3rd Natura 2000 biogeographical seminar for the
Mediterranean and Black Sea marine regions
12-14 March 2024, Marseille
Palais du Pharo, Marseille, France

REEForest Life- Restoration of *Cystoseira* macroalgal FORESTs to enhance biodiversity along Mediterranean rocky REEF

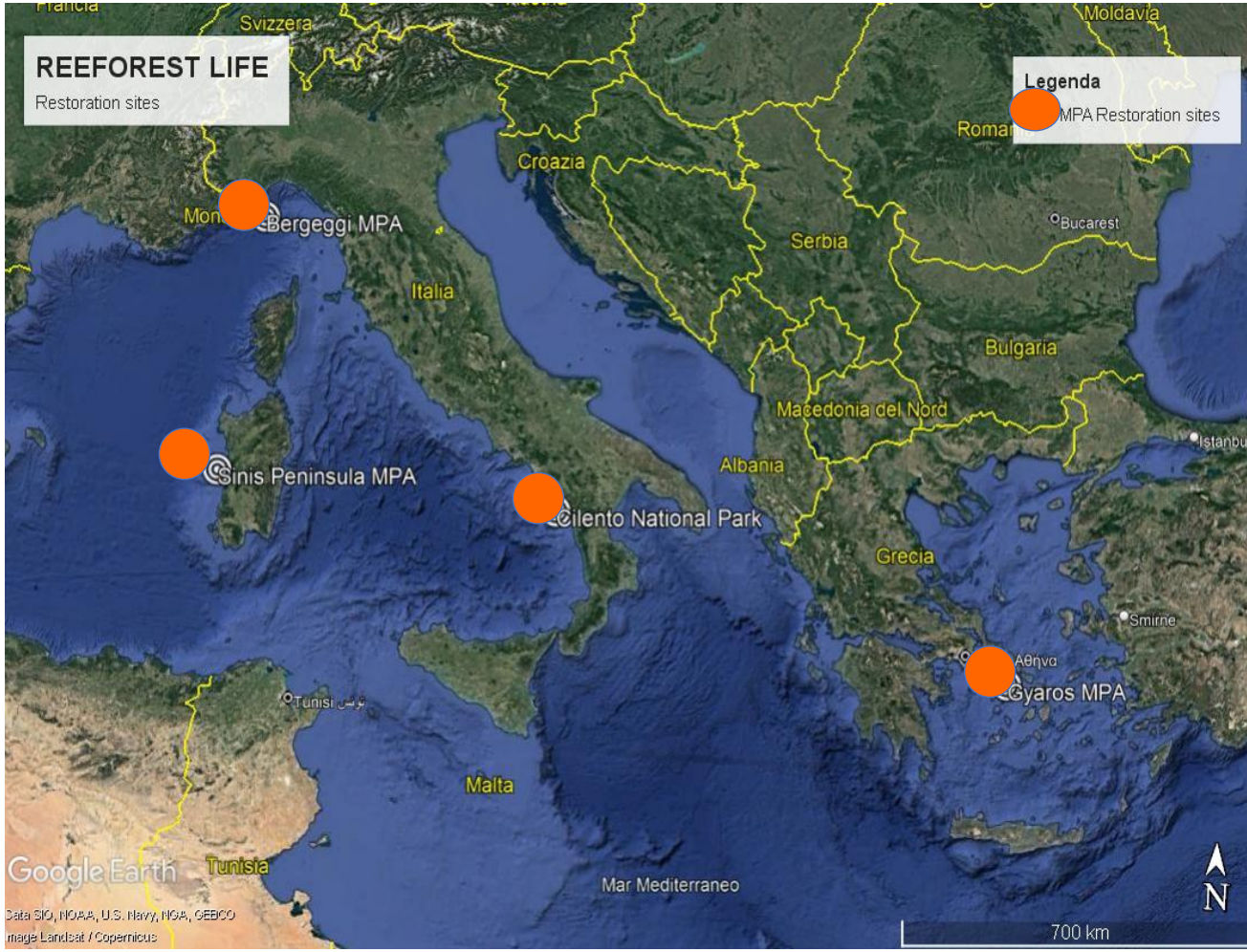
Annalisa Falace
University of Trieste, Italy

Natura 2000 Biogeographical Process in the Marine Regions

REEForest aims TO RESTORE the ENDANGERED *CYSTOSEIRA* ALGAL FORESTS in 4 MPAs WHERE THE CAUSES OF DEGRADATION HAVE BEEN ADDRESSED

PROJECT LOCATION : 4 Natura2000 sites Italy (Bergeggi, Sinis, Cilento MPAs) Greece (Gyaros MPA)

DURATION: Start: 01/09/22 - End: 31/08/26



PROJECT'S IMPLEMENTORS:

Coordinating Beneficiary: University of Trieste

Associated Beneficiaries:

- Univ. Genova
- Univ. Napoli Parthenope
- ISPRA
- HCMR

4 Research Institutes

- Cilento National Park
- Bergeggi MPA,
- Sinis MPA,

3 Marine Protected Areas

- Shoreline

1 Private company

MACROALGAL FORESTS → designate populations of large brown algae

Orders Laminariales, Tilopteridales, Desmarestiales, Fucales

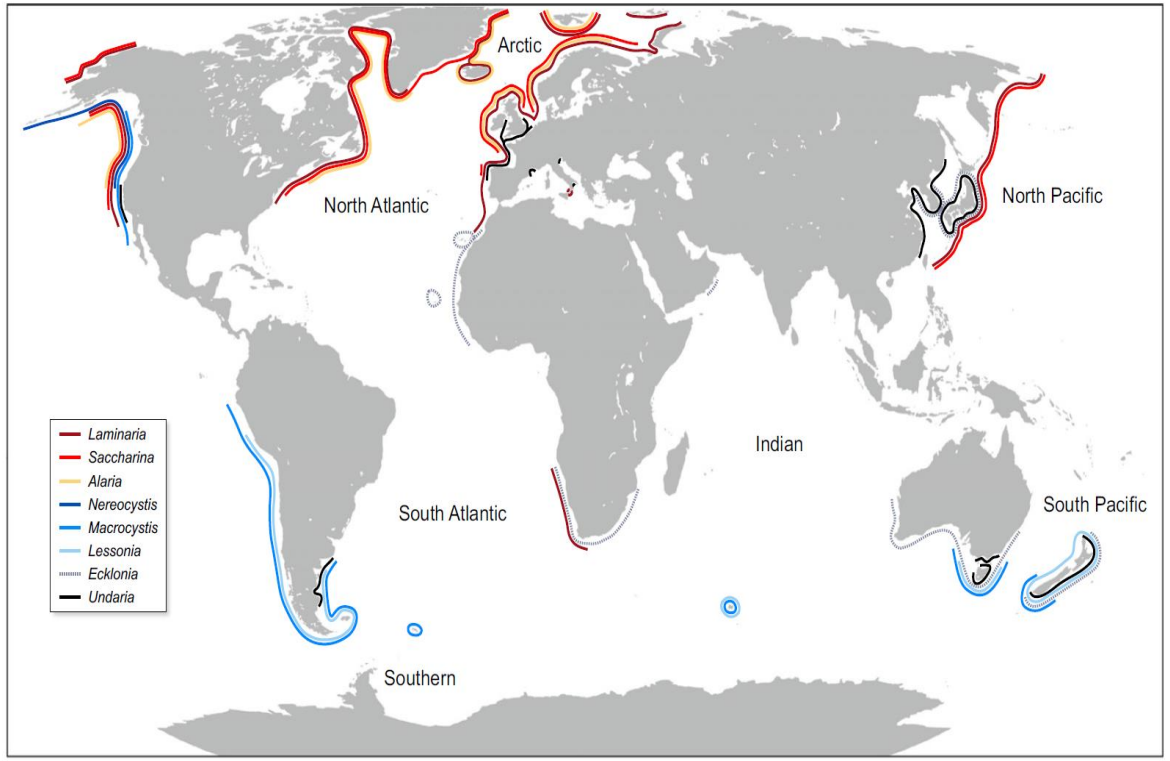
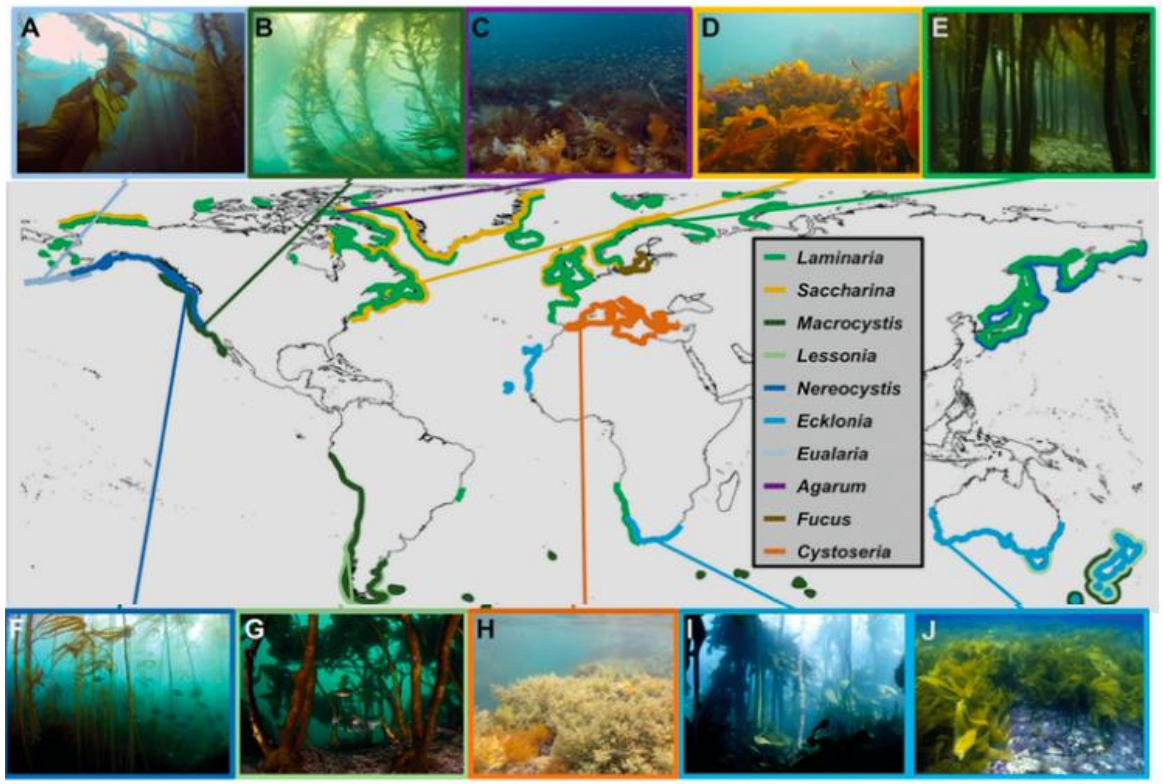


Fig. 1 Approximate global distribution of major kelp genera (Laminariales). Modified and adapted from Steneck & Johnson (2013), Teagle *et al*. (2017) and Wernberg *et al*. (2019).



Wernberg and Filbee-Dexter 2019 *MEPS*

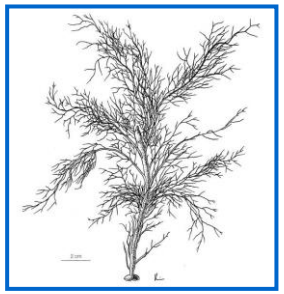
In **Mediterranean** the *Cystoseira* s.l.

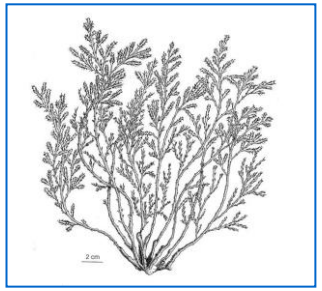
from the **intertidal** to the **sublittoral**

- **40** taxa Atlantic/Mediterranean
- **25 are endemic to the Mediterranean**

great **taxonomic complexity** and **morphological plasticity**

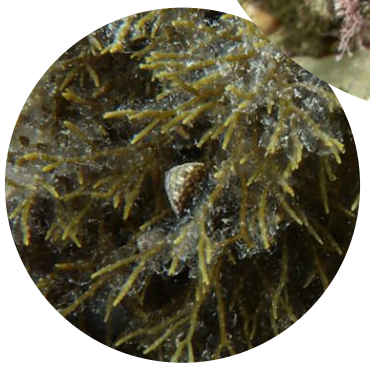
- wide biogeographical distribution
- local ecological conditions (depth, light, temperature, seasonality)
- hybridization between strictly related species

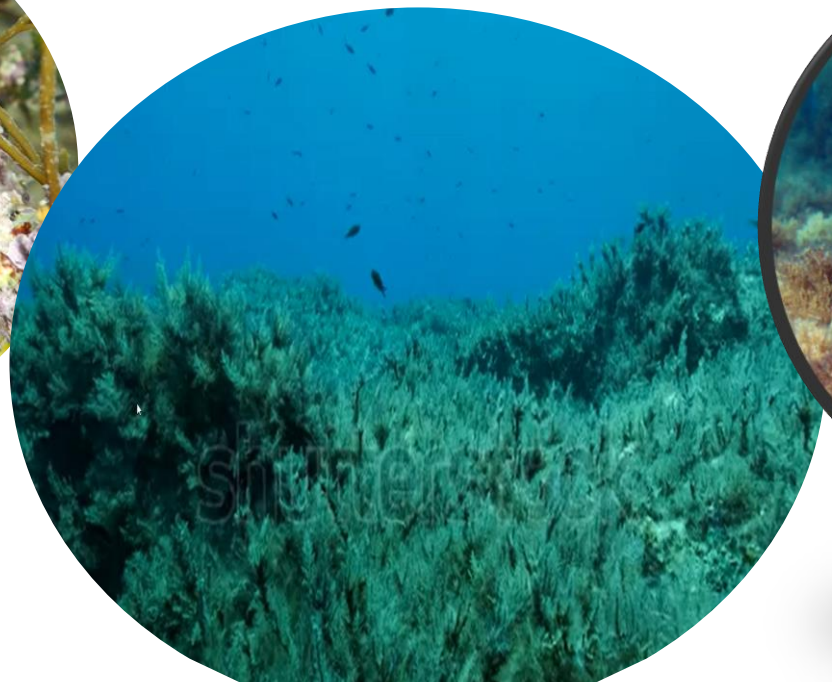




Provision of critical ecosystem services

- ✓ Ecosystem engineers
- ✓ Relevant in coastal food webs
- ✓ Bioindicators of the Good Ecological Status (*sensu* WFD, 2000)





The status of *Cystoseira s.l.* forests

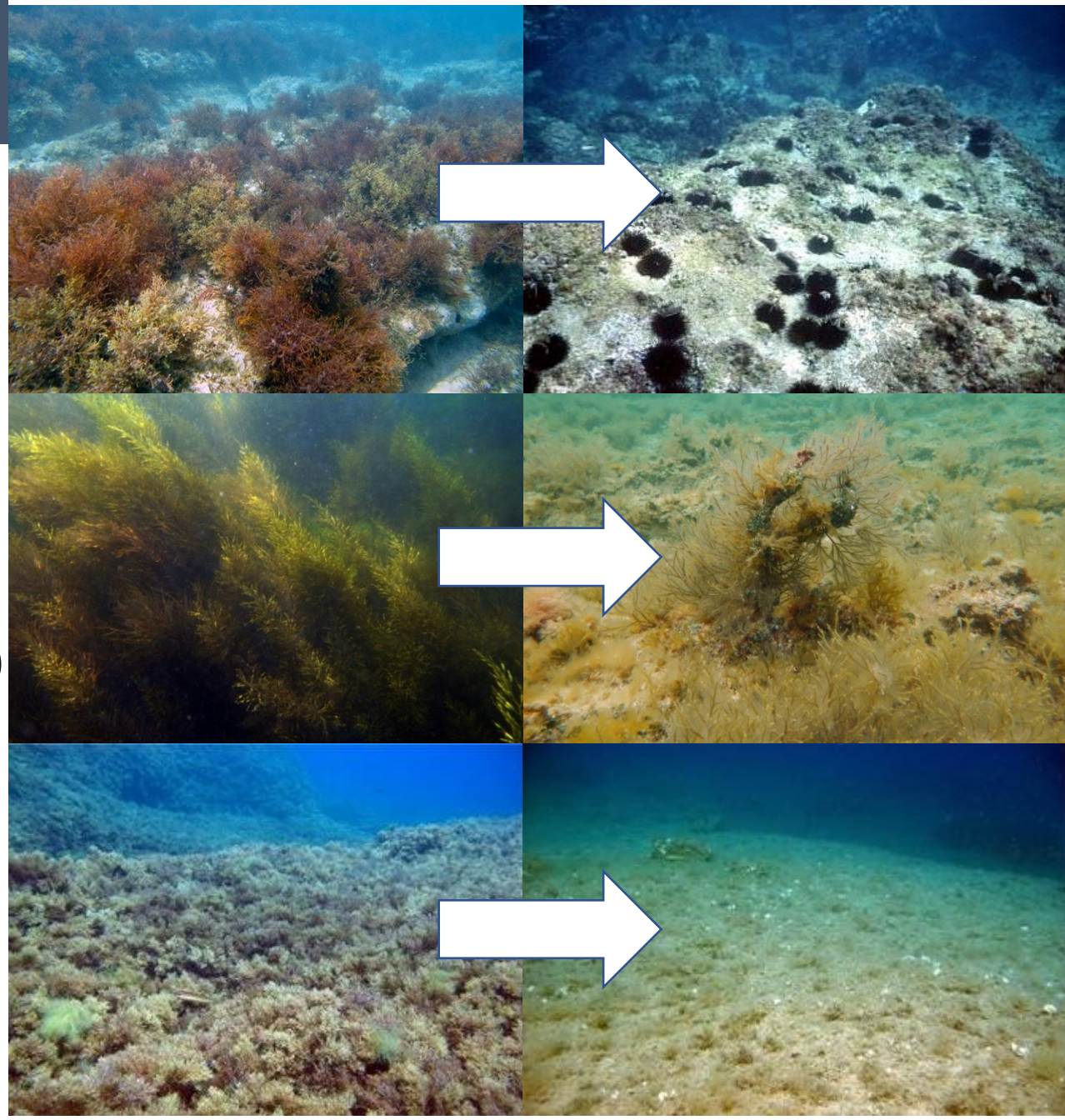
Threatened by Global Changes

- ✓ **Rising temperatures, MHWs**
- ✓ **Eutrophication**

and local impacts

- ✓ **Coastal development**
- ✓ **Low water quality** (runoff-nutrient and metal pollution)
- ✓ **Sedimentation**
- ✓ **Grazing**

REPLACEMENT → **species of lower structural/ecological value**



How to face *Cystoseira s.l.* decline?

PROTECTION

Habitat Directive: 1170 (Reef)

EUROPEAN RED LIST OF HABITATS as **ENDANGERED** (Habitat Type: A3.13)

Bern & Barcelona Conventions

Water Framework Directive

Natural recovery is rare

because of the

limited dispersal capacity

and **rapid zygote sinking**

RESTORATION

UNITED NATIONS DECADE ON ECOSYSTEM RESTORATION 2021-2030

14 LIFE BELOW WATER

SUSTAINABLE DEVELOPMENT GOALS

in line with EU policies as **BIODIVERSITY STRATEGY TO 2030** and **MARINE STRATEGY**, and international policies as the "**DECADE OF ECOSYSTEM RESTORATION**" declared by UN/IUCN and the **GREEN NEW DEAL**

Ecological Restoration in the Med: *Cystoseira s.l.*

- **Project ANIMA Conservación y restauración de poblaciones de especies amenazadas del género *Cystoseira*** Spanish Ministry (CGL2016-76341-R, MINECO/FEDER, UE)
- **CYSTORE © Project** Valorisation écologique des ouvrages maritimes par la transplantation des algues du genre *Cystoseira*
- **Faraglioni of Capri environmental restoration;** financially supported by Municipality of Capri
- **Factors affecting Adriatic brown algal forests and solutions for habitat restoration,** J1-1702 financially supported by the Slovenian Research Agency.
- **RENOVATE Project: ecosystem approach for compensation and mitigation actions in the coastal marine environment**
- **AFRIMED Project**
- **Italian PNRR**
- **etc….**

ROC·POP Life

aimed to restore *Cystoseira sensu latu* species in Marine Protected Areas

REEForest Life

Promoting biodiversity enhancement by Restoration Of Cystoseira POPulations (LIFE16 NAT/IT/000816 ROCPOP.Life)

Restoration of *Cystoseira* macroalgal FORESTs to enhance biodiversity along Mediterranean rocky REEFs LIFE21 NAT/IT/004309 REEForest.Life

The scale matters!!

Restoration at scale of > 500s meters

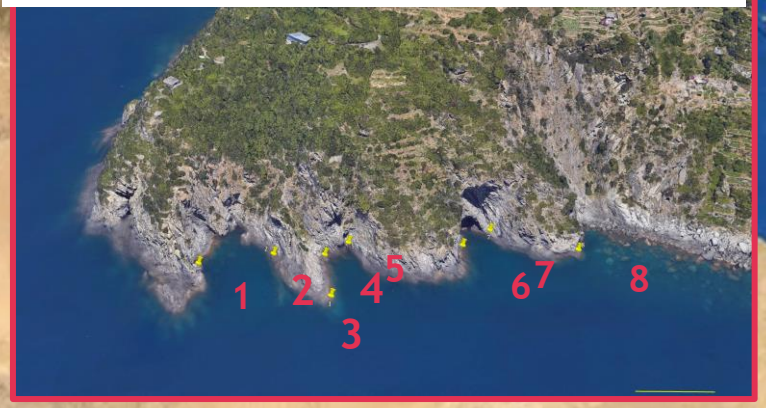
1

2

650 m

1

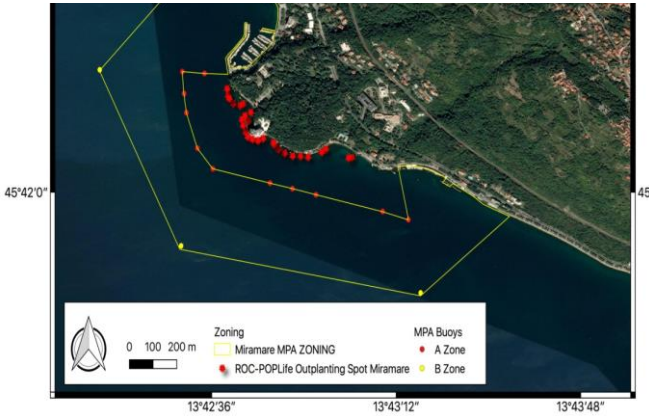
CinqueTerre MPA (Italy)



1000m

2

Gulf of Trieste



ROC·POP Life

Restoration at scale of > 1000s meters by 2026

REEForest Life

1 Sinis MPA
2 Bergeggi MPA
4 Castellabate MPA
5 Gyaros MPA

HOW TO RESTORE?

RESTORATION

where disturbances are no longer present or have been reduced!

- No eutrophication
- No grazing
- Trampling, anchoring, trawling regulated

Data

Historical presence
Causes of loss
Absence of disturbance

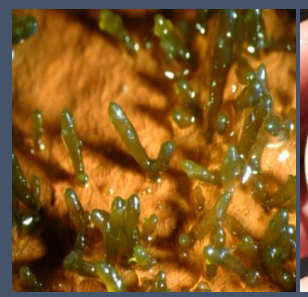
MPAs

TRANSPLANTATION

SEEDINGS

in situ
FERTILE APICES IN THE FIELD

ex situ
LABORATORY-CULTURED JUVENILES



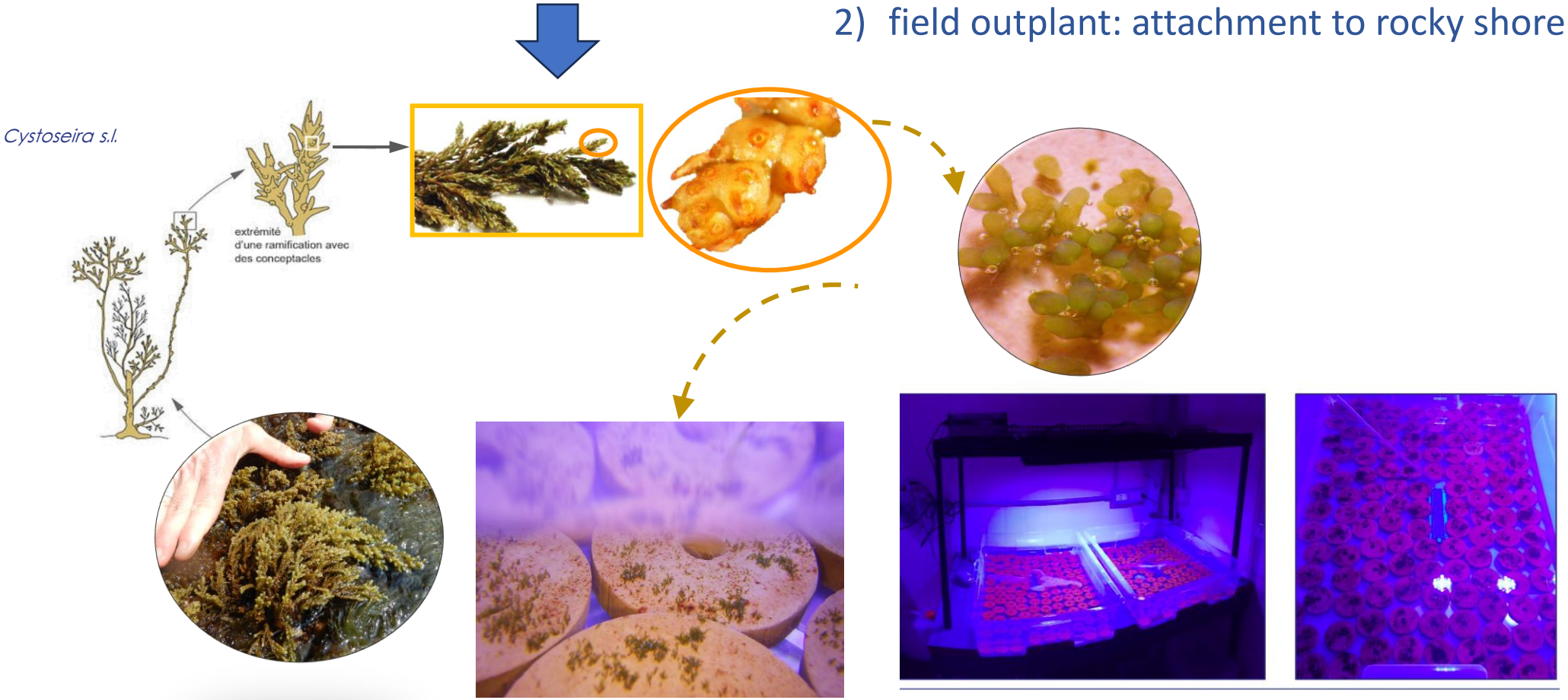
How?

Learning from ROC·POP Life

REEForest Life

<u>Ecologically sustainable approach</u> consisting of two steps:

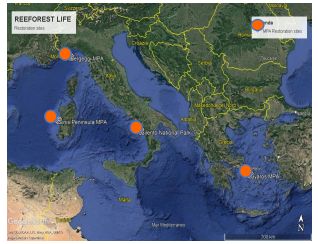
1) germling cultures in the laboratory
2) field outplant: attachment to rocky shore



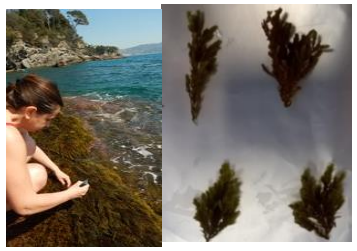
REEForest Life

Ecologically sustainable approach

work-flow



Sites selection



Collection of fertile branches

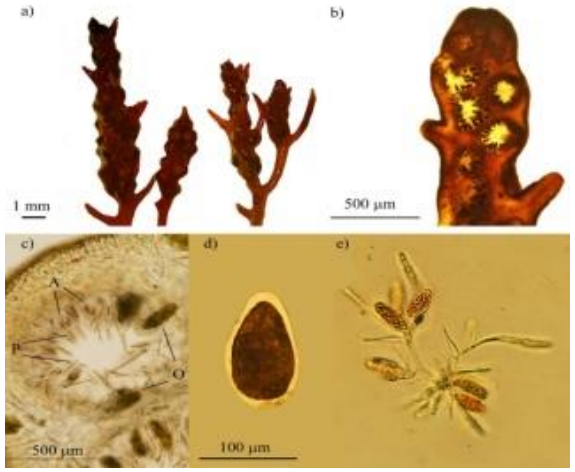
Cultivation

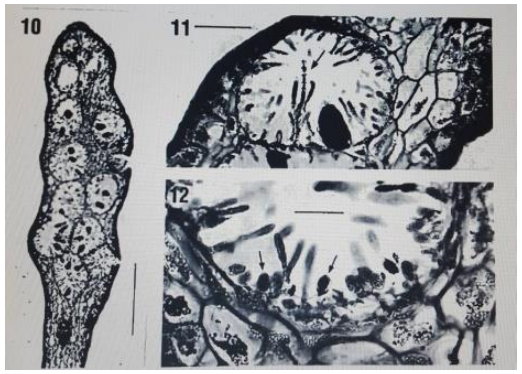
Outplanting

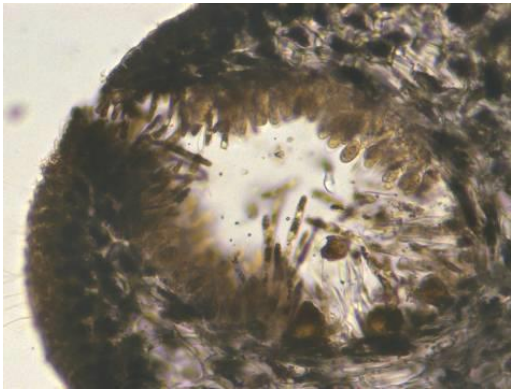
Knowledge of reproductive phenology, embryology and seedling development.

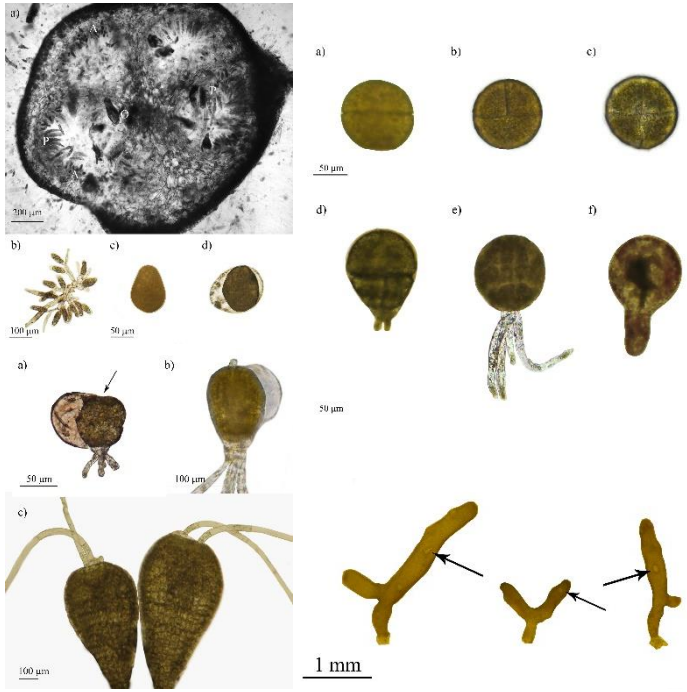
- *E. amentacea*
- *G. barbata*
- *E. crinita*
- *E. barbatula*
- *E. giacconei*
- *E. montagnei*
- *G. nodicaulis*
- *C. zosteroides*

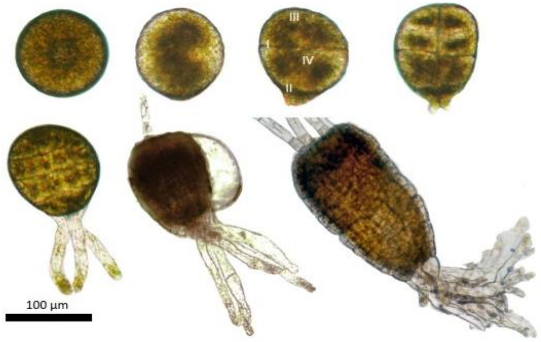
cultivation protocols











PLOS ONE

RESEARCH ARTICLE

Ex situ cultivation protocol for *Cystoseira amentacea* var. *stricta* (Fucales, Phaeophyceae) from a restoration perspective

Annalisa Falace[1]*, Sara Kaleb[1], Gina De La Fuente[2], Valentina Asnaghi[2], Mariachiara Chiantore[2]

1 Department of Life Sciences, University of Trieste, Trieste, Italy, 2 Department of Earth, Environment and Life Sciences, University of Genova, Genova, Italy

PeerJ

First *ex situ* outplanting of the habitat-forming seaweed *Cystoseira amentacea* var. *stricta* from a restoration perspective

Gina De La Fuente[1], Mariachiara Chiantore[1], Valentina Asnaghi[1], Sara Kaleb[2] and Annalisa Falace[2]

[1] Department of Earth, Environment and Life Sciences, University of Genoa, Genoa, Italy
[2] Department of Life Sciences, University of Trieste, Trieste, Italy

WEBBIA

Webbia
Journal of Plant Taxonomy and Geography

ISSN: 0083-7792 (Print) 2169-4060 (Online) Journal homepage: https://www.tandfonline.com/loi/tweb20

Reproductive phenology, zygote embryology and germling development of the threatened *Carpodesmia barbatula* (= *Cystoseira barbatula*) (Fucales, Phaeophyta) towards its possible restoration

Gilda Savonitto, Giuseppina Alongi & Annalisa Falace

plants

MDPI

Article

First Restoration Experiment for *Gongolaria barbata* in Slovenian Coastal Waters. What Can Go Wrong?

Martina Orlando-Bonaca[1,*], Valentina Pitacco[1], Petra Slavinec[1], Milijan Šiško[1], Tihomir Makovec[1] and Annalisa Falace[2]

frontiers in Marine Science

ORIGINAL RESEARCH

Is the South-Mediterranean Canopy-Forming *Ericaria giacconei* (= *Cystoseira hyblaea*) a Loser From Ocean Warming?

Annalisa Falace[1*], Giuliana Marletta[2], Gilda Savonitto[1], Fabio Candotto Carniel[1], Marina Srijemsi[1], Stanislao Bevilacqua[1], Mauro Tretiach[1] and Giuseppina Alongi[2]

DE GRUYTER

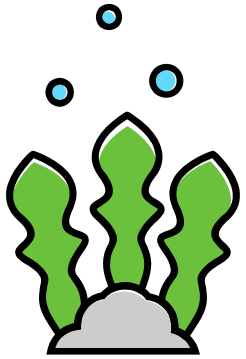
Botanica Marina 2022; aop

Research Article

Polytimi Ioli Lardi*, Ioanna Varkitzi, Konstantinos Tsiamis, Sotiris Orfanidis, Drosos Koutsoubas, Annalisa Falace and Maria Salomidi

Early development of *Gongolaria montagnei* (Fucales, Phaeophyta) germlings under laboratory conditions, with a view to enhancing restoration potential in the Eastern Mediterranean

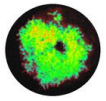
USE OF ALGAE BIOSTIMULANT TO ACCELERATE THE GROWTH OF SEEDLINGS



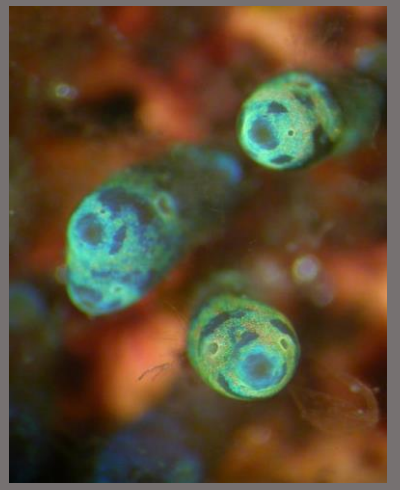
SEEDLINGS

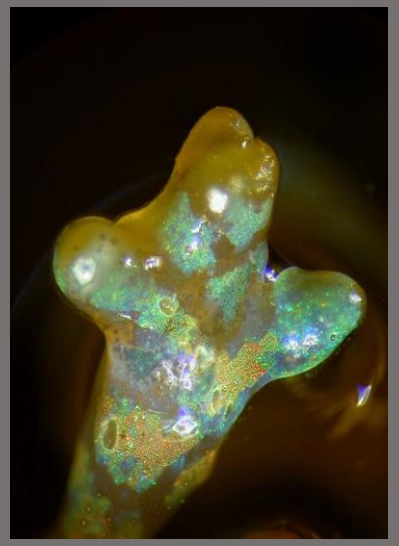
SURVIVAL

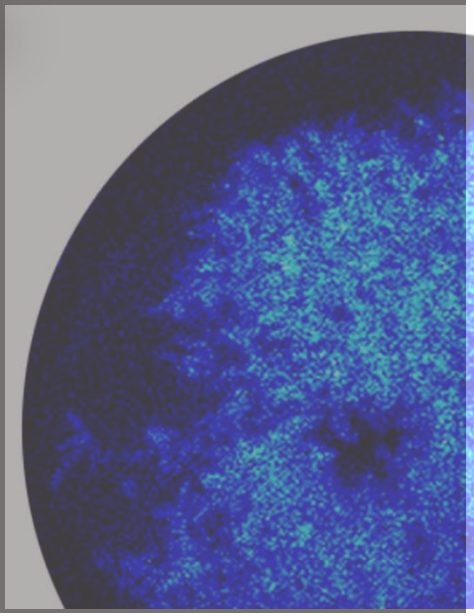
GROWTH



FITNESS
(PAM-Imaging)







Faster growth shortens time to deployment, increases outplanting success, reduces cost

27 days

< 0.5mm

Improved culture protocols

15 days

2.75 ± 0.46 mm

How?

HYBRID METHOD → after mesocosm, the culture period extended **outdoor**

advantages of ex-situ culture and suspended algacultures

Received: 29 May 2020 | Revised: 22 October 2020 | Accepted: 14 December 2020
DOI: 10.1002/aqc.3555

RESEARCH ARTICLE

WILEY

Addressing reproductive stochasticity and grazing impacts in the restoration of a canopy-forming brown alga by implementing mitigation solutions

Gilda Savonitto[1] | Gina De La Fuente[2] | Enrico Tordoni[1] | Saul Ciriaco[3] | Marina Srijemsi[1] | Giovanni Bacaro[1] | Mariachiara Chiantore[2] | Annalisa Falace[1]

frontiers | Frontiers in Marine Science

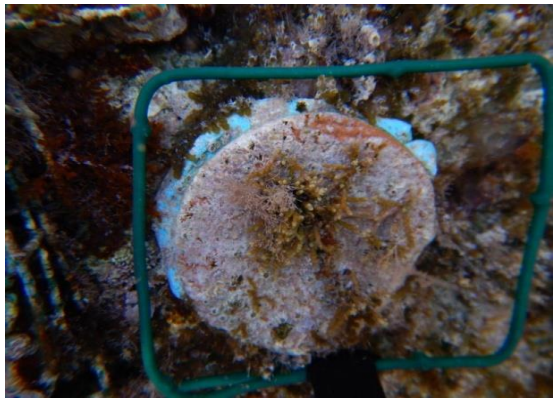
Where and how - new insight for brown algal forest restoration in the Adriatic

Martina Orlando-Bonaca[1]*, Gilda Savonitto[2], Valentina Asnaghi[3,4], Domen Trkov[1], Valentina Pitacco[1], Milijan Šiško[1], Tihomir Makovec[1], Petra Slavinec[1], Ana Lokovšek[1], Saul Ciriaco[5], Mariachiara Chiantore[3,4], Sara Kaleb[2], Emmanuelle Patricia Descourvières[2], Marina Srijemsi[2] and Annalisa Falace[2]

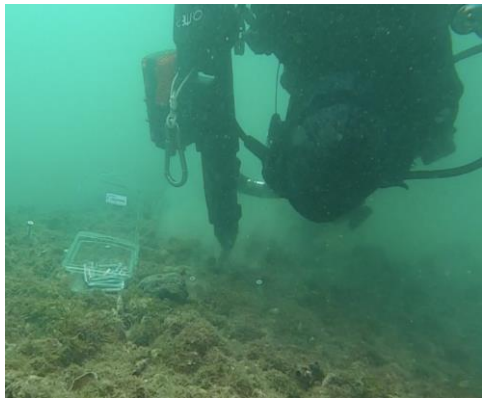
How?

OUTPLANTING

epoxy



screws & drilling



OUTPLANTING

underwater drill
to drill holes in the rock

screw the tiles

Intertidal

OUTPLANTING

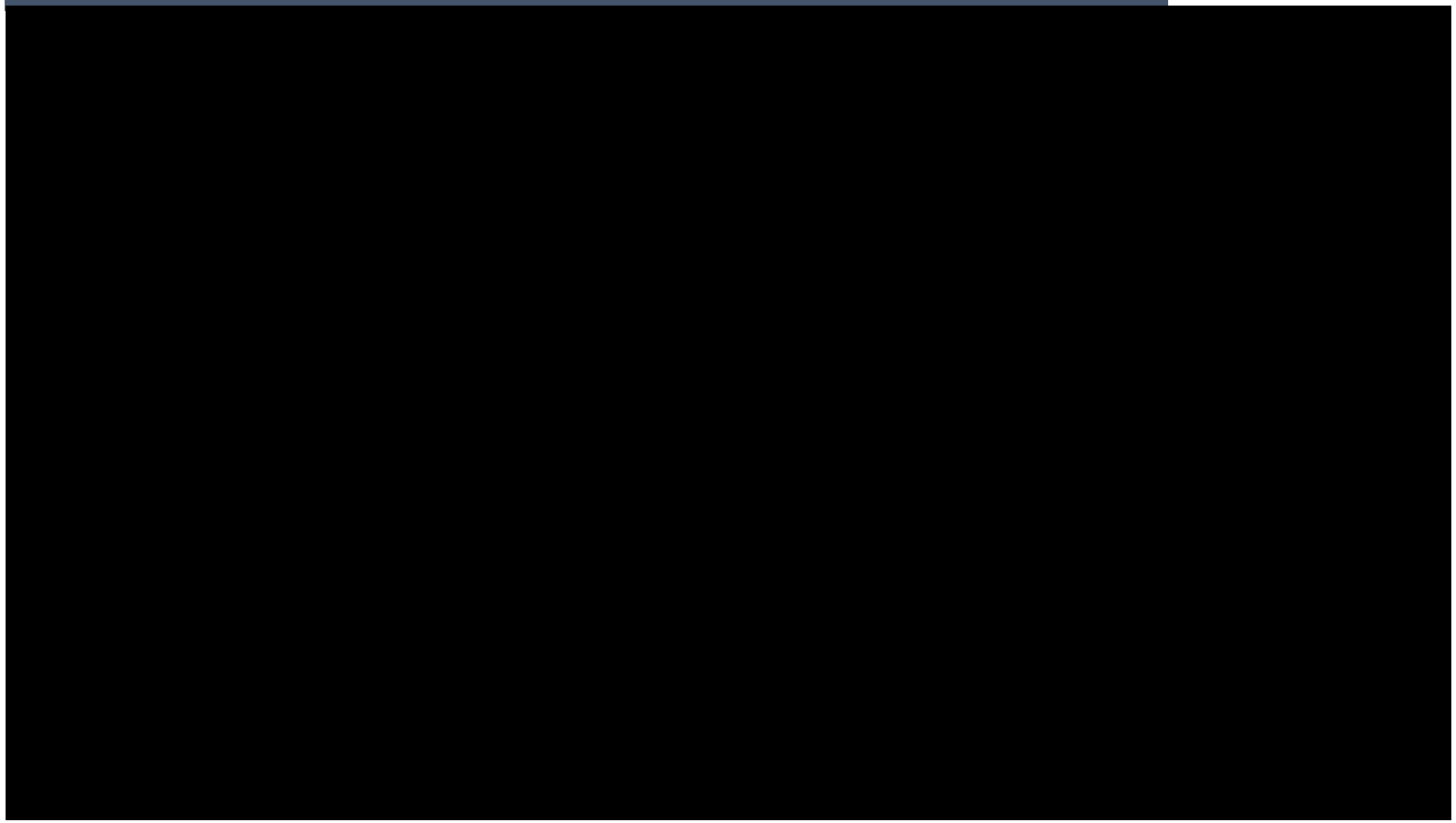
Intertidal

OUTPLANTING

Subtidal

Monitoring

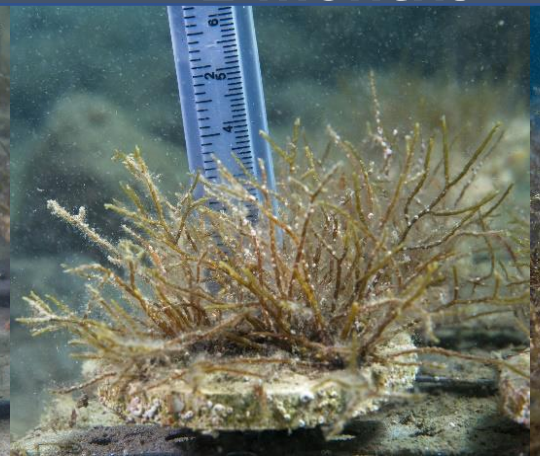
Restoration efficiency



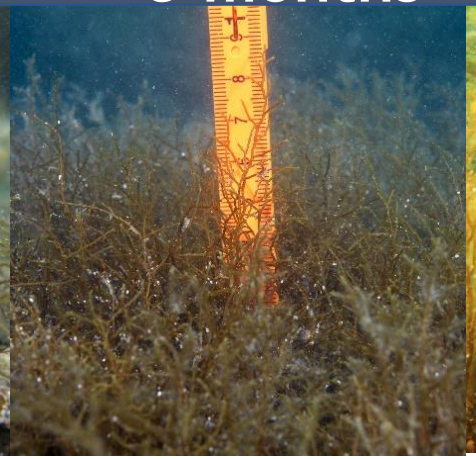
- **survival/growth** of seedlings
- **fertility** (new recruits)
- **Ecological Status** (Carlitt, Ecosystem-Based Quality Index)
- **Natural Capital** of the *Cystoseira* habitat
- **Ecosystem services** (e.g. associated biodiversity)

1 month

2 months

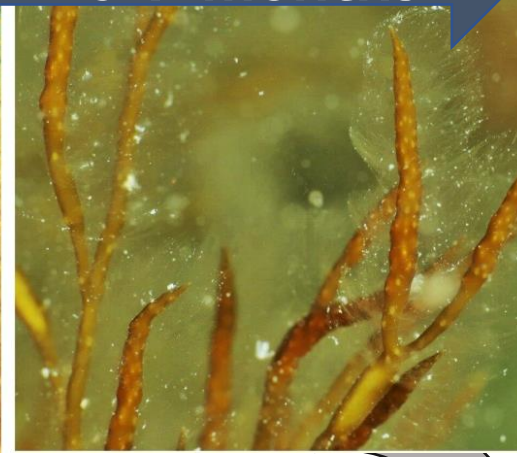


3 months



4 months

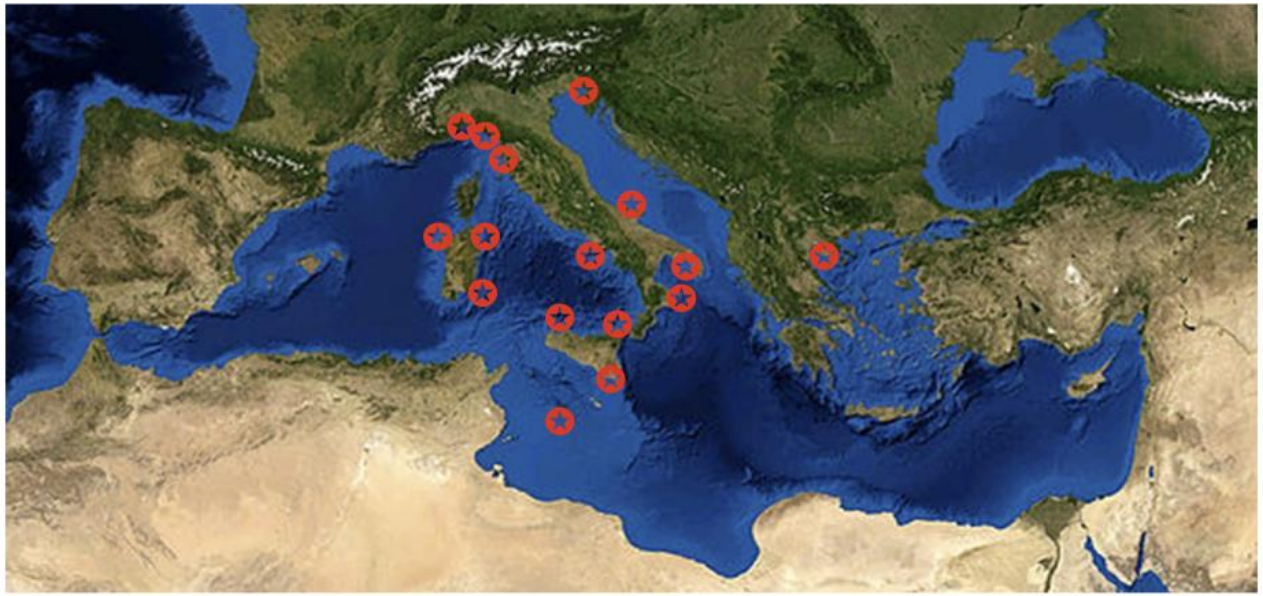
6-7 months



thalli became **fertile** in the next reproductive season

→ **spillover**

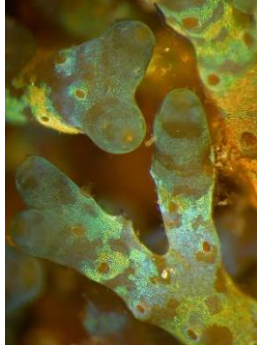
REPLICATION



Reeforest Replication

UPDATE MANAGEMENT PLANS IN AT LEAST 11 MPAS WITH THE INCLUSION OF CYSTOSEIRA AS A BIODIVERSITY TARGET → this will enable the **INCLUSION OF *Cystoseira* monitoring** in **their conservation strategies** and ensure that marine forests become an **INDICATOR FOR THE EFFECTIVE MANAGEMENT OF MPAS**.

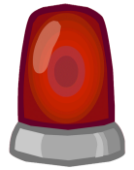
Take-home messages



- **BIOLOGICAL AND ENVIRONMENTAL CHALLENGES CAN BE OVERCOME**

  →The **knowledge acquired** can guide the **selection of the «best» sites, species and protocols for restoration**

- **CLIMATIC CHALLENGES: PLANNING THE UNEXPECTED!!!**



  → **Climate change** makes **restoration urgent** though **limiting its feasibility at the same time** (natural populations and outplants undergo the same threats)

- **SUCCESSFUL RESTORATION** require some kind of **'future-proofing'** by planting **warm-water-adapted genotypes or species,** to restore at least the ecosystem functions if not the original biodiversity

THANK YOU