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Marine Ecosystem Restoration in Changing European Seas

Findings from the Field - A Summary for Policy Makers

merces restoring marine ecosystems

UN environment programme WCMC

NIVA Norwegian Institute for Water Research

THE CHALLENGE

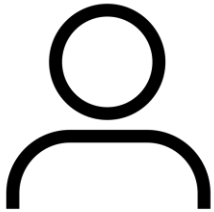
European marine ecosystems are being lost and degraded at an alarming rate, impacting people and nature. Over-exploitation, pollution, invasive species and physical damage are directly causing habitat loss, whilst a changing climate will further compromise the health and resilience of our oceans.

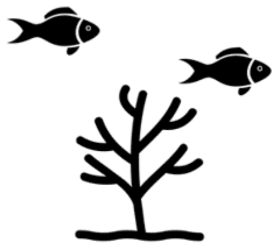
There is an increasing recognition of the urgent need to prevent, halt and reverse this degradation. We need to combine reduction of pressures with effective ecosystem restoration to actively improve our seas and the benefits they provide to people and nature.

2021 marks the start of a significant decade for restoration. The emerging EU Biodiversity Strategy 2030 calls for a strong national and regional focus to restore European habitats whilst the UN Decade on Ecosystem Restoration calls for an increase to the scale, scope and pace of restoration efforts worldwide. Using pioneering research and multi-sectoral partnerships we can ensure our marine and coastal ecosystems are restored effectively and sustainably during this decade and beyond.

41%

of EU citizens live along the coastline



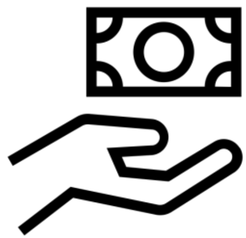


70%

of European marine habitats are in an “unfavourable” conservation status

€485 billion

is generated every year from maritime activities in European seas.



Sources: EEA, 2014: Marine Messages; Maes et al., 2020

PIONEERING RESEARCH: MERCES researchers have undertaken some of the first restoration efforts in deep-sea habitats, including seamounts in the Azores.

In the field in the Azores © Martina Milanese, IMAR, MERCES

THE VISION

To support ambitions for healthy European seas, the European Commission, under its Horizon 2020 Research and Innovative Programme, launched a first-of-its-kind multi-national marine restoration project:

MERCES - Marine Ecosystem Restoration in Changing European Seas (2016-2020)

MERCES used innovative solutions to explore different options for restoring degraded shallow and deep-sea ecosystems across Europe.

This document is part of a series of Summary for Policy Makers that explore the findings from

128 restoration sites
led by **28 institutions**
in **12 countries**
over **4 years**

The expertise obtained from MERCES is vital to upscale marine restoration efforts across Europe and to meet national, regional and global targets.

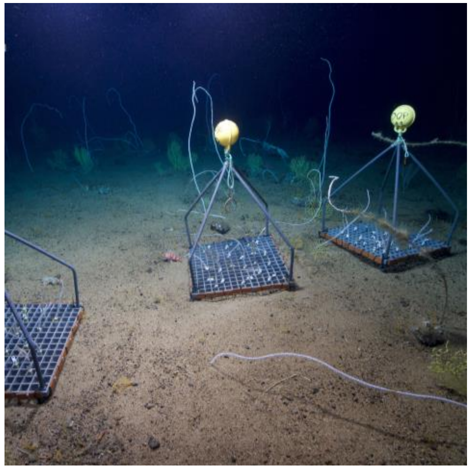
THE MERCES APPROACH

From kelp forests in Norway and seagrass meadows in Italy to seamounts in the Azores, MERCES explored restoration actions for 35 important habitat-forming species in 128 locations.

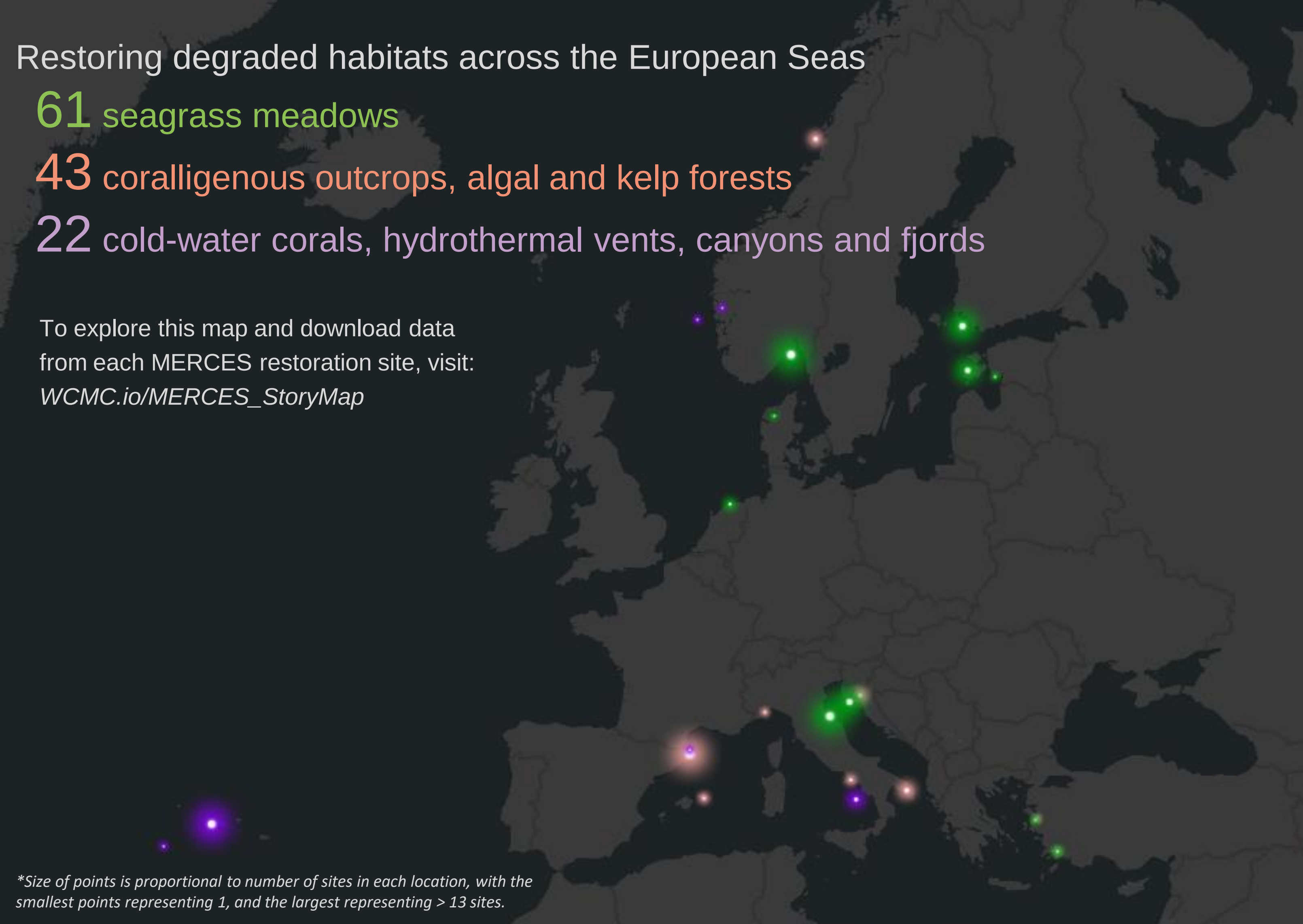
Restoration efforts included "active" approaches, where species were added or removed (86% of sites), and "passive" approaches where areas were protected to allow habitats to recover naturally (14% of sites). As a project driven by innovation, over 80% of sites tested novel techniques. Among many others, active ecosystem restoration techniques included...

… introducing *Mytilus edulis* mussels to *Zostera marina* seagrass meadows in Norway,

… experimenting with different substrates to restore macroalgae forests in Spain,



… and deploying coral fragments onto seamounts hundreds of meters below the Atlantic waves.


Restoring degraded habitats across the European Seas
61 seagrass meadows
43 coralligenous outcrops, algal and kelp forests
22 cold-water corals, hydrothermal vents, canyons and fjords
To explore this map and download data
from each MERCES restoration site, visit:
WCMC.io/MERCES_StoryMap
*Size of points is proportional to number of sites in each location, with the
smallest points representing 1, and the largest representing > 13 sites.

RESTORATION THROUGH INNOVATION: In the Netherlands, MERCES researchers deployed Biodegradable Elements for Starting Ecosystems (BESE) units to restore seagrass meadows.

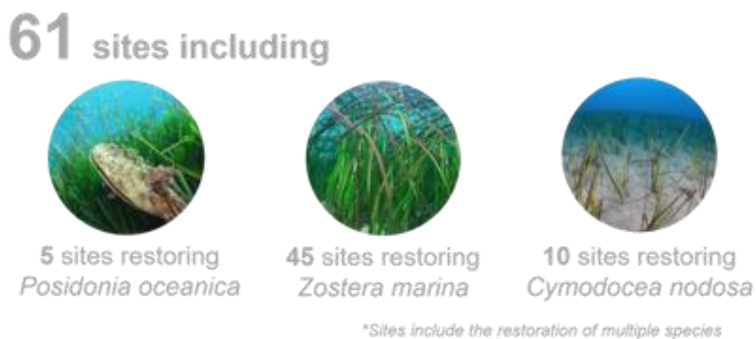
BESE units © Laura Govers

FINDINGS FROM THE FIELD

Restoring seagrass meadows

Seagrass meadows cover an estimated 6,000 km² of European waters - more than twice the size of Luxembourg. They play a critical key role as nursery grounds for fish and in protecting the coast from storms and floods.

See MERCES 'Manual of restoration measures in soft bottoms based on surveys and experiments' for more information on how to restore effectively.



Restoring seagrass meadows – aligning science and policy

MERCES offers a plethora of evidence from small scale restoration efforts. In order to successfully upscale restoration efforts, we need to combine our knowledge of species with effective management and supporting policy. The following summarises such efforts for seagrass meadow restoration:

- **Matching restoration goals with species recovery rates:** The time scale for recovery should be assessed carefully depending on the seagrass species in question. For example, *Posidonia oceanica* is a slow-growing species while *Cymodocea nodosa* and *Zostera marina* exhibit faster clonal growth. Therefore restoration efforts, including length of funding, monitoring and overall objectives, should align with such time frames.

- **Management to reduce and remove pressures:** Seagrass meadows are extremely vulnerable to anthropogenic pressures. It is important that pressures, such as eutrophication (which limits light availability and growth) and habitat destruction are removed and appropriate sediment conditions are re-established. Supportive policies and management should aim to reduce such pressures in combination with restoration.

- **Long-term management and monitoring:** As a long-term process, seagrass meadows undergoing restoration efforts need long-term management to monitor the effects on the ecosystem as a whole. This can include introduction of healthy populations of associated species, especially top predators, which can control algal (over)growth through trophic cascades.

- **Active restoration at large scales:** In general, large-scale planting has been identified as an important method for increasing success of seagrass restoration. Greater spatial distribution allows for greater access to donor populations, which increases the probability of recovery success. Therefore, active restoration of seagrass meadows at large scales is encouraged.

FINDINGS FROM THE FIELD

Restoring coralligenous outcrops, algal forests and kelp forests

European seas contain a range of important shallow coastal habitats, such as coralligenous outcrops, algal forests, kelp forests and sponges. These are critical to a healthy sea - providing a habitat for species, regulating nutrients, and acting as feeding and nursery grounds for turtles, fish and birds.

See MERCES 'Criteria and protocols for restoration of shallow hard bottoms and mesophotic habitats' for more information on how to restore effectively.

43 sites including

5 sites restoring *Paramuricea clavata*

2 sites restoring *Laminaria hyperborea*

6 sites restoring *Cystoseira elegans*

Sites include the restoration of multiple species

Coral reefs, Islas Medes, Spain © Juanma Clemente-Alloza

ECOSYSTEM SERVICES: Coralligenous habitats and other healthy marine ecosystems are attractive to divers, snorkellers and tourists - just one of many ways in which our oceans support the well-being of communities and economies throughout Europe.

Restoring kelp forests – aligning science and policy

Kelp forests are recognized hot spot of diversity and provide food and habitat to diversified assemblages of understory species and enhance coastal primary productivity. The following concepts have been identified for effective restoration of kelp forests:

- **Understanding local conditions:** Before any restoration action can take place, an in-depth understanding of the drivers, feedback effects and critical thresholds for the shifts is needed. Management plans for kelp forest restoration should include knowledge of the interaction with local predators (such as sea urchins), prevalence of turf algae as well as an understanding of local and global conditions.

- **Removing pressures:** Pressures from urbanization, eutrophication and increasing sediment loads in coastal areas have led to the loss of such forests which results in simpler and less productive communities such as barrens and algal turfs. Kelp forests show a high recovery rate following removal of pressures such as sea urchins and eutrophication. Supportive policies and management should aim to reduce such pressures in combination with restoration efforts.

- **Restoring at the large scale:** Transplanted or recovered kelp plants can quickly support restoration in adjacent barren areas. Restoration actions for kelp forests may therefore be implemented at large spatial scales in suitable areas to improve success of restoration efforts.

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Restoring macroalgal forests – aligning science and policy

Macroalgal forest ecosystems, including Cystoseira species, play a key role in European coastal ecosystems, supporting primary production and complex food webs and delivering a multitude of other goods and services for people and nature. The following summarises considerations for effective restoration approaches of macroalgal forests.

- **Understanding growth and health:** Shallow outcrops have high growth and fast dynamics and may be easier to restore compared to deeper outcrops (e.g., below 30 m depth). In situations where natural and donor populations are in a critical state, active restoration (planting) should be avoided, and restoration should rely on recruitment enhancement and the growth of juveniles. In these situations, a longer time (possibly decades) for restoration must be accepted.

- **Combining restoration efforts:** Restoration practitioners have found that a combination of two approaches (such as sea urchin eradication to control their impact, and recruitment enhancement techniques) were most effective for Cystoseira forestation from a shallow degraded barren ground.

- **Reducing pressures:** Anthropogenic pressures such as eutrophication, chemical pollution, coastal development, sedimentation should be reduced to improve restoration success. Supportive policies and management should aim to reduce such pressures in combination with restoration efforts.

merces restoring marine ecosystems

Restoring ecosystem engineers - the case of the coralligenous outcrops

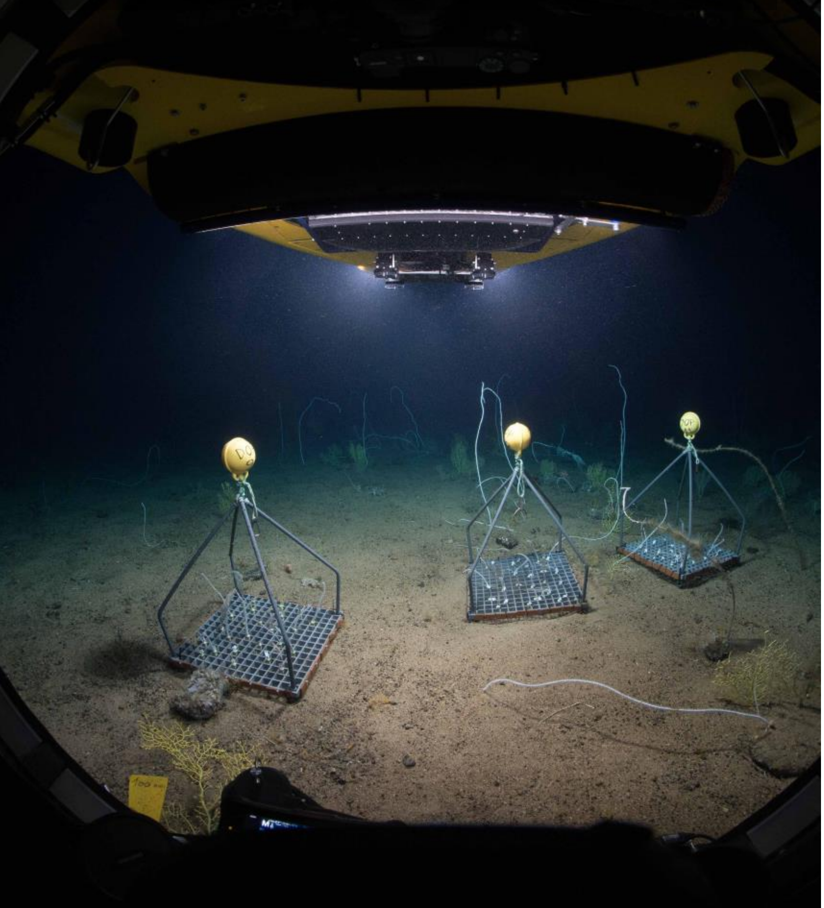
Coralligenous outcrops harbour approximately 10% of marine Mediterranean species, many of which are long-lived algae and sessile invertebrates. Such habitats are however affected by several pressures and have declined in recent decades. The following summarises considerations for effective restoration:

- **Restoring at the local scale:** Due to coralligenous outcrops growing in a highly fragmented way with low connectivity, it is suggested that restoration actions should be considered over a local scale (meters). Restoration should focus on structural species that provide habitat for associated species.

- **A long-term restoration process:** Transplantations are noted as a successful method, resulting in high survival rates and requiring low initial effort. However, being slow-growing, long-lived species with limited recruitment, restoration of transplanted coralligenous species, such as sponges (e.g., *Petrosia fisciformis, Spongia lamella, S. officinalis*) and octocorals (e.g., *Paramuricea clavata*, *Corallium rubrum)* can take decades. Bryozoans, such as *Pentapora fascialis*, show faster growth rates and can restore structural complexity in five to ten years.

- **Management to reduce pressures in combination:** Coralligenous assemblages are presently threatened by a combination of nutrient enrichment, invasive species, increase of sedimentation and mechanical impacts, mainly from fishing activities, as well as climate change. Reduction of pressures should be a priority before starting restoration actions.

RESTORING THE DEEP: Coral fragments collected from bycatch were grown in laboratories and replanted on the Condor Seamount. Landers were deployed over 100m below sea level.



Coral gardens in the Azores, Portugal © Oceano Azul fundacao, IMAR Azores, Atlas, MERCES

FINDINGS FROM THE FIELD

Restoring deep-sea habitats

Seamounts, canyons, vents and fjords act as oases for life in the deep sea and are home to species found nowhere else, such as cold-water corals. Restoration of such habitats is pioneering with new techniques being trailed in MERCES.

See MERCES 'Effectiveness of tools and techniques for restoration the deep-sea' for more information on how to restore effectively.

22 sites including

3 sites restoring *Viminella flagellum*

6 sites restoring *Dentomuricea meteo*

3 sites restoring *Callogorgia verticillata*

*Sites include the restoration of multiple species

Restoring deep-sea habitats – aligning science and policy

Deep-sea habitats host one of the most extensive ecosystems on Earth and play a key role in the providing essential goods and services for human well-being. The following concepts have been identified for consideration in deep-sea habitat restoration efforts:

- **Long-term monitoring and management:** Given the slow growth rate of deep sea habitats, restoration measures are needed to ensure the long-term process of restoration continues. Restoration actions need to mirror ecological recovery time period for individual species.

- **Removing pressures:** Cold-water coral habitats are sensitive to a range of human activities. These include exploration, extraction and commercial bottom fisheries. The latter is considered the major pressures, often resulting in the removal of entire communities. Due to cold water corals having a slow recovery potential, the reduction of such pressures should be a priority before starting and during long-term restoration actions.

- **Combining active and passive restoration:** Due to the remoteness of these habitats, restoration actions are highly dependent on expensive technologies (e.g., large ships and remotely operated vehicles (ROVs). With deep-sea habitat restoration actions being costly in comparison with shallow-water habitats, this may reduce the capacity and feasibility for large-scale restoration actions. Thus, a combination of restoration approaches will likely be necessary, with assisted regeneration at small scales and natural regeneration (through fisheries closures, marine protected areas) at large scales.

MOVING FORWARD

Reflecting across all 128 MERCES restoration sites provides a unique opportunity to identify best practices, highlight knowledge gaps and improve the effectiveness and efficiency of future restoration.

Importance of a baseline, a goal and a monitoring framework

Restoration is often conducted without a specific end goal or target. Before a restoration action is started, greater consideration needs to be given to what changes are desired, by when and how changes through time can be monitored in order to evaluate success. The Legally Binding Instrument for restoration provides such an opportunity to set baselines, goals and accompanying monitoring frameworks.

Quantifying and communicating the benefits of restoration

Changes in ecosystem services following restoration are not routinely studied or included as criteria of success. Consequently, it is currently difficult to make an evidence-based "business case" for restoration and evaluate trade-offs and scenarios. There is therefore a pressing need to quantify the services provided to nature and people in order to communicate and champion the wide-reaching benefits it provides. *See MERCES 'Social Cost and Benefit Analysis Summary for Policy Makers' for more information.*

Selecting an effective and resilient restoration approach

Restoration isn't a short-term fix and should not be done without considering the wider ecosystem. In order to deliver long-term, ecosystem-level changes, practitioners must consider the environmental and anthropogenic context of each site and select and perhaps modify the most effective restoration technique. *See MERCES 'Restoration of Marine Ecosystems: A Manual for Users' for more information.*

MOVING FORWARD

Defining restoration success

Success needs to be determined on a site-by-site basis, depending on the habitat and restoration action. Criteria utilised within MERCES included survival, growth rates and increasing biodiversity. The effectiveness of actions was determined by making comparisons to control sites, historical data and healthy ecosystems. Data, including criteria of success for each MERCES site, can be found at *WCMC.io/MERCES_StoryMap*.

Investing in the process of ecosystem restoration

Restoration is a long-term process, with some marine ecosystems taking decades to fully recover and deliver potential ecosystem services. Only through continued monitoring can we understand the changes and recovery rates of individual species, habitats and ecosystems and their associated ecosystem services. Such actions require investment in sustainable funding mechanisms that match restoration timeframes and deliver upscaling required to meet global goals and targets. See ‘Restoring marine ecosystems cost-effectively: lessons learned from the MERCES project’ for more information.

Azores © Oceano Azul fundacao, IMAR Azores, Atlas, MERCES

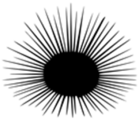
Learning from failures

As an innovation-driven project, MERCES provided an opportunity to learn from unsuccessful techniques to better inform future efforts. 45% of the sites reported their restoration actions were unsuccessful during MERCES, calling for greater investment in research of effective methods.

Box 2. Factors impacting restoration success

Oceanographic

In changing seas, local oceanographic conditions affect restoration efforts. Several transplants were lost in storm surges and sites were affected by warmer sea termperatures.



Ecological

The presence of parasites, invasive species and predation from grazing invertebrates, such as sea urchins, affected several sites.

Technical

MERCES enabled new techniques for restoration to be tested. Lessons were learned regarding the artificial substrates used and the methods for attaching transplants.

Comparison

For some restoration sites, there was no measured change in the habitat when compared to control sites of natural habitat.

Cancer pagurus, the brown crab,in Ølbergholmen Island, Norway © Eli Rinde, MERCES

BIOTIC & ABIOTIC PRESSURES - In Ølbergholmen Island, Norway, predation from *Cancer pagurus* crabs and intense waves caused by winter storms destroyed the reintroduced *Zostera marina* seagrass.

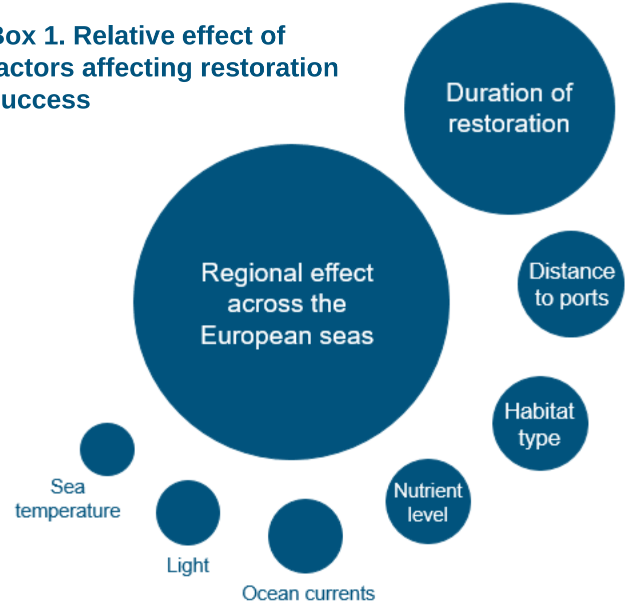
Coral gardens in the Azores, Portugal © Oceano Azul fundacao, IMAR Azores, Atlas, MERCES

Location matters

In which regional sea the restoration efforts were located had the largest effect on success (30%), closely followed by duration of the action (22%) and the distance to the nearest port (10%).

This highlights the importance of accounting for local context and anthropogenic pressures when undertaking restoration. There is a pressing need for further research on the effectiveness of restoration efforts in different localities and under a variety of environmental and human pressures.

Box 1. Relative effect of factors affecting restoration success



MOVING FORWARD

Habitat- and region-specific approaches

By exploring restoration of 35 important habitat-forming species in 128 locations, MERCES provided the unique opportunities to compare across habitats, approaches and regions. It is evident that different habitats and regions have different challenges and different factors that impact recovery success. This means the there are many roads to success and failure. We therefore require restoration protocols to be habitat- and region-specific, with methodologies that are tailored rather than standardised. Such methodologies need to consider:

- The choice of the donor and recipient sites – to ensure that the restoration site has suitable physical conditions and biological characteristics, as similar as possible to that of the donor site.

- The identification of the best transplantation methodology – a multitude of transplantation techniques exists for different species and habitats. The choice of the right technique (or combination of techniques) requires reviewing existing literature and outcomes of previous restoration projects.

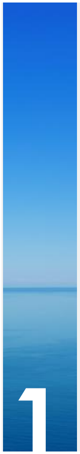
- Understanding the influence of positive species interactions – the presence of species could improve survival by for instance providing habitat or refuge, which may speed up the recovery. Instead of only minimizing competition and predation, restoration actions should also focus on positive, including co-restoration of several habitats.

- Understanding the potential for regime shifts – if the habitat is prone to regime shifts, in-depth understanding of the drivers, feedback effects and critical thresholds for the shifts, including the interaction between species (positive and negative) and local and global stressors, is needed.

RECOMMENDATIONS

2021 marks the start of the UN Decade on Ecosystem Restoration, the UN Decade of Ocean Science for Sustainable Development and the development of EU Legally Binding Instrument for restoration under the EU Biodiversity Strategy 2030. The high political will and support from civil society surrounding ecosystem restoration provides a unique opportunity to implement and upscale effective and sustainable marine restoration across European seas and beyond.

The following recommendations draw together findings from MERCES with the view to informing coordinated upscaling of marine and coastal restoration across Europe.



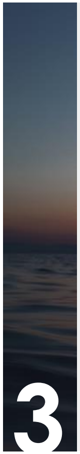
Coordinate policies & practice

Increased coordination of national, European and international action and policy to maximise the impact and efficiency of restoration efforts. The EU Biodiversity Strategy 2030 and Legally Binding Instrument for restoration offers a unparalleled opportunity to develop national and regional restoration goals and targets in alignment with other processes relating to the blue economy and related MEAs, such as the CBD and UNFCCC.

Provide long-term funding

Restoration requires long-term, sustainable financing to be successful. With some marine ecosystems taking decades to fully recover, funding commitments need to match these timeframes. Innovative funding and cross-sectoral collaborations are urgently needed to support the design, implementation and long-term monitoring of sustainable and effective restoration efforts.

All findings and resources are available at www.merces-project.eu

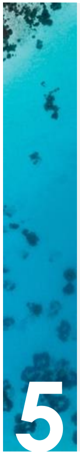


Prioritisation and Upscaling

In order to deliver transformative change, marine ecosystem restoration must be upscaled and undertaken in parallel with terrestrial and freshwater restoration efforts. In the context of climate change and urban expansion, restoration actions need to be prioritised in order to ensure restoration efforts are effective and resilient as well as delivering maximum carbon and biodiversity benefits.

Research and communication

There is a need to better understand and communicate the pathway to restoration success, including the time scale and the thresholds that need to be passed in order to stimulate a tipping point for nature and the provision of ecosystem services. The UN Decades on Ecosystem Restoration and Ocean Science for Sustainable Development offer a catalyst for such necessary research.



Tackling the root of the problem

As part of the mitigation hierarchy, restoration actions should be paired with supportive and robust management practices that reduce anthropogenic pressures. Addressing the root cause of ecosystem degradation and loss is vital. Restoration policies and activities under the EU Biodiversity Strategy 2030 must therefore seek to target pressure reduction, from the sea and on land, as well as undertake effective and sustainable restorative actions.

Collaborations for change

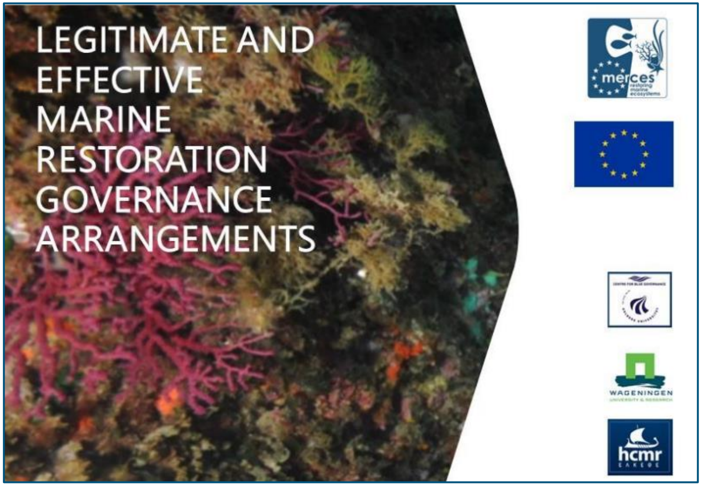
From increased social awareness for civil society to greater engagement with the private sector, there is a need to build trans-disciplinary collaborations to deliver effective restoration. The importance of cross-sectoral and inter-disciplinary collaboration is core to the global success of the UN Decade on Ecosystem Restoration and the regional and national success of the EU Biodiversity Strategy 2030.

All findings and resources are available at www.merces-project.eu

FIND OUT MORE

Find out more in our series of Summaries for Policy Makers

View all MERCES resources, including project outputs, practitioner manuals and summaries for policy makers at: www.merces-project.eu



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