

The marine restoration digital toolbox

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Why make a “digital toolbox” for marine restoration best practices?

- Marine restoration community is small but developing
 - EU Nature Restoration Law (adopted June 2024) will lead to rapid community growth
 - Potential for greenwashing!
 - Difficult to say what is “successfully restored”, what methods to use for monitoring, where to find permit/funding guidance and much more



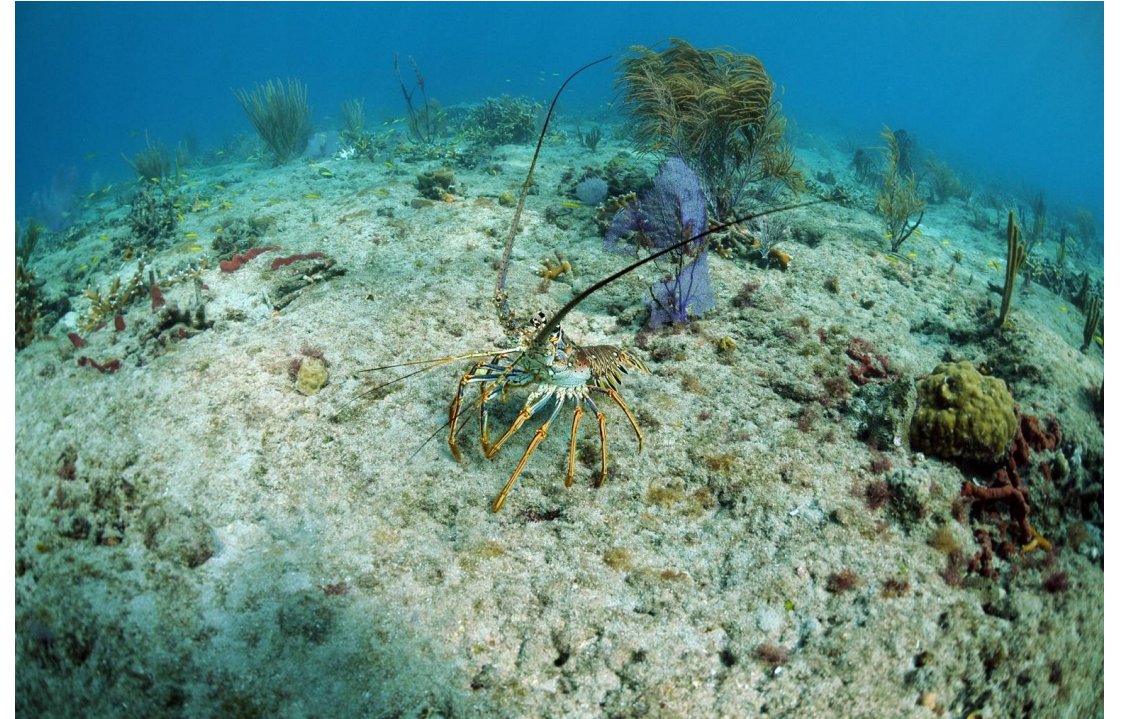
What is the digital toolbox?

A series of interactive applications to support the development, implementation, and monitoring of marine restoration projects.

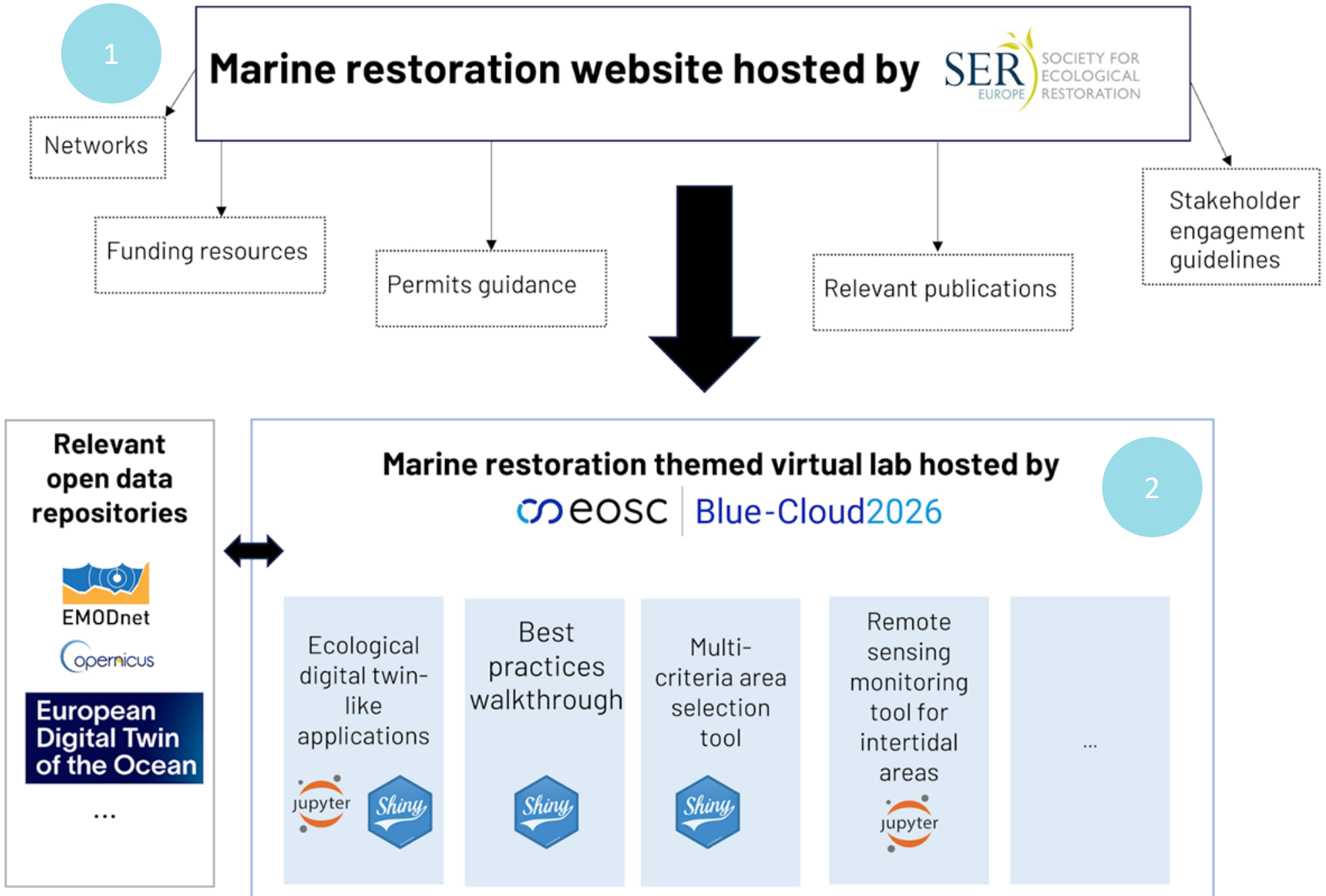


How does the toolbox accomplish this?

- 1) Direct users to existing resources/networks [through our website hosted in SER's Restoration Resource Centre]
- 2) Produce tool demonstrators [hosted on Blue-Cloud]



Marine restoration toolbox

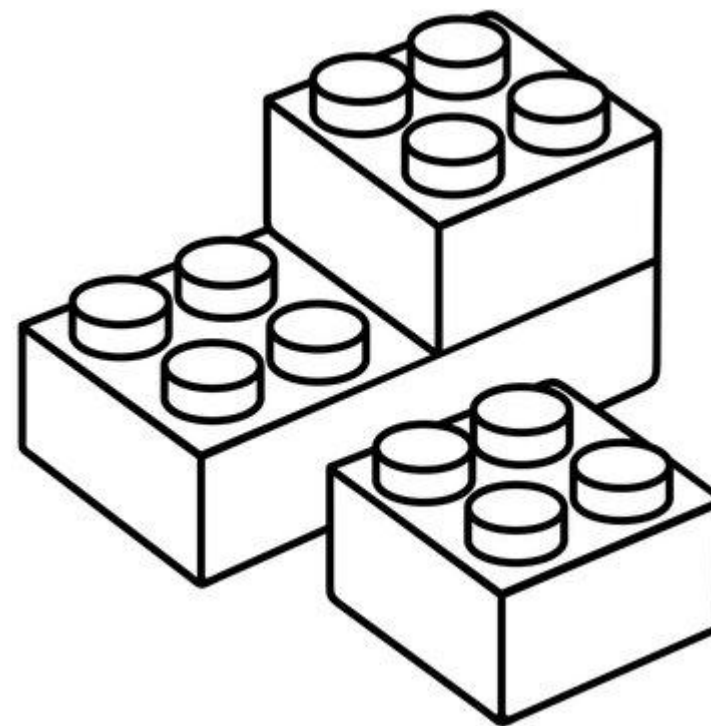


A fully modular collection of tools

Possible to add new tools

- Open to the inclusion of new habitats
- Using platforms/infrastructure that is already familiar and common for ease of system transfer

All dimensions of the toolbox are possible to build off of



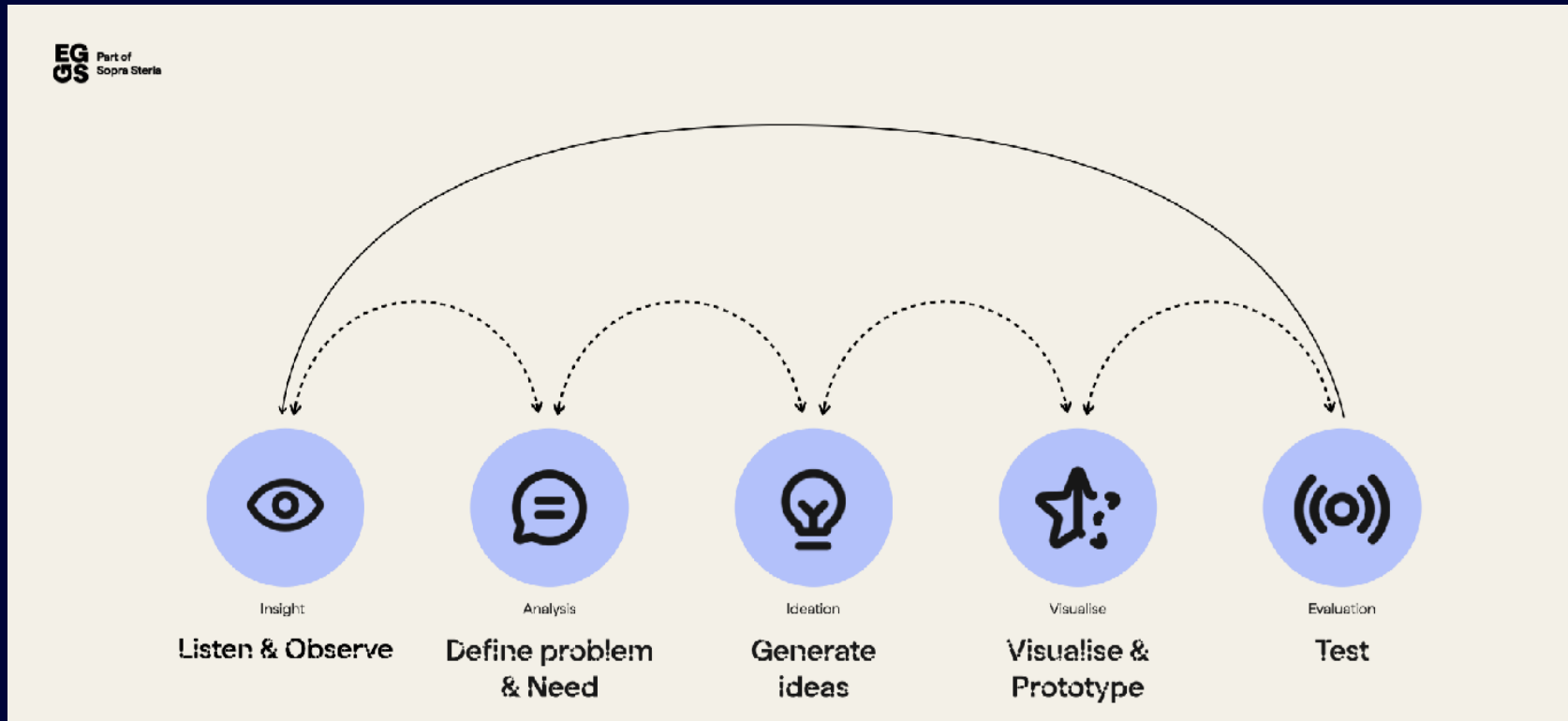
The challenges behind open science

Sense of data “ownership”

- “Publish or perish”
- Lack of knowledge in the ecology community about how to implement FAIR principles
- Feeling making data available (e.g., through EMODnet) is not pressing/difficult/additional challenge



A recap on the website (co)-design process



Who will use the marine restoration toolbox?

- Worked with a design firm to help defining users and their needs
 - Made “user profiles” based on interviews with potential users
 - Website design/content based on users’ needs/wishes and “user journey”



Sally Restoration practitioner

“ One time we found a good location by our own measurements. Then we saw that the location was red marked on the Government’s map, whilst their green marked locations were according to us, not good. The reason for this were Hydrodynamics (water parameters) - the Government didn’t get enough data. The current wave action was the problem. ”

Background

Sally works as a restoration practitioner for a small company that restores ecosystems. From early on in her career, Sally learned that each site is different, and solutions for one site cannot be replicated for another. Therefore, they have to spend a lot of time collecting data for finding a good location and best practices to adapt to the specific conditions of the site, for each project. Sally dreams about an interactive map where they can add data and quickly determine whether an area is likely to be successful or not. Additionally, she envisions a library where best practices and experiences can be shared.

Challenges

- **Lack of methodologies** or instruments for marine restoration
- There is no solution that fits all which makes the process complicated
- It’s **hard to know what location that is good** and meets all the requirements for a restoration

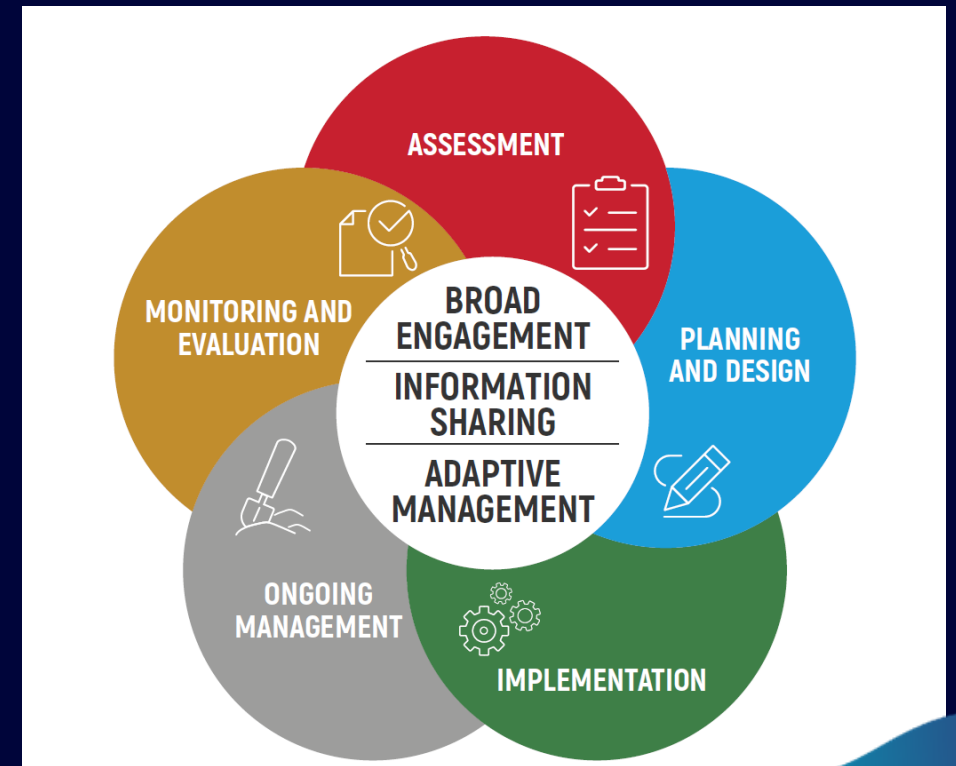
Wishes

- Adaptable and flexible **guidelines**
- Feasible and **practical methods**
- Interactive map (containing all data needed) to be able to **see if an area is likely to be successful or not**
- Enabling easy **sharing of experiences and best practices**



Example of how the “user journey” informed the website design

- The “sock drawer” problem
- Structure follows the “Standards of Practice to Guide Ecosystem Restoration”
- Iterative testing (SER conference, here)



The Blue- Cloud marine restoration virtual lab

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What is in the marine restoration virtual lab?

- 2 tools currently online
- 7 more in planning phase (5 digital twins, 1 multi-criteria area selection tool, 1 more system-specific protocol development tool)



Blue-Cloud2026

A federated European FAIR and Open Research Ecosystem
for oceans, seas, coastal and inland waters



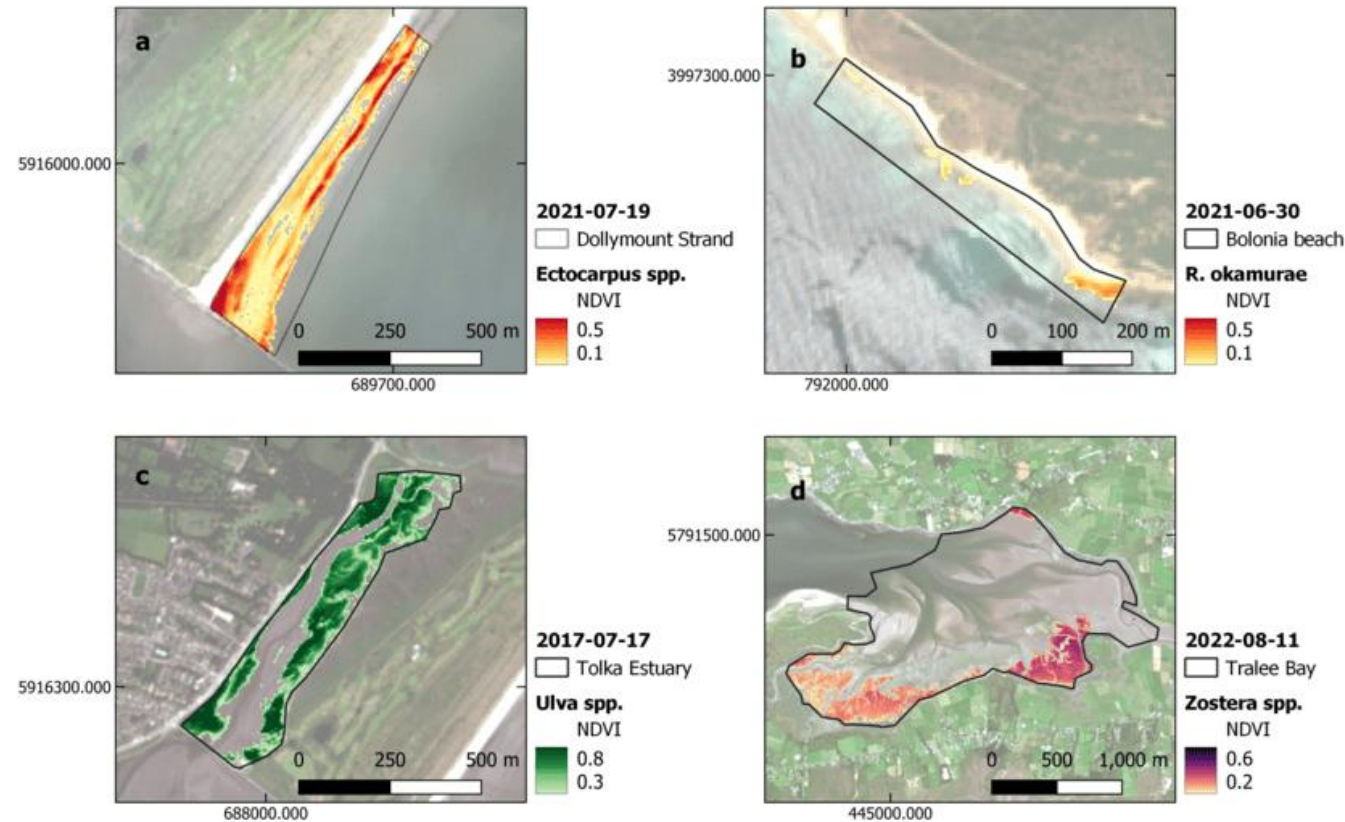
Tool catalogue
(can be
accessed on
marine
restoration
toolbox)

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Aims of our tool

- Monitoring intertidal habitats using remote imaging is difficult due to tides and cloudy days
 - BioIntertidal mapper selects images where tide is low and no clouds
- In our tool, we allow for selecting indices beyond NDVI
- Making the work accessible to people not able/willing to read a journal article for academic audience (in a Jupyter notebook with text explanations)



Haro et al. 2023



[MRVL Tool Catalogue – Marine Restoration Toolbox](https://climarest.wpenginepowered.com)
climarest.wpenginepowered.com

BioIntertidal Mapper Tool

- This tool is aimed at being used during the monitoring phase of projects
- The primary target user groups are restoration practitioners and researchers

Brief description of tool: This tool can be used for monitoring changes to the area extent of seagrass, macroalgae, and macrophytobentos over time in intertidal areas using remote sensing data. The Jupyter Notebook on Blue-Cloud first provides a walk through for users to register and use Copernicus' data services to access satellite images from the Sentinel-2 program. The tool then demonstrates how to pull images and filter out images with a user-determined amount of cloud cover as well as images where the area of interest is covered by the tide.

[Go to tool](#)

[Read more on BioIntertidal Mapper](#)

[Sentinel-2 Data Access](#)



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Filter files by name

/ ... / EcologicalRestorationLab / Bio-intertidal-mapper /

Name	Last Modified
downloads	4 months ago
shapefiles	4 months ago
processing.py	3 months ago
README.md	3 months ago
requirements.txt	3 months ago
seagrass_detect...	3 months ago

Tool for monitoring intertidal ecosystems

Who this tool is for and the tool's aim

This is a tool aimed at **restoration practioners** monitoring an area, **scientists** and **area managers** (e.g., working for municipalities, federal agencies, consultants) monitoring the success of a restoration action aimed at an intertidal habitat. Examples include the restoration/rehabilitation of **microphytobenthos**, **seaweeds**, **seagrasses** and **macroalgae forests**. Here we walk you through how to use free satellite images that are collected regularly through the Copernicus program (from the ongoing SENTINEL-2 mission) to measure the percent cover of an intertidal area.

This tool aims to make the functionality in BioIntertidal Mapper - the work of Haro and colleagues (<https://www.sciencedirect.com/science/article/pii/S2352711023002169>) - more easily accessible for non-experts wanting to monitor their own area.

We will provide an adaptation of the Python code created by Haro and colleagues in the form of a Jupyter Notebook and apply it to an example for a gentle introduction to a tool made for monitoring intertidal habitats. Specifically we will show BioIntertidal Mapper can be used, with detailed information on what code elements you can change to adapt to your unique case.

```
[1]: # Necessary imports
import processing
import openeo
```

Create a connection with dataspace.copernicus.eu.



[MRVL Tool Catalogue – Marine Restoration Toolbox \(climarest.wpenginepowered.com\)](https://climarest.wpenginepowered.com)

Macroalgal Forest Protocol Development Tool

- This tool was created with the aim to be used in the development phase of projects
- The primary target user groups are both restoration practitioners and from local government authorities/regulatory agencies

Brief description of tool: In this survey, users walk through a series of questions rooted in SER's best practices guidelines, tailored to macroalgal forest restoration. Through going through the survey, users are asked questions that should be addressed in the protocols they develop actions targeting the restoration of macroalgal forests. The survey refers users to a number of resources that may help users answer the survey. The survey is a simple interactive web application, and questions and user responses can be downloaded as a csv file.

[Go to tool](#)

[GOOS Macroalgal Canopy Cover and Composition Spec Sheet](#)



GET STARTED RESTORING A MACROALGAL FOREST: A WALKTHROUGH OF BEST PRACTICES

This survey is a tool aimed to help those restoring macroalgal forests collect the right data to develop, implement, and monitor their restoration action. The walkthrough helps users ask the right questions of themselves and stakeholders before implementing actions, including reflecting on whether restoration is the appropriate action to take in an action.

Question 1: What kind of restoration action are you developing?

- Ecological Restoration (as defined by the Society of Ecological Restoration): the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed.
- Assisted regeneration (as defined by Society of Ecological Restoration): Restoration at sites of intermediate or greater degradation requires removal of the causes of degradation and active interventions to correct abiotic and biotic damage and trigger biotic recovery (e.g. by mimicking natural disturbances or by providing key resources).
- Rehabilitation (as defined by the Society of Ecological Restoration): The goal of rehabilitation projects is not native ecosystem recovery, but rather reinstating a level of ecosystem functioning for renewed and ongoing provision of ecosystem services potentially derived from nonnative ecosystems as well.

Survey completed

Thank you for completing this survey. Your survey has been submitted. Click the button below to download your results.

 Download CSV

Question 12: What

- Genetic vari
- Status of the
- Donor popul

Question 13: What techniques will you employ?

- Removal of stressors
- In situ transplant
- Ex situ transplant

Question 14: What target species indicators are you measuring?

Example: "Canopy cover"

Question 15: What ecosystem-based indicators are you using?

Example: "Species Richness of Associated Marine Fauna"

Submit