What is causing restoration of habitats in Europe to fail or succeed?

Figure 1. Map of the restoration sites included in the MERCES project.

Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
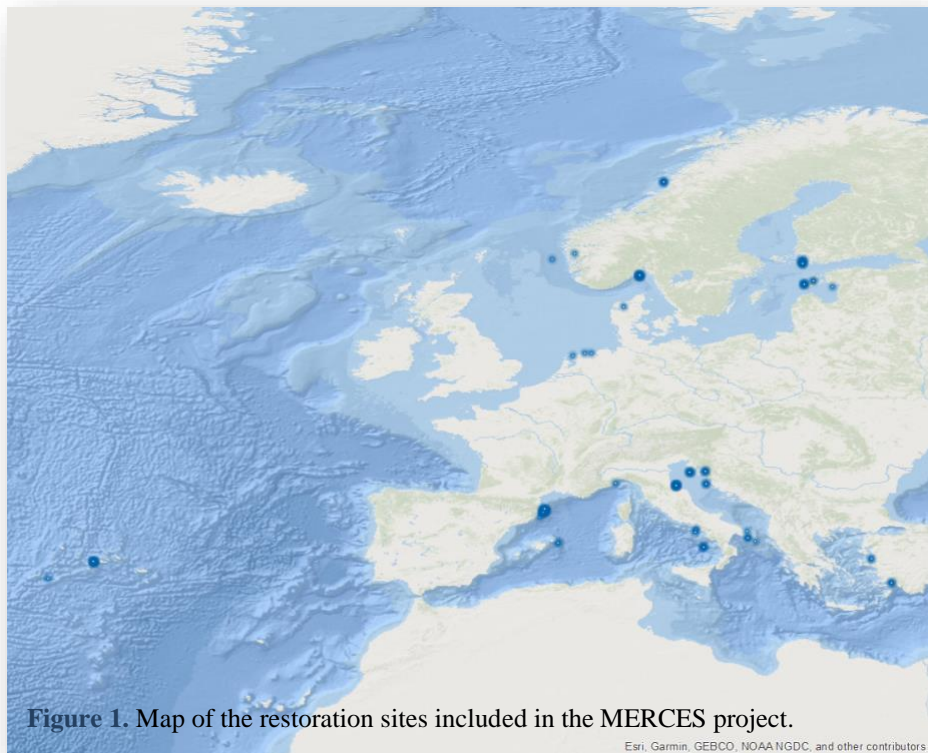
The aim of this work has been to analyse the recovery efficiency and potential of different habitats across Europe.

The MERCES project **restoration sites** are shown in Figure 1. The **focal habitats** were seagrass meadows, macroalgae beds, kelp forests, seamounts and coralligenous assemblages (Figure 2). More information on the data and models used in the analyses is found in the Supplementary report.

A definition of success was needed for each individual site to measure the impact on and benefits for restoration. The success criteria varied; survival of transplants was the most commonly used criterion for success (in 73% of the cases), but recruitment and survival of recruits were also a commonly used criteria (22% of the cases).
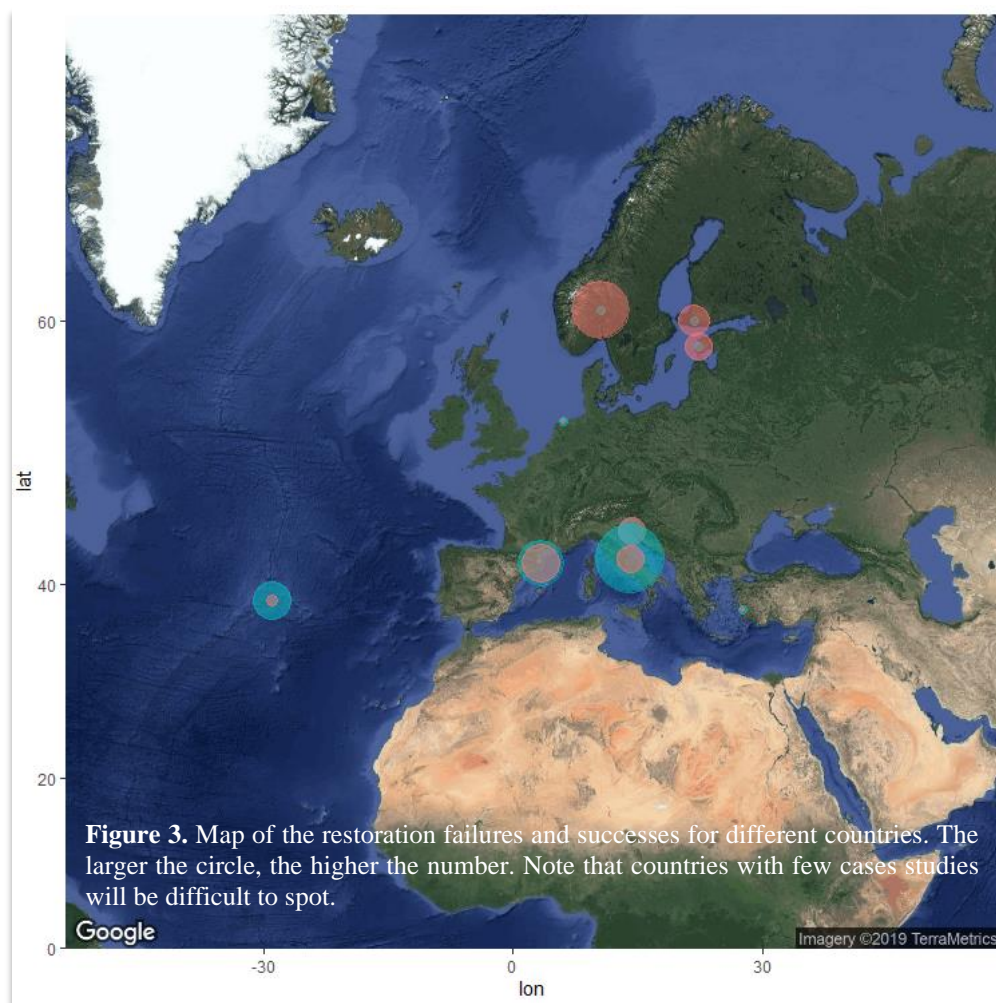
Overall results showed that restoration took place at 128 sites, in 12 countries (from Norway to Turkey), by 28 partners and over a period of maximum 4 years. Most of active actively restored habitats (110 sites) restoration (82%) used experimental techniques, sometimes combined with more established methods. Most of the sites (59%) were restored by transplanting the focal species or habitat, but also transplanting a second species (such as blue mussels in order to enhance conditions) was common (12%). Other techniques include removal of species (such as destructive grazers) and enhancing settlement and recruitment (using for instance growth plates and seed injections).

Almost half (41%) of the actively restored sites were successful

Seamounts had the highest success rate (77%) amongst the actively restored cases, followed by macroalgae beds (46%), coralligenous assemblages (41%), seagrass meadows (35%) and kelp forests (25%, which was only one success). As MERCES tested new restoration techniques, such as artificial substrates and methods for attaching transplants, more restoration attempts may have failed that if more traditional methods were applied. Figure 3 shows the number of successes and failures on a map.


A

B

C

D

E

Figure 2. Pictures of the focal habitats analysed in this study. A: seagrass meadow (*Zostera marina*), B: macroalgae bed (*Treptacantha elegans*), C: kelp forest (*Laminaria hyperborea*), D: seamount with octocorals (*Callogorgia verticillata*, *Acanthogorgia* sp. and *Dentomuricea*) and E: coralligenous assemblage. Photos by Christoffer Boström (A), Alba Medrano (B), Janne K. Gitmark (C), EMEPC, ROV Luso (EMEPC/Luso/Açores/2009) (D) and Cristina Linares (E).

Figure 3. Map of the restoration failures and successes for different countries. The larger the circle, the higher the number. Note that countries with few cases studies will be difficult to spot.

Much of the variation among sites was highly related to habitat type, which makes analysing the overall effect of the environmental variables difficult.

There was also *a large regional effect*, captured by the level of dissolved oxygen and many successes in the Mediterranean Sea and the Azores compared to other regions.

Figure 4. Donut chart of the duration of the restoration activity in this project
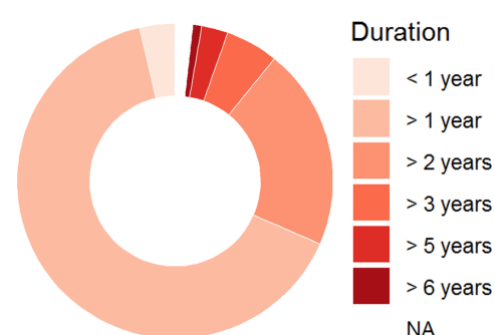
The duration of the restoration effort had a positive impact on the restoration success, which underlines the need for setting aside enough time for the restoration activity. In most of the cases (61%) the restoration lasted between 12 and 24 months, but some lasted shorter (8%) and some longer (31%), Figure 4.

Distance to main port had an impact on restoration success, and the results indicated that anthropogenic disturbance and pressure decreases the potential for restoration success.

Even though light, temperature, nutrient conditions and overlap with areas of management interest explained a lot of the variation on the data, the effects that these variables have on restoration success is not so strong or clear, and more in-depth analyses is needed in the future.

Analysing the *presence of pressures* on restoration success revealed no pattern. Such pressures might for instance be nutrient enrichment, introduction of non-indigenous species or temperature and wave exposure changes. The same was the case when looking at the *number of pressures* at a site, both for all habitats together and when looking at each habitat separately. The intensity of the pressures (e.g. heavy smothering or high densities of non-indigenous species) and the type of pressures (e.g. physical, such as abrasion, or biological, such as introduction of pathogens) will be important. However, this was beyond the scope of this work, and we suggest that this is studied on more detailed in the future.

The presence of different *ecosystem services* was identified for each habitat in each case study area. Ecosystem service restoration needs to be assessed to identify policy recommendations, including identification of ecological bottlenecks, thresholds for effective ecosystem service restoration and upscaling to the correct management level. It is tempting to believe that restoring the habitats will restore ecosystem services. However, whether or not this is true has not been possible to assess from the data collected during the MERCES process. We suggest more focus on this in the future.

Marine Ecosystem Restoration in Changing European Seas MERCES

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