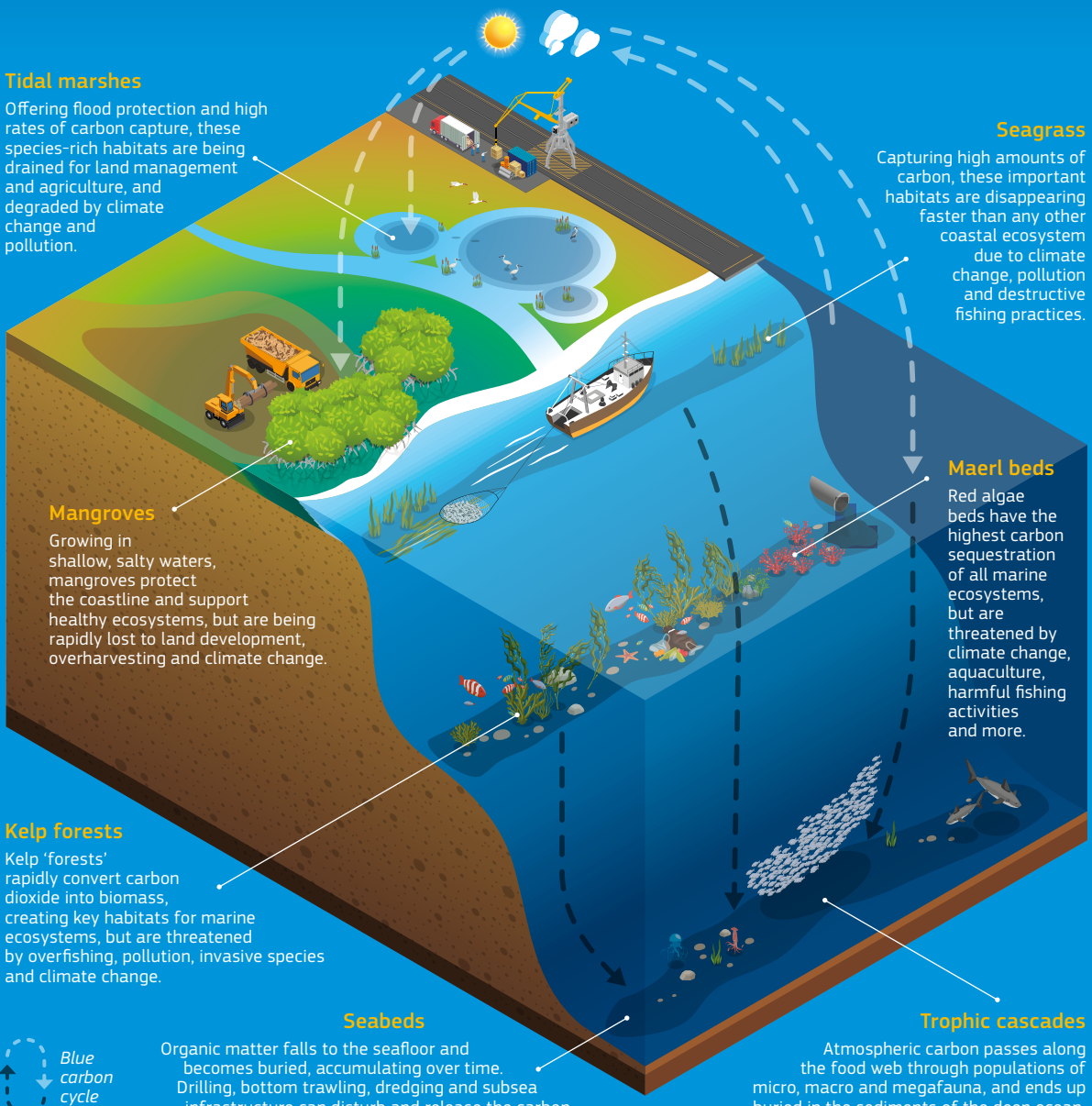
Data is being collected from publicly available databases, including the climate modelling CMIP Archive and the Surface Ocean CO_2 Atlas, scientific literature and experiments, to inform new simulations.

These will model the likely impacts of significant societal transformations, such as carbon neutrality goals enshrined in the European Green Deal, which is anticipated to increase demand for seafloor minerals.

"We will create exploitation scenarios for ocean resource extraction, linked to the Shared Socioeconomic Pathways, outlining the impact of human processes on ocean carbon cycling," adds Sanders. The findings will ultimately inform policymaking, supporting the United Nations Framework Convention on Climate Change's ambition of including oceanic carbon storage in the global stocktake, and the Intergovernmental Panel on Climate Change.

What is blue carbon?

Blue carbon describes biologically driven carbon fluxes and storage in marine ecosystems that are amenable to management. Coastal and ocean ecosystems can capture and store atmospheric carbon at rates much higher than forests, but climate change and centuries of human activity has left them fragmented and degraded. Protecting, restoring and sustainably managing Europe's blue carbon ecosystems can help the EU meet its climate neutrality goals, and deliver a healthier, more resilient environment for people and the planet.



Source: Blue Carbon: Challenges and opportunities to mitigate the climate and biodiversity crises, European Marine Board Policy Brief, 2023

NEW SOLUTIONS, TOOLS, TECHNIQUES

"In Brest, we have implemented artificial reefs for new oysters to grow, while in the Arctic, we've built a barrier to prevent coastal erosion from the melting of the permafrost."

Ida Beathe Øverjordet, CLIMAREST project coordinator

PROJECT ID CARD

Full name:	Coastal Climate Resilience and Marine Restoration Tools for the Arctic Atlantic basin
Project dates:	1 December 2022 – 30 November 2025
Coordinated by:	SINTEF Ocean in Norway
Funded under:	Horizon Europe – Food, Bioeconomy Natural Resources, Agriculture and Environment
CORDIS factsheet:	cordis.europa.eu/project/id/101093865
Project website:	climarest.eu
Total budget:	EUR 8 701 780
EU contribution:	EUR 8 499 999

CLIMAREST

Restoring Europe's coastal regions

The CLIMAREST project brings together experts from across the EU to develop innovative restoration solutions and holistic strategies promoting sustainable, resilient coastal regions.

Coastal ecosystems are among the most vital habitats on Earth. However, these delicate structures are under threat from a range of natural and anthropogenic forces, including climate change, pollution and habitat destruction. The EU-funded CLIMAREST project is addressing this problem by focusing on restoration and protection.

Project coordinator, Ida Beathe Øverjordet, explains: "We want to encourage the restoration of marine environments at scale, and to put together protocols and procedures that will enable coastal communities to be more resilient."

CLIMAREST brings together 18 partner organisations with one goal: to integrate techniques and approaches that will enhance coastal restoration across Europe. At the heart of the project lies the development of tools and protocols that will connect research findings to relevant stakeholders. These will also better equip policymakers at EU level with the necessary knowledge to enact and sustain coastal restoration plans.

The project also aims to demonstrate effective restoration actions across five demonstration sites, spanning the entire length of the European coastline: from the Arctic region of Svalbard to the shores of Madeira, encompassing a range of diverse coastal ecosystems. This gives CLIMAREST the ability to address the unique challenges and opportunities specific to each coastal area, and tailor restoration strategies accordingly.

The team is implementing the following solutions at its five pilot locations. Sea urchin control has been implemented in Madeira, while protocols for restocking the European lobster population have been established in Spain. Seagrass meadows in Ireland are serving as crucial testing grounds for transplanted species.

"In Brest, we have implemented artificial reefs for new oysters to grow," notes Øverjordet. "While in the Arctic, we've built a barrier to prevent coastal erosion from the melting of the permafrost." These methods and strategies will be applied to other locations in the EU with comparable coastal conditions, to validate their ability to be adapted and reproduced at scale.

Ultimately, CLIMAREST is contributing to the preservation of crucial habitats, improving marine restoration and providing a more resilient future for European coastal ecosystems and communities.

"FutureMARES gives science-based guidance on how best to implement the restoration of marine habitats."

Myron Peck, FutureMARES scientific coordinator

PROJECT ID CARD

Full name:	Climate Change and Future Marine Ecosystem Services and Biodiversity
Project dates:	1 September 2020 – 31 August 2024
Coordinated by:	Foundation for Dutch Scientific Research Institutes in the Netherlands
Funded under:	Horizon 2020 – ENVIRONMENT
CORDIS factsheet:	cordis.europa.eu/project/id/869300
Project website:	futuremares.eu
Total budget:	EUR 8 555 905
EU contribution:	EUR 8 555 905

FutureMARES

Boosting marine conservation through nature-based solutions

The FutureMARES project is exploring how natural interventions can protect biodiversity and human communities from climate change.

Ocean and coastal waters harbour a large portion of the world's biodiversity. These ecosystems provide a range of services which support food security, regulate the environment and carry significant cultural weight.

To protect them, researchers and policymakers are increasingly turning to nature-based solutions (NBSs), which are both inspired and supported by nature.

In the EU-funded FutureMARES project, a consortium of world-leading, interdisciplinary experts is using direct measurements and beyond state-of-the-art modelling to further our understanding of the complex links between biodiversity, NBS and ecosystem services.

"Ecosystem-based management, adaptive marine spatial planning and habitat restoration can help support and enhance the capacity of marine and transitional ecosystems to adapt and mitigate unwanted impacts of climate change," explains Myron Peck, the scientific coordinator of FutureMARES at the Royal Netherlands Institute for Sea Research (NIOZ).

Peck and his team are investigating 'climate rescuer' species that create habitats such as seagrass meadows, kelp forests and marine animal reefs, which can shelter species from the negative effects of ocean warming and acidification. These habitats are also providing key ecosystem services, such as reducing coastal erosion and functioning as carbon sinks, regulating the climate.

The team is also explicitly considering the range of impacts from climate change on habitat suitability, exploring strategies to preserve the integrity of food webs and identifying climate refugia – areas where conditions are stable or changing slowly – to help marine conservation. The project is also studying sustainable, nature-inclusive harvesting (NIH) of seafood from fisheries and aquaculture.

So far, project partners have created 39 unique 'Storylines' that showcase historical and future impacts of climate change on species and habitats important to NBSs and NIH. These also include examples of effective restoration, effective conservation and NIH.

Among other outputs, FutureMARES has: gained new ecological knowledge to plan effective NBSs; created detailed future scenarios of NBSs under climate change; studied the climate sensitivity of species and communities; and developed climate risk assessment tools to see how global warming impacts the services biodiversity provides to human society.

"FutureMARES gives science-based guidance on how best to implement the restoration of marine habitats and networks of marine protected areas, delivering significant benefits for climate change mitigation and supporting policies such as the goals of the EU's Biodiversity Strategy as well as the proposal for a Nature Restoration Law," says Peck.

"We believe this will encourage a more widespread uptake of ecosystem-based management across Europe."

Emma Verling, Marine SABRES project coordinator

PROJECT ID CARD

Full name:	Marine Systems Approaches for Biodiversity Resilience and Ecosystem Sustainability
Project dates:	1 September 2022 – 31 August 2026
Coordinated by:	University College Cork in Ireland
Funded under:	Horizon Europe – Food, Bioeconomy Natural Resources, Agriculture and Environment
CORDIS factsheet:	cordis.europa.eu/project/id/101058956
Project website:	marinesabres.eu
Total budget:	EUR 8 755 388
EU contribution:	EUR 8 755 388

Marine SABRES

Marine SABRES charts new waters in ecosystem-based management

Future cohabitation between human and marine habitats calls for sensible and well-informed decisions.

The health of the oceans is critical to global biodiversity and human livelihoods. To strike a balance between ecological preservation and our dependence on marine resources, the Marine SABRES consortium has been exploring innovative tools such as socio-ecological systems (SESs) and ecosystem-based management.

While SESs have long been crucial analytical models used to describe human and ecological systems' interactions – considering biological, social and economic factors holistically – they're also notoriously complex, explains project coordinator Emma Verling, a research fellow at University College Cork's Environmental Institute.

"The complexity of SES models can deter their use. With this project, we aim to simplify them to aid managers in making informed decisions, especially when balancing various needs such as conservation and economic development. We believe this will encourage a more widespread uptake of ecosystem-based management across Europe."

Beyond efforts to simplify the models, the project will also demonstrate the value of these streamlined versions in three distinct demonstration areas, each chosen for its unique environmental and socio-economic contexts: the Tuscan Archipelago, the Greenland-Iceland-Faroes region, and Macaronesia on Africa's north Atlantic coast.

"In the Tuscan Archipelago, we aim to restore seagrass beds, crucial for biodiversity and carbon sequestration, by developing sustainable mooring and boating practices," says Verling. "We will study the effects of climate change and changing oceanographic conditions on the ecosystem state across Iceland, Greenland and the Faroe Islands in close cooperation with the fishing industry, and in Macaronesia, we'll test out specific coastal restoration and conservation interventions while monitoring their impact on touristic activities."

Each area focuses on different threats, allowing Marine SABRES to tailor its conservation strategies effectively and demonstrate their applicability across various marine contexts.

Looking ahead, Marine SABRES seeks not only to demonstrate effective conservation strategies within these three systems, but also to provide a model that can be scaled up to more complex systems worldwide. The project's outcomes are expected to inform and influence both European and international maritime policies.

"Gardening of sponges, seagrasses, seaweeds and corals will be made by professionals but especially by tourists."

Sergio Rossi, OCEAN CITIZEN project coordinator

PROJECT ID CARD

Full name:	Marine forest coastal restoration: an underwater gardening socio-ecological plan
Project dates:	1 January 2023 – 31 December 2026
Coordinated by:	University of Salento in Italy
Funded under:	Horizon Europe – Food, Bioeconomy Natural Resources, Agriculture and Environment
CORDIS factsheet:	cordis.europa.eu/project/id/101093910
Project website:	oceancitizen.eu
Total budget:	EUR 11 183 070
EU contribution:	EUR 10 369 172

OCEAN CITIZEN

An underwater garden planted by tourists

The OCEAN CITIZEN project is developing an innovative plan to boost marine forest coastal restoration through an artificial reef regeneration protocol.

Europe faces alarming degradation to its marine ecosystems, threatening biodiversity and the livelihoods that depend on it. There is particular concern for vulnerable ecosystems dominated by marine forests, such as sponge grounds, seagrasses, corals and gorgonian gardens.

Active restoration reconstructs habitats using methods in which scientists actively plant organisms following ecosystem-based solutions. The technique aims to enable connectivity between marine protected and healthy areas, further bolstering natural restoration and coastal resilience to climate change.

In the EU-funded OCEAN CITIZEN project, researchers and private companies are developing a new approach, using active restoration to recover neglected marine biomes – focusing on marine forests. The project will create underwater artificial reefs to boost biodiversity, combining citizen science with the latest ecological research.

OCEAN CITIZEN will first conduct an in-depth study of the potentially regenerated areas, before adapting the artificial reef material, morphology and distribution to enhance the effects on biodiversity and carbon sequestration. The team will then create an economic model to make underwater gardening self-sustainable, through tourism and biodiversity credits for marine forests.

“Gardening of sponges, seagrasses, seaweeds and corals will be made by professionals, but especially by tourists,” explains Sergio Rossi, a marine research scientist at the University of Salento and OCEAN CITIZEN project coordinator. “They will act as true gardeners, as we understand them on land: they will plant, observe changes and take care of the actively planted organisms,” he says.

The project will be carried out in a series of ‘clusters’ which will trial different restoration techniques in the Arctic, Baltic, Mediterranean and Atlantic seas.

OCEAN CITIZEN aims to move beyond the notion of ecosystem restoration to regeneration: this includes improving habitat connectivity and functionality by considering the interdependent links between, for example, seaweeds, seagrasses and marine animal forests in natural habitats.

“We are also making proofs in the ocean twilight zone and continental shelf areas to understand the overall success of this habitat restoration and functional regeneration,” adds Rossi. “The model will be exported to other areas, to enable the upscaling of this initiative.”

"The difficulty of achieving an integrated vision and measures to improve safety and boost biodiversity requires a wider and maintained support for restoration."

Agustin Sanchez-Arcilla, REST-COAST project coordinator

PROJECT ID CARD

Full name:	Large scale RESToration of COASTal ecosystems through rivers to sea connectivity
Project dates:	1 October 2021 – 31 March 2026
Coordinated by:	Polytechnic University of Catalonia in Spain
Funded under:	Horizon 2020 – ENVIRONMENT
CORDIS factsheet:	cordis.europa.eu/project/id/101037097
Project website:	rest-coast.eu
Total budget:	EUR 18 482 592
EU contribution:	EUR 17 823 755

REST-COAST

Giving large-scale coastal ecosystem restoration a boost

Scientists are supporting the development of large-scale coastal restoration projects, connecting rivers to oceans for wide-scale benefits.

Coastal areas are some of the most productive and biodiverse ecosystems on the planet. With high levels of biodiversity, they have a large and often underappreciated potential for carbon capture and storage.

Future management of these resources is essential to meeting the ambitious climate goals set out by the EU. However, many existing interventions are small scale, and focus on specific ecological or risk problems. A broader approach could bring compounding benefits to connected ecosystems, lowering costs and boosting natural capital.

Upscaling such restoration projects faces several barriers in both planning and governance, however, including in technical, financial and socio-economic aspects. Addressing these is the goal of the EU-funded REST-COAST project.

"The difficulty of achieving an integrated vision and measures to improve safety and boost biodiversity requires a wider and maintained support for restoration," explains Agustin Sanchez-Arcilla, professor at the Polytechnic University of Catalonia in Spain and REST-COAST project coordinator.

The REST-COAST project, a collaboration between 38 partners, aims to develop large-scale projects that increase the connectivity between rivers, coasts and oceans to improve the resilience of coastal ecosystem services. It will assess the potential benefits of restoring several ecosystems, including coastal marshes, seabed meadows and coastal dunes.

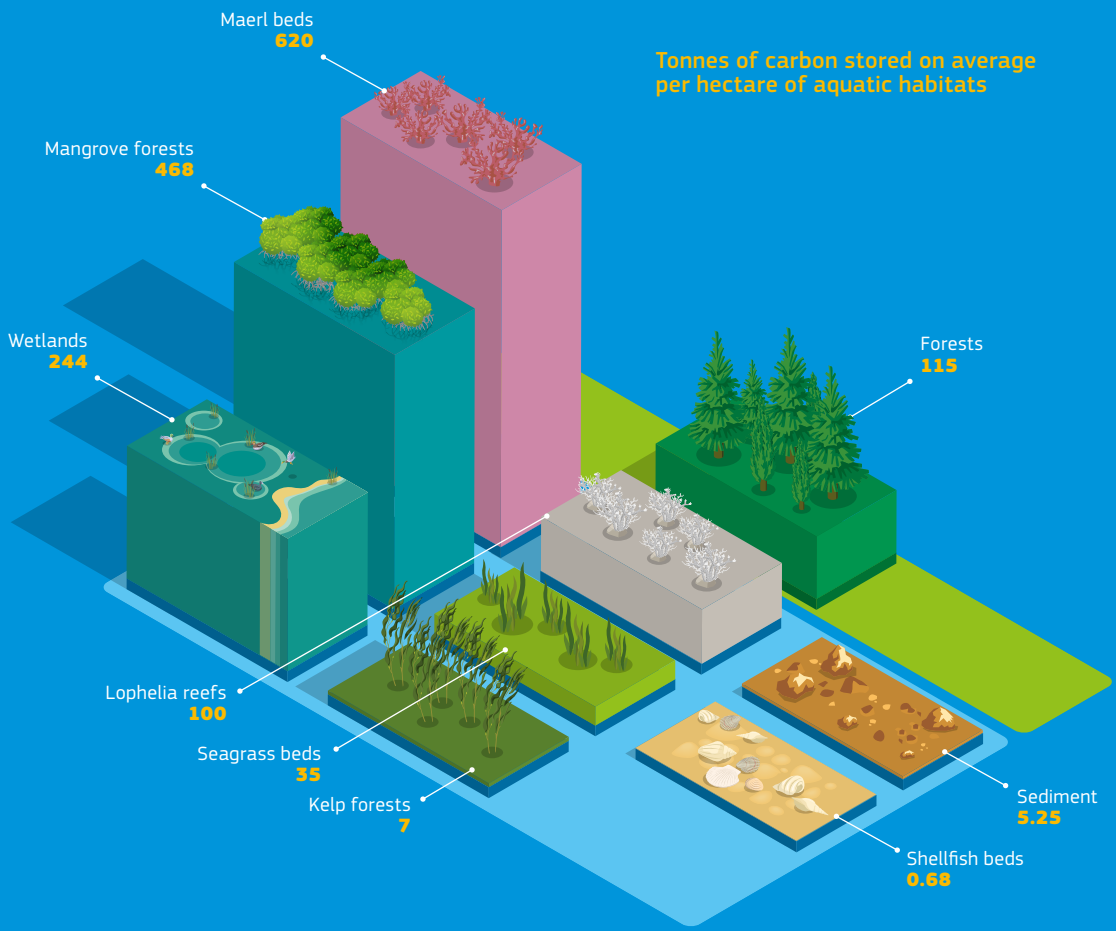
"The delivery of ecosystem services needs a large enough restoration scale to assess the benefits of such ecosystem services, since the small-scale interventions commonly performed in the past do not provide a substantial enough demonstration in quantitative terms – for instance, in erosion and flooding risk reduction and blue carbon gains," says Sanchez-Arcilla.

The team will combine observations with model simulations, and run nine pilots in the main EU regional seas: the Atlantic, Baltic, Black, Mediterranean and North seas – with the aim of increasing the commitment of citizens, stakeholders and policymakers. These pilots will also benefit from advances in ecosystem service valuation and from the analysis of market conditions carried out through the project.

C stores by the seashore

Blue carbon represents a natural climate solution based on the natural processes of ecosystems and their constituents and biodiversity, established through millions of years of species co-evolution. Preserving blue carbon goes hand in hand with preserving ecosystems, and ecosystems-based sustainable management can help restore healthy carbon sequestration functions. To do so, it is necessary to understand which habitats are carbon hotspots and are best suited to management and protection. The ocean absorbs around 15 billion tonnes of carbon every year, yet the amount stored within each ecosystem is difficult to measure. Disturbing these habitats, even the seabed itself, releases stored carbon back into the atmosphere. Further research is needed to better quantify the storage potential and the impact of nature restoration on climate change mitigation policies in Europe.

The chart below shows how many tonnes of carbon are on average stored in each hectare of the various typical blue carbon habitats, based on the best available data.



Source: European Environment Agency, Nature

VALUING BLUE CARBON ECOSYSTEM SERVICES

"The health or condition of one ecosystem affects the health of another."

Cindy Cornet, MaCoBioS project co-manager

PROJECT ID CARD

Full name:	Marine Coastal Ecosystems Biodiversity and Services in a Changing World
Project dates:	1 June 2020 – 31 May 2024
Coordinated by:	University of Portsmouth in the United Kingdom
Funded under:	Horizon 2020 – ENVIRONMENT
CORDIS factsheet:	cordis.europa.eu/project/id/869710
Project website:	macobios.eu
Total budget:	EUR 6 980 658
EU contribution:	EUR 6 980 658

MaCoBioS

New tools to support marine ecosystem biodiversity

Understanding how marine ecosystems interact and interconnect with human well-being could lead to policies and actions that better support biodiversity.

Marine vegetated ecosystems such as seagrass beds and kelp forests perform a number of critical ecosystem functions. These include carbon storage, coastal protection and providing habitat for marine species.

"Seagrass beds are often part of a mosaic of interconnected habitats," explains MaCoBioS project co-manager Cindy Cornet from the University of Portsmouth in the United Kingdom. "For example, Caribbean seagrass beds are often associated with coral reefs and mangrove forests, and the health or condition of one ecosystem affects the health of another."

The EU-funded MaCoBioS project set out to better understand the complexity of these interconnections in order to implement effective blue nature-based solutions (NBSs) that better preserve the health and biodiversity of these valuable ecosystems.

To do this, fieldwork has been carried out in the seas around northern Europe, the Mediterranean and the Caribbean. This involved the implementation of innovative technologies such as remote sensing and passive acoustic monitoring, as well as visual observations.

"We've since been very busy developing conceptual models for each of our focused ecosystems, including coral reefs, seagrass beds, mangrove forests and kelp forests," says Cornet.

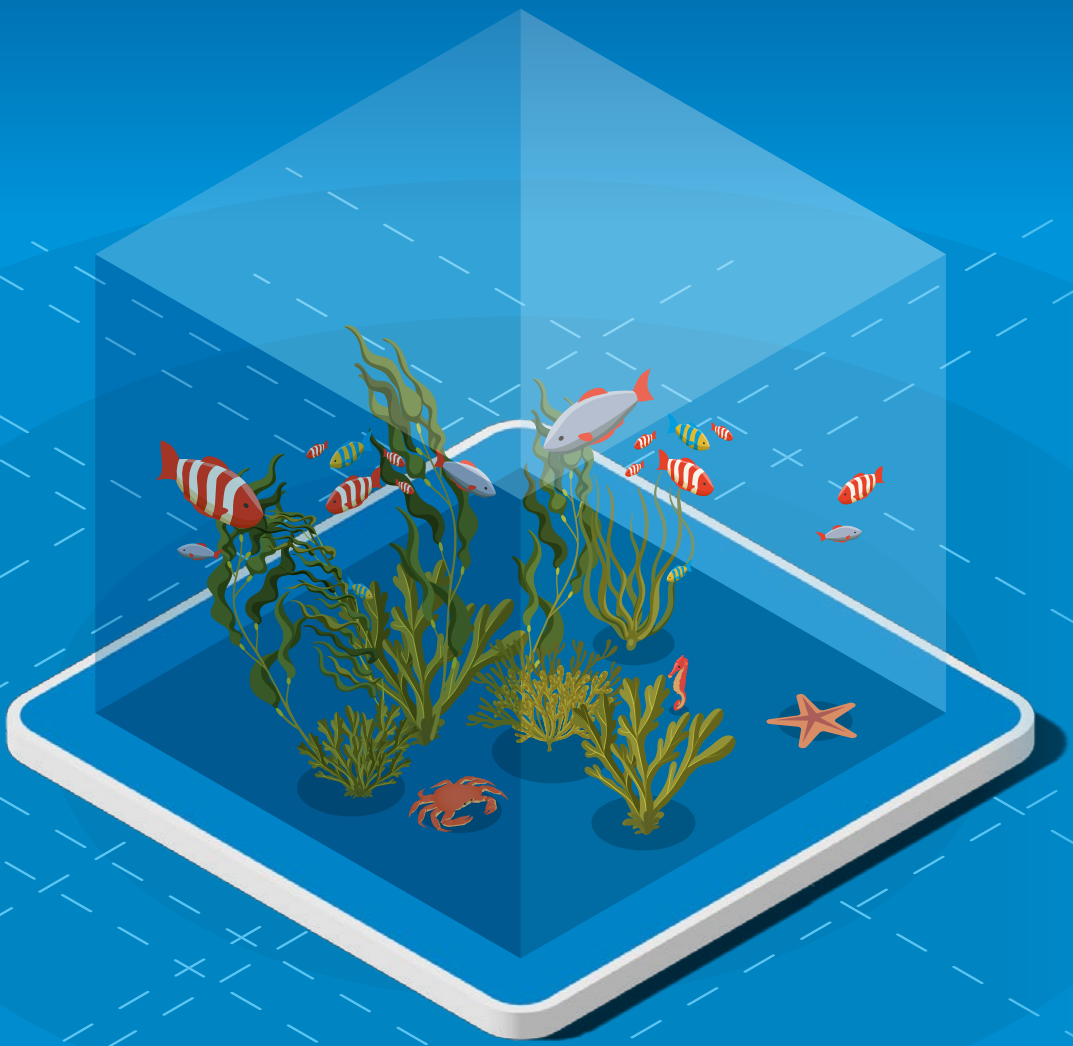
"We've also developed a multi-risk assessment framework, an adaptive capacity assessment framework and other decision support tools. These are all interconnected to support practitioners and decision makers in implementing appropriate blue NBSs."

Every framework, model and tool will be gathered in a toolbox and made freely available at the end of the project. The project team is also currently organising a major blue NBS event, which will be held at UNESCO headquarters in Paris, France.

"By definition, NBSs have to be designed to work with nature, and bring benefits to both biodiversity and human well-being," adds project co-manager Ewan Trégarot. "We hope that future research projects, practitioners and decision makers will take up the suite of tools we are developing to support blue NBS implementation – which has been seriously lagging behind terrestrial and urban NBSs. Most importantly, we hope that this will contribute to ensuring the sustainable management of marine and coastal socioecological systems."

"We want to show how biodiversity is connected to ecosystem functioning."

Jan Marcin Węsławski, MARBEFES project coordinator



PROJECT ID CARD

Full name:	MARine Biodiversity and Ecosystem Functioning leading to Ecosystem Services
Project dates:	1 September 2022 – 31 August 2026
Coordinated by:	Institute of Oceanology, Polish Academy of Sciences in Poland
Funded under:	Horizon Europe – Food, Bioeconomy Natural Resources, Agriculture and Environment
CORDIS factsheet:	cordis.europa.eu/project/id/101060937
Project website:	marbefes.eu
Total budget:	EUR 12 915 070
EU contribution:	EUR 12 915 068

MARBEFES

The changing shape of Europe's seas

Europe's marine life is undergoing dramatic transformations due to increasing human activity and environmental shifts.

Beneath the waves lies a complex network of life, but human activity and climate change threaten this delicate balance. Recognising the need for extensive research into diverse marine environments, Horizon Europe is funding the MARBEFES project.

The project team is embarking on a 4-year journey to analyse biodiversity across 12 zones that span the full range of Europe's seas. From Arctic to semi-tropical regions, each area holds its own significance, in terms of not only biodiversity but also cultural heritage and traditional uses by coastal communities.

"Thanks to climate change, we are observing the movement of biogeographical zones from south to north," explains project coordinator Jan Marcin Węsławski, a professor at the Institute of Oceanology of the Polish Academy of Sciences. "We want to show how biodiversity is connected to ecosystem functioning, and it is by no means a simple relationship."

The project brings together a multidisciplinary team of experts in marine biology, ecology, social science, oceanography and environmental science. The primary goal is to advance our understanding of marine biodiversity and how it affects the services that oceans provide, from blue carbon processes to fishery production.

While marine biologists are studying species distributions and ecological shifts, social scientists will delve into public perceptions and attitudes towards biodiversity changes. By understanding both scientific findings and societal perspectives, MARBEFES aims to bridge the gap between knowledge and action, empowering communities to adapt to these evolving coastal environments.

Through collaborative research efforts, MARBEFES studies will: expand marine knowledge, aiding conservation efforts; strengthen marine policies for sustainable use; raise public awareness and involvement in marine conservation; and promote the development of a sustainable blue economy. Through these actions, MARBEFES will provide help to preserve the EU's marine life, while ensuring economic activities such as fishing and tourism are sustainable in the long term.

"We will contribute evidence about whether primary marine producers can help offset CO_2 emissions and make specific suggestions for marine protected areas, especially in the Arctic."

Mikael Sejr, POMP project coordinator

PROJECT ID CARD

Full name:	Polar Ocean Mitigation Potential
Project dates:	1 February 2024 – 31 January 2028
Coordinated by:	Aarhus University in Denmark
Funded under:	Horizon Europe – Food, Bioeconomy Natural Resources, Agriculture and Environment
CORDIS factsheet:	cordis.europa.eu/project/id/101136875
Project website:	pomp-project.eu
Total budget:	EUR 4 847 238
EU contribution:	EUR 4 847 238

POMP

Uncovering novel polar blue carbon ecosystems

The EU-funded POMP project's results should help reduce uncertainties about the amount of CO_2 taken up by algae in the polar oceans.

Climate change is altering Arctic and Antarctic regions faster than the global average. As these areas are pivotal to the global climate system, this accelerates an environmental feedback loop. Critically, a warmer climate results in the loss of ice cover, in turn changing the polar oceans' ecosystems.

"To understand the longer-term consequences, we need to know how ice loss alters marine ecosystems' structure, biodiversity and capacity to take up CO_2, slowing climate change," says Mikael Sejr from Aarhus University's Department of Ecoscience in Denmark, and project coordinator of the POMP project.

Sejr and his team will compile existing knowledge of the distribution of carbon- and biodiversity-rich habitats, and the expected impact of continued warming. While synthesising knowledge of both Arctic and Antarctic oceanic changes is challenging, POMP's partners bring a strong track record of polar research in Europe, Canada and Greenland, yielding extensive data, much collected at sites which have long been documenting climate change impacts.

Once collated, this local data will be combined with remote sensing data to train coastal and global ocean ecosystem models. "These models will study how different marine ecosystems have responded to changes in sea ice, glaciers and snow cover over the last 20-30 years, as well as forecast the likely impacts on future carbon fixation, storage and sequestration," explains Sejr.

The team are initially focusing on fixation by primary producers or plants, followed by storage (such as living biomass, over decades) and finally sequestration, with atmospheric removal over centuries to millennia.

The gathered data suggest that increased transport of turbid freshwater from land into the coastal ocean might reduce coastal productivity, and the ability of marine ecosystems to capture carbon, in the future.

"We will contribute evidence about whether primary marine producers can help offset CO_2 emissions and make specific suggestions for marine protected areas, especially in the Arctic," concludes Sejr.

"The aim is to develop a model that can inform policymakers and managers of the effects of human actions on the blue carbon reservoirs."

Marja Koski, SEA-Quester project coordinator

PROJECT ID CARD

Full name:	Blue Carbon production, export and sequestration in emerging polar ecosystems
Project dates:	1 February 2024 – 31 January 2028
Coordinated by:	Technical University of Denmark in Denmark
Funded under:	Horizon Europe – Food, Bioeconomy Natural Resources, Agriculture and Environment
CORDIS factsheet:	cordis.europa.eu/project/id/101136480
Project website:	N/A
Total budget:	EUR 5 497 977
EU contribution:	EUR 5 111 918

SEA-Quester

Investigating the carbon potential of new polar ecosystems

Researchers are exploring the possibilities of blue carbon export and sequestration in emerging polar biological communities.

Climate change is causing dramatic shifts in the environment and ecology of polar regions, leading to the creation of new marine ecosystems. "Novel ecosystems are those that emerge at areas which have previously been permanently covered in ice – and include both coastal habitats such as macroalgal beds, and open ocean areas where phytoplankton bloom dynamics might change," explains Marja Koski, professor at the National Institute of Aquatic Resources, Technical University of Denmark (DTU Aqua) and SEA-Quester project coordinator.

Novel ecosystems can also appear when the distribution of species changes due to shifting environmental conditions. The peak distribution of many species is moving away from warmer temperatures at lower latitudes, towards the poles, which can result in new combinations of species within communities.

The EU-funded SEA-Quester project is setting out to study these new ecosystems and to assess their carbon storage, export and sequestration. The team will conduct a series of ocean-going cruises, as well as laboratory experiments, followed by research and analysis of the implications of novel polar ecosystems for marine biodiversity, and their role in the global climate system.

SEA-Quester will explore new ecosystems in several focus areas in the Arctic (East and West Greenland, the Fram Strait and Svalbard), sub-Arctic (Baltic Sea) and Antarctic (South Georgia and the Southern Ocean).

Researchers will use existing data sets, new observations and modelling, undertake several cruises in East Greenland, Svalbard and other locations, and carry out shore-based work, for example in Greenland's Disko Bay.

"By combining these data sets, we will build an understanding of blue carbon stocks, the residence times of carbon in these different reservoirs, and how environmental change affects them," adds Koski. These insights will then inform models and provide input to Earth system models.

"The aim is to develop a model that can inform policymakers and managers of the effects of human actions on the blue carbon reservoirs," says Koski. "We hope the results will contribute to a better understanding of how blue carbon contributes – or doesn't – to CO_2 removal."

Glossary

Biodiversity is a measure of the number and variety of different organisms (including plants, animals, fungi and microbes) that are present in a habitat. Environmental degradation typically leads to a fall in biodiversity.

A **biological carbon pump** is a series of processes through which inorganic carbon, such as carbon dioxide, is captured by photosynthetic organisms living near the ocean surface, and then transported to deeper waters, possibly becoming stored long term in the ocean sediment.

Biomass is physical matter of organisms. It includes both live organisms, and non-living biological material such as plant litter, wood, shells, coral fragments and bones.

Blue carbon describes biologically driven carbon fluxes and storage in marine ecosystems that are amenable to management. These ecosystems include mangroves, salt marshes and seagrasses. If degraded, blue carbon ecosystems are likely to release their carbon back into the atmosphere.

The **carbon cycle** is the flow of carbon in various forms (as carbon dioxide, in mineral form and incorporated into plants, animals and other forms of life) through the atmosphere, oceans, land surface, seafloor, ice sheets and glaciers, and Earth's interior.

An **ecosystem** describes a community of living organisms, their non-living environment, and the interactions within and between them. The boundaries of an ecosystem can change over time, and the scale of an ecosystem ranges from the microscopic to the entire planet.

Ecosystem-based management is an environmental management approach that aims to consider interactions between all elements present in an ecosystem, including humans, in its decision-making.

Nature-based solutions make use of natural processes to tackle socio-environmental issues, for example, encouraging the growth of mangrove forests to protect coastlines from erosion.

Phytoplankton are microorganisms that live in water and feed on sunlight. They are a fundamental component of the food web in seas, rivers and lakes.

Sequestration is the process of removing carbon from the atmosphere and storing it long term. This happens naturally through processes such as plant growth. Choices in how an ecosystem is managed can increase or decrease the rate of its carbon sequestration.

A carbon **sink** is any process which accumulates carbon, preventing its release into the atmosphere, over a long period of time.

Socioecological systems are analytical models that consider biological, social and economic factors to describe interactions between humans and ecosystems.

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