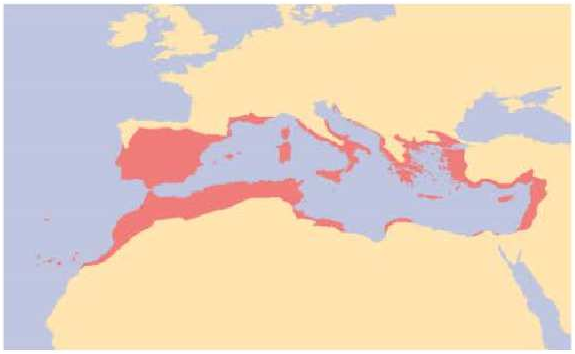
La conservazione *ex situ* della flora autoctona: uno strumento fondamentale per il recupero e la conservazione degli habitat Mediterranei

Gianluigi Bacchetta & Marco Porceddu

Parco Botanico di Radicepura – Giarre, 06 Dicembre 2019

Mediterranean region

The Mediterranean Region harbours more than half of the habitat types listed in the EU Habitats Directive. Of these, 37 occur only in this region.
The large number reflects not only the region's warm climate, variable geology and complex topography with many isolated areas, but also the fact that much of the region was spared by the ravaging effects of the last Ice Age that spread across Europe.

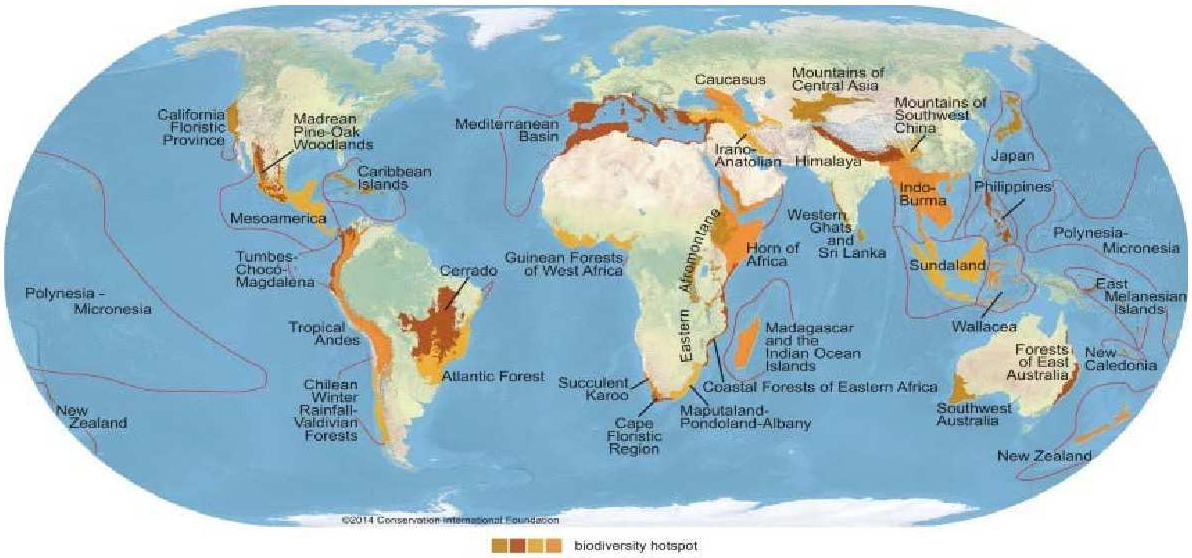


Biogeographic Mediterranean Region
(Médail & Quézel, 1999; Rivas Martìnez et al., 2004)

Disjointed areas with Mediterranean climate
(Di Castri et al., 1981)

Plant diversity in the Mediterranean Basin

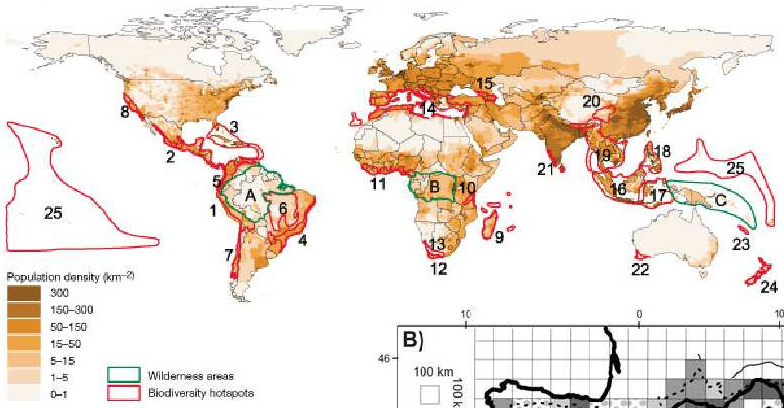
The Mediterranean Basin, with ca. 11.8 endemic plants per 100 km^2, has been recognized as one of the priority regions for plant conservation in Europe and identified as one of the 36 most important "biodiversity hotspots" of the planet.



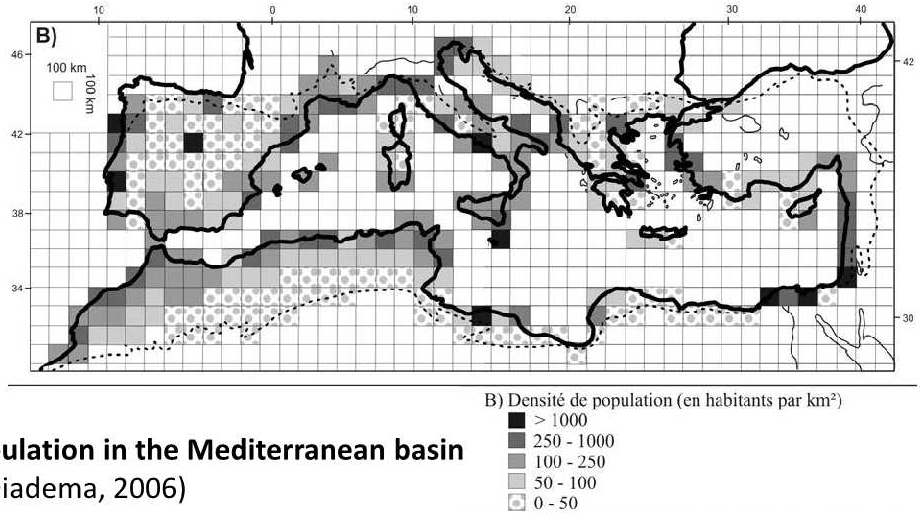
Conservation International (conservation.org) defines 35 biodiversity hotspots — extraordinary places that harbor vast numbers of plant and animal species found nowhere else. All are heavily threatened by habitat loss and degradation, making their conservation crucial to protecting nature for the benefit of all life on Earth.

Threats in the Mediterranean region

Population density



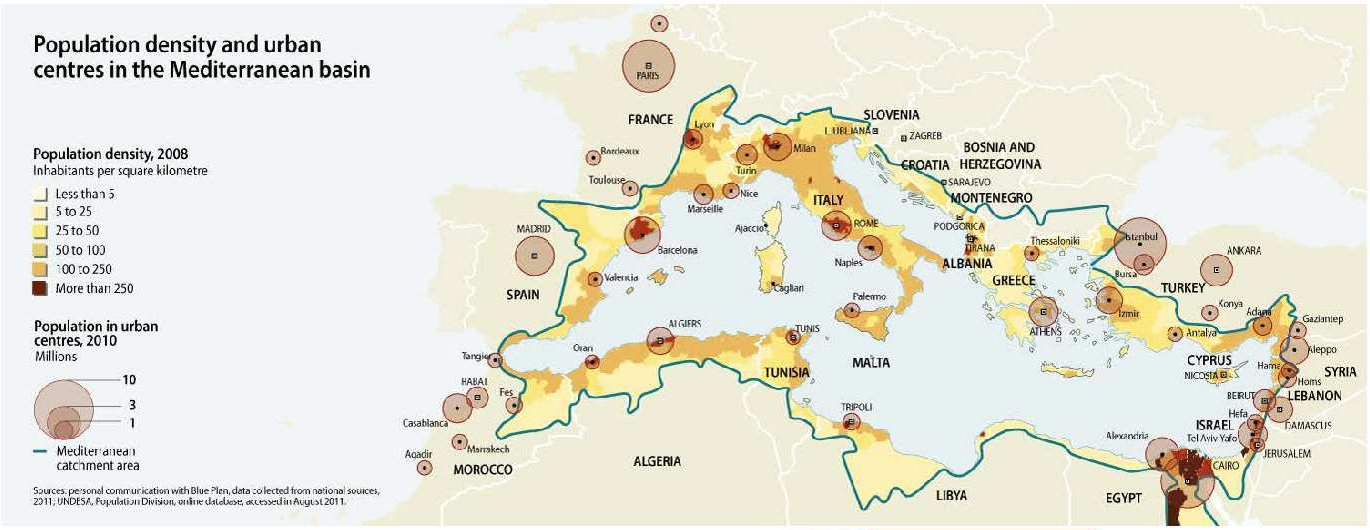
Human population in the biodiversity hotspots (Cincotta et al., 2000)

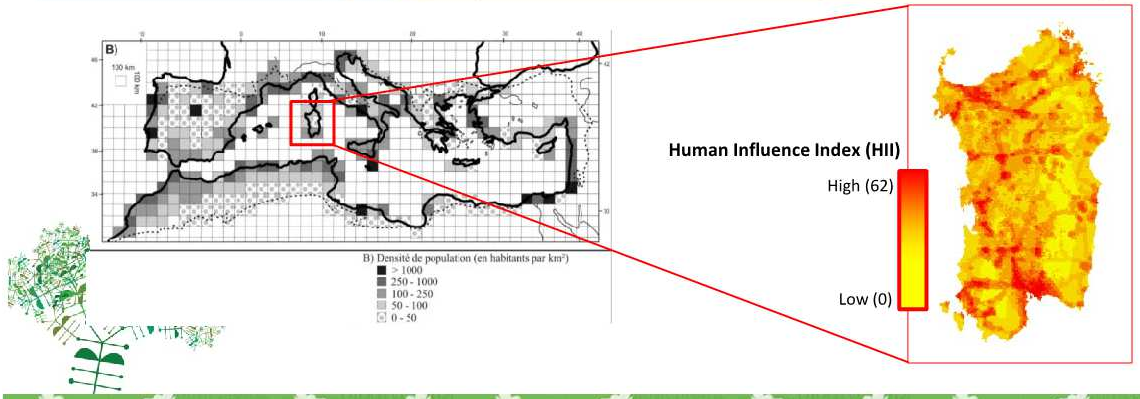


Human population in the Mediterranean basin (Médail & Diadema, 2006)

Threats in the Mediterranean region

Population density



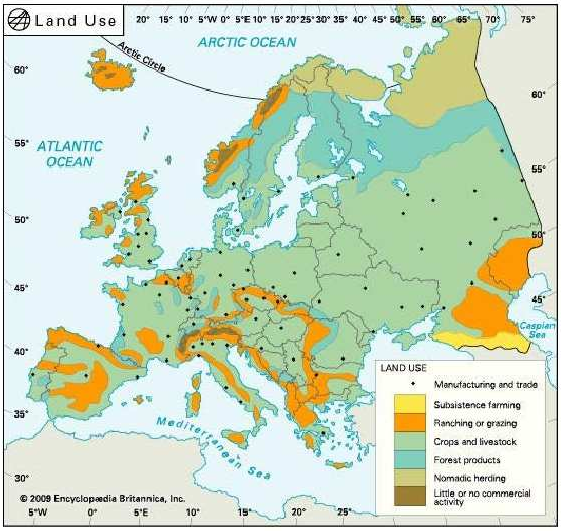


Wildlife Conservation Society - WCS, and Center for International Earth Science Information Network - CIESIN - Columbia University (2005)

Threats in the Mediterranean region

Land uses

Mediterranean plant biodiversity is, to a large extent, the result of a traditional and harmonious use of the environment. However, since the end of the nineteenth century, this balance has been upset in most places by over exploitation of natural resources or a general shift away from the land - two processes that have had different but equally harmful consequences for the conservation of species and habitats.

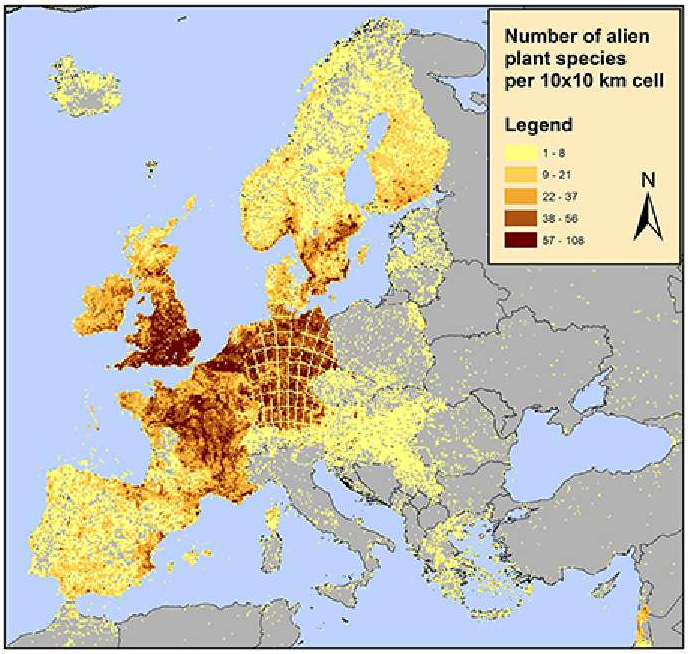


The 'old world' Mediterranean Basin has experienced agriculture for thousands of years; its high plant diversity is often attributed to the coevolution of plants with people (Di Castri, 1981).

Threats in the Mediterranean region

Invasive Alien Plants

Distribution of alien plants in Europe on a 10 × 10 km^2 grid according to the available data in the European Alien Species Information Network
(EASIN; Katsanevakis et al., 2015; Trombetti et al., 2013)



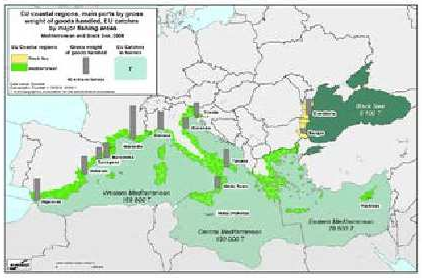

Oxalis pes-caprae

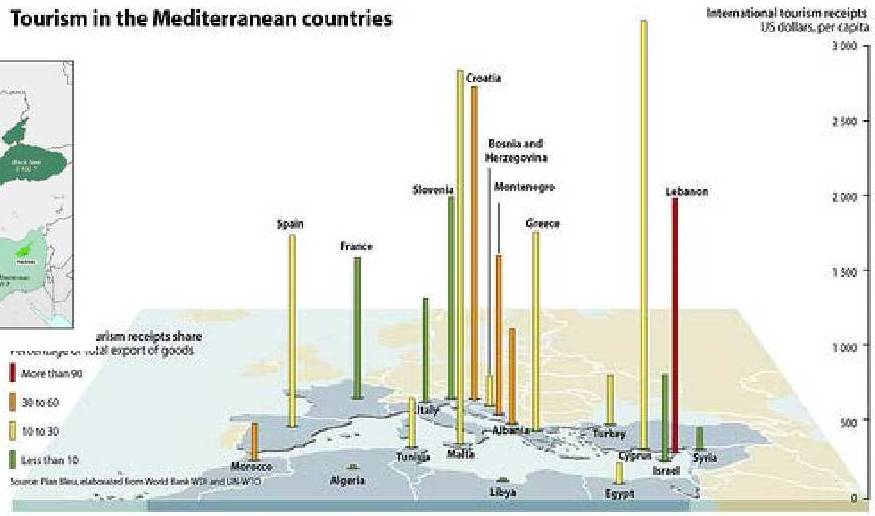

Eichhornia crassipes

Threats in the Mediterranean region

Tourism

Over the decades, tourism has become one of the fastest growing economic sectors in the world, a key driver for socio-economic progress and a key income source for many countries. The Mediterranean region, with its rich history and unrivalled natural beauty, has long been one of the top tourism destinations in the world, hosting more than 320 million tourists in 2015, more than double the number recorded in 1995.

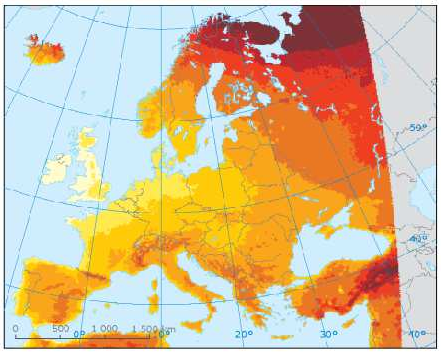


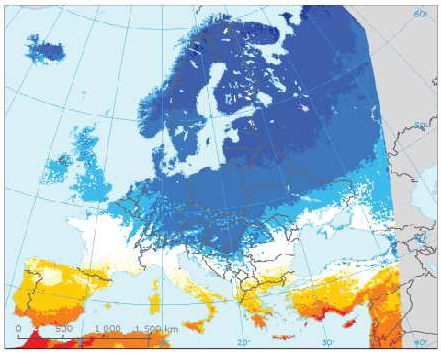


(Bas Amelung & David Viner, 2006)

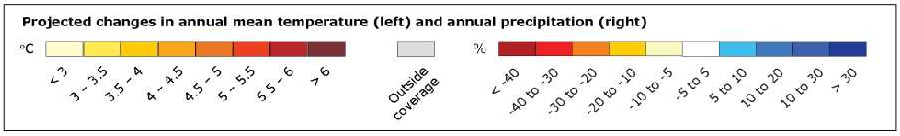
Threats in the Mediterranean region

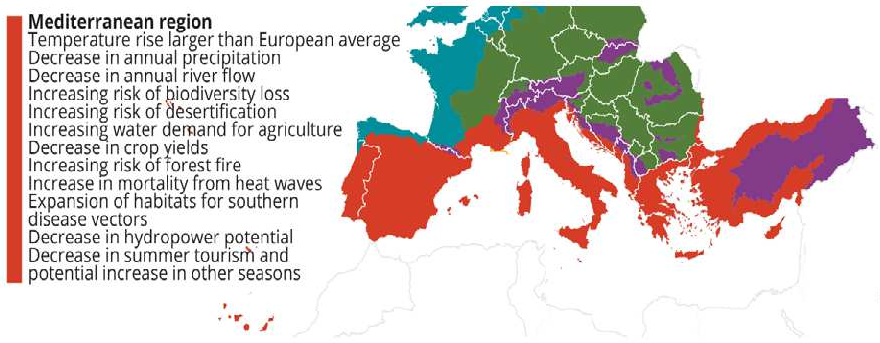
Climate change





Climate change projections for Europe based on an ensemble of regional climate model simulations provided by the EURO-CORDEX initiative.





European Environment Agency

Threats in the Mediterranean region

Biodiversity Loss

Plant extinction rates are suggested to correlate with the age and duration of large-scale western colonization, with lowest extinction rates in the Mediterranean Basin (1.1%) compared to Western Australia (6.6%) (Greuter, 1994; Underwood et al., 2009).
Conservation outcomes are the full set of quantitative and justifiable conservation targets in a hotspot that need to be achieved in order to prevent biodiversity loss.

It can be defined at three scales:

- **Species**
- **Site**
- **Landscape**

Reflecting a simplification of a complex hierarchical continuum of ecological scales. The three scales interlock geographically through the presence of species in sites and of sites in landscapes. They are also logically connected. If species are to be conserved, the sites on which they live must be protected and the landscapes or seascapes must continue to sustain.

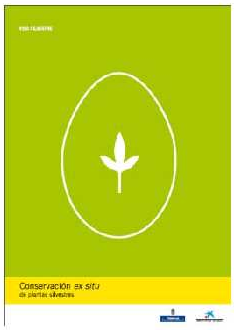
It can be done in two ways:

- ***In situ***
- ***Ex situ***

Sardinian Germplasm Bank (BG-SAR)

***Ex situ* conservation:**

The Sardinian Germplasm Bank (BG-SAR) was founded in 1997 and is a facility of the *Hortus Botanicus Karalitanus* (HBK).



The main objectives of BG-SAR are the collection, multiplication and management of the germplasm belonging to rare, threatened and endemic *taxa* and/or with agronomic/cultural interest.

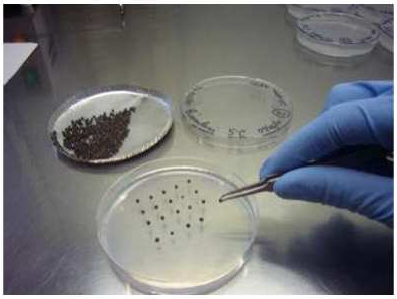
Seed banking procedures

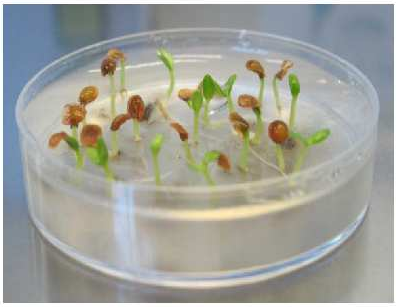
- ☐ The collected germplasm is introduced in the Bank after a **quarantine period**; it is stored in a room with controlled environmental parameters that allows a slow and gradual post-ripening and then it is cleaned.
- ☐ The germplasm is therefore selected and stored in a dry room at **15°C** and **15% R.H**; when optimal parameters for long term conservation are reached, the samples are closed hermetically in glass vials with silica gel.
- ☐ When samples are big enough, part of them samples is stored at +5°C and used for habitat restoration programs or exchanges with other scientific or no profit institutions through the ***Index Seminum***.

Taxa stored at the BG-SAR

BG-SAR preserves approximately 3000 seed lots, many of which endemics of Sardinia.
In particular, the bank preserves the germplasm of ca. 47% of policy species and ca. 42% of exclusive Sardinian endemics.
Among them, it is important to highlight that the bank preserves most of the exclusive endemics taxa included in the Annexes of the Habitats Directive (DIR 92/43/EEC).

Seed ecophysiology studies



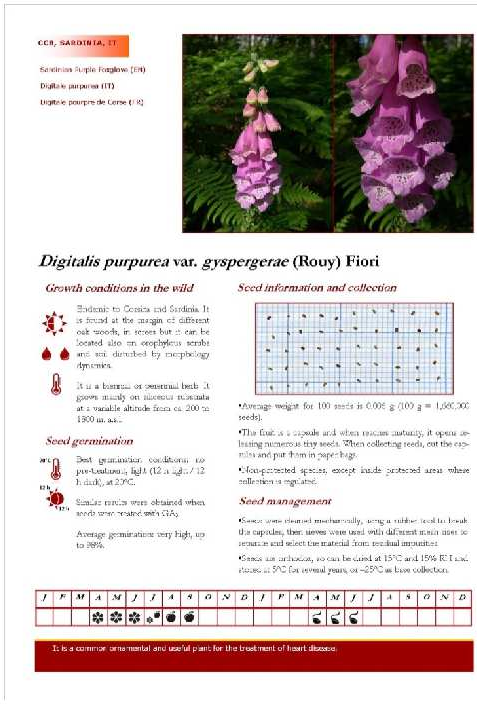


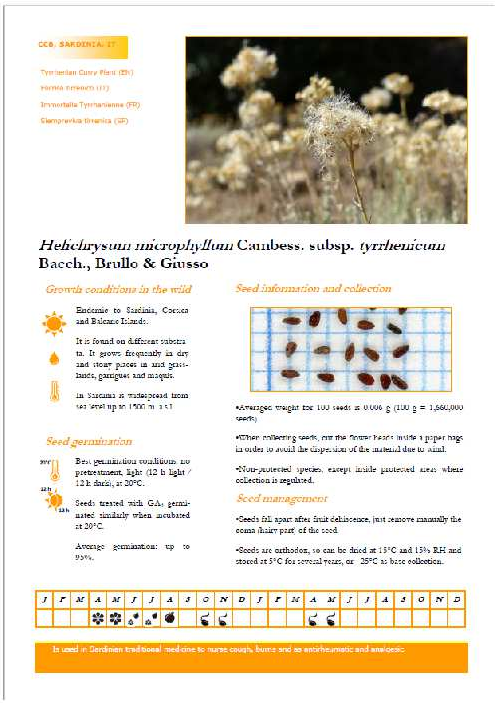
Germination tests are conducted in plastic sterile Petri dishes, incubated in growth chambers (Sanyo MLR-351) equipped with white fluorescent lamps, set to six different constant temperatures (**5, 10, 15, 20, 25 and 30°C**) and an alternate temperature regime (**25/10°C**) with a photoperiod of 12 hours of irradiance per day.

Different pre-treatments (e.g. pre-chilling, warming, scarification) and/or hormones treatments to remove an eventual seed dormancy are carried out.

Seed ecophysiology studies

Studies on the germination ecophysiology are constantly carried out to increase the ecological knowledge for each of the preserved *taxa*.





Seed ecophysiology studies: some examples

Important to highlight that the germination ecophysiology studies permit to individuate and define the optimum germination protocol for multiplication of the plants by seeds.

Paeonia corsica Sieber *ex* Tausch

Seeds are Morphologically dormant (MD)

+

Seeds have a Physiological component of dormancy (PD)

+

Seeds require cold stratification to break shoot dormancy (Epicotyl dormancy)

=

Seeds of *Paeonia corsica* are therefore: Epicotyl MorphoPhysiological Dormant (MPD)

Sequential temperature control of multi-phasic dormancy release and germination of *Paeonia corsica* seeds

Marco Porceddu[1,], Efisio Mattana[1,2], Hugh W. Pritchard[2] and Gianluigi Bacchetta[1]*

Journal of Plant Ecology

Seed ecophysiology studies: some examples

Gentiana lutea L. *subsp. lutea*

Seeds are MorphoPhysiological Dormancy (MPD)

Discovering the type of seed dormancy and temperature requirements for seed germination of *Gentiana lutea* L. subsp. *lutea* (Gentianaceae)

Alba Cuena-Lombraña, Marco Porceddu ✉, Caterina Angela Dettori, Gianluigi Bacchetta

Journal of Plant Ecology, Volume 11, Issue 2, 6 February 2018, Pages 308–316,
https://doi.org/10.1093/jpe/rtx003

Gentiana lutea subsp. *lutea*

Seed ecophysiology studies: some examples

Helichrysum microphyllum subsp. tyrrhenicum

Specific studies permit to investigate the correlation between seed traits and germination responses of a taxon along an altitudinal gradient.

plant biology
Plant Biology ISSN 1435-8603

RESEARCH PAPER

Seed traits and germination behaviour of four Sardinian populations of *Helichrysum microphyllum* subsp. *tyrrhenicum* (*Asteraceae*) along an altitudinal gradient

R. Picciau[1,2], S. Serra[1,2], M. Porceddu[1,2] & G. Bacchetta[1,2]

Differences in seed traits and germination were detected among the studied populations of *Helichrysum microphyllum* subsp. *tyrrhenicum*.
However, these differences were not correlated with altitude.

Seed ecophysiology studies: some examples

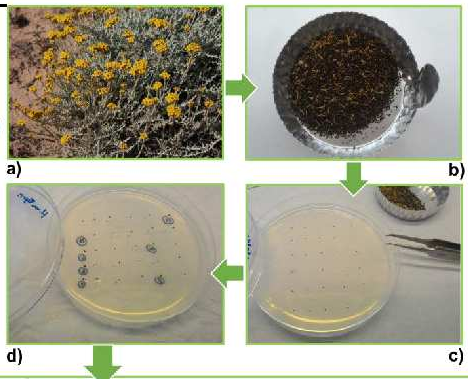
Phytoremediation - Helichrysum microphyllum subsp. tyrrhenicum

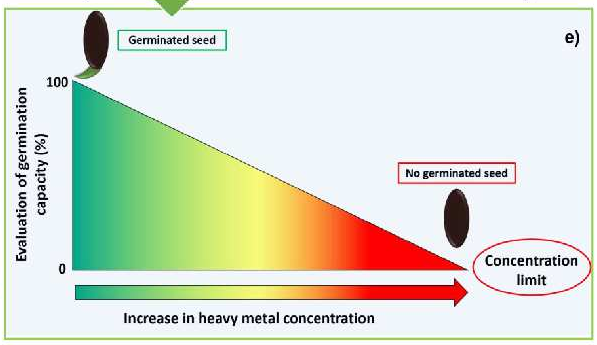
Previous knowledge permit to increase the scientific research field in the study of the mitigation of environmental impacts in abandoned mining areas and in finding solutions to ensure human health and environmental protection.

ORIGINAL PAPER

Effects of zinc and lead on seed germination of *Helichrysum microphyllum* subsp. *tyrrhenicum*, a metal-tolerant plant

M. E. Boi[1,2,3,4] · M. Porceddu[1,2] · G. Cappai[3] · G. De Giudici[4] · G. Bacchetta[1,2]





Seed conservation consortia

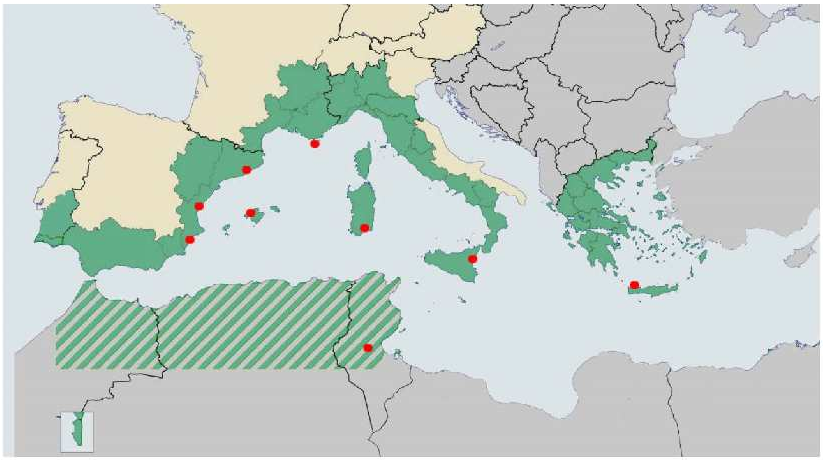
HORTUS
BOTANICUS
KARALITANUS

BG-SAR participates in seed conservation consortia as:

Seed conservation consortia

In 2004 establishment of a plant conservation network at Mediterranean level

Gen medOc
BANQUES DE SEMENCES DE LA MÉDITERRANÉE



Programme Interreg IIIB
MEDOCC
Pour la cohésion des territoires de l'Europe du Sud
FEDER

SEMCLIMED

IMPACT DU CHANGEMENT CLIMATIQUE SUR LA FLORE MÉDITERRANÉENNE ET ACTIONS DE CONSERVATION

Impacts of climate change on the Mediterranean Flora and conservation measures

GENMEDA MISSION

Conservation of the Mediterranean flora genetic resources

Objectives

1. To reinforce and enhance the effectiveness of flora conservation.

2. To promote and develop actions **for environmental education and dissemination** in order to increase public awareness concerning biodiversity conservation.

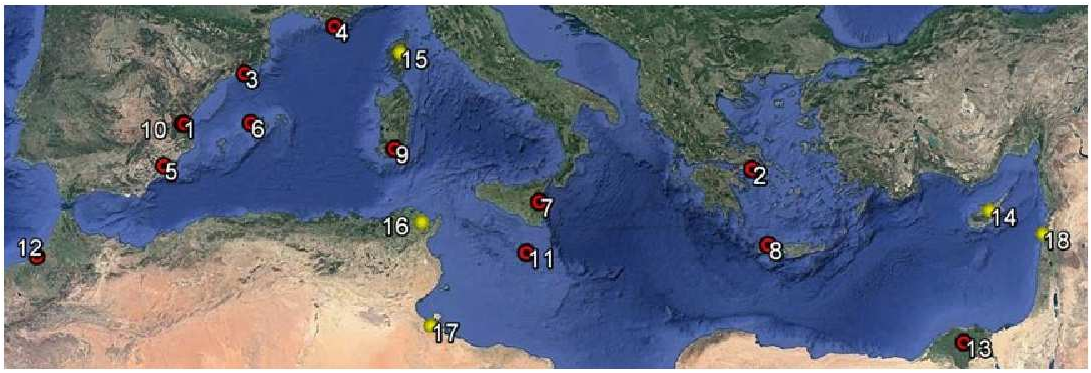
3. To draw up **joint initiatives and projects** enabling the progress of the scientific and technical knowledge on conservation and/or management of flora genetic materials.

4. To give **support to the decision-making processes** concerning vegetal biodiversity conservation policies in the Mediterranean regions.

Réunion GENMEDA à Rome 2011. De gauche à droite: Anna Guglielmo (Secrétaire), Myriam Virevaire (Présidente) et Gloria Ortiz (Trésorière).

GENMEDA

GENMEDA members and associate members



1. **CIEF**, Valencia, Spain
2. **National and Kapodistrian** University of Athens, Greece
3. **Institut Botànic** - Jardí Botànic de Barcelona, Spain
4. **Conservatoire Botanique National Méditerranéen de Porquerolles**, France
5. **Consejería de Turismo, Cultura y Medio Ambiente** (Región de Murcia), Spain
6. **Fundació Jardí Botànic de Sóller**, Spain
7. **Università degli Studi di Catania**, Italy
8. **CIHEAM** Mediterranean Agronomic Institute of Chania, Greece
9. **Università degli Studi di Cagliari**, Italy
10. **Jardí Botànic of the Universitat de València**, Spain
11. **Argotti Botanic Gardens Universita of Malta**, Malta
12. **Institut Scientifique de Rabat**, Morocco
13. **University of Mansoura**, Egypt
14. ***Agricultural Research Institute**, Cyprus
15. ***Conservatoire Botanique de Corse**, France
16. ***National Research Institute for Rural Engineering, Water and Forestry** (INRGREF), Tunisia
17. ***Arid Regions Institute**, Tunisia
18. *__University Saint Joseph__ and __'Jouzour Loubnan__' Seed bank, Lebanon

2004-2006	**GENMEDOC** project (Interreg IIB MEDOCC) (coord. CIEF)
2006-2008	**SEMCLIMED** project (Interreg IIB MEDOCC) (coord. CIEF)
2009	*preparatory* meetings for establishment of GENMEDA network
2010	signing of GENMEDA **statute** & internal functioning rules (13 founding members)
2011-2014	MAVA project (coord. KEW) **'Ensuring the survival of endangered plants in the Mediterranean'** - 4 GENMEDA members (islands) participating
2014-2015	**ECOPLANTMED** project (coord. MAICh) - 3 GENMEDA members participating
2016-(2018)	**CARE-MEDIFLORA** project (2nd MAVA project)- coord. IUCN-MED (Bertrand de Montmollin) & MAICh - 4 GENMEDA members (islands) participating Support from the project to GENMEDA

Italian Network of Germplasm Banks for the Ex Situ Conservation of Native Flora (RIBES)

The RIBES network

- RIBES is the **Italian seed-bank network for native species conservation**
- It was established in December 2005
- Actually is made of **17 seed-banks**. They are mainly University seed-banks but also include local governmental agencies, and national parks
- They represent **14 Italian regions** and include key members that are already involved in other **international networks** such as **ENSCONET**, **GENMEDOC** , and **OSSSU** providing in this way an active connection with the European context

NETWORK OBJECTIVES:

Provide a national framework to conserve the seeds of rare and endangered species. Operate jointly on a national scale in connection with the CBD National Focal Point (Environmental Ministry)

- Actually, the network preserves seeds of **over 3000 taxa.**
- In particular, according to the 2015 census, the RIBES network preserve **37% of the Italian CWRs listed in the FAO Treaty:** in 14 seed-banks are preserved **6029 accessions of 229 CWR taxa**, belonging to 11 families and 57 genera.

Among them:

- **28 endemic taxa**, 20 of them exclusive of 1 Italian region
- **12 threatened (CR, EN, VU) taxa and 7 near threatened**, for a total of 19 priority taxa
- **4 taxa are listed in the Annex II of Habitats Directive 92/43/EEC**: *Brassica macrocarpa*, *B. glabrescens*, *B. insularis*, and *Crambe tataria*

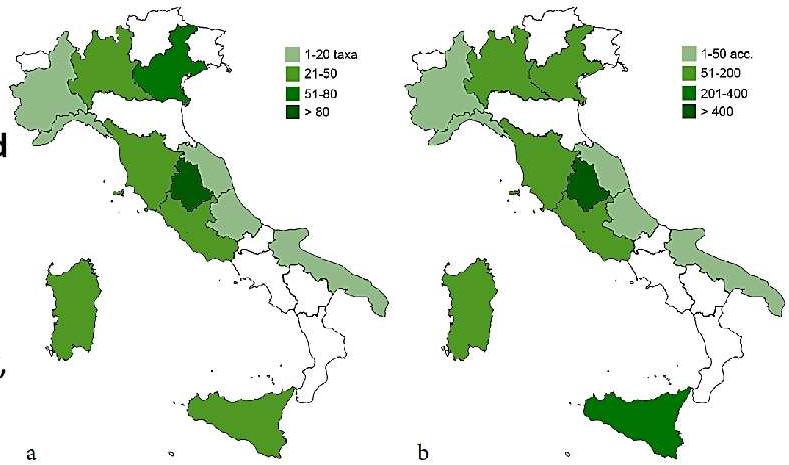
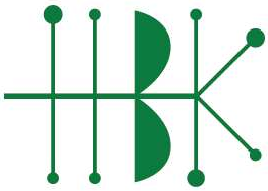


FIGURE 3. Number of a) CWR taxa and of b) their accessions stored in seed-banks in the Italian regions

RIBES

The Other RIBES activities

- Collaboration with the *Italian National Institute for Environmental Protection and Research* (ISPRA).
- Publications.
- Scientific divulgation activities.



HORTUS
BOTANICUS
KARALITANUS

BG-SAR is involved in many conservation projects:

EcoplantMed

Ecological Restoration

"There are no economies without ecosystems, but there are ecosystems without economies..." **The Economics of Ecosystems and Biodiversity (TEEB) Report, European Communities (2008)**

- ☐ The process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed (SER, 2004).

- ☐ Represents a holistic process aimed at fully repairing ecosystem structure, function, and the provision of goods and services.

- ☐ Provides a conceptual framework where the link between nature and culture is especially inspiring. It is an important management approach that can contribute to broad societal objectives for sustaining a healthy planet and delivering essential benefits to people (SCBD, 2010), by renewing economic opportunities, rejuvenating traditional cultural practices and enhancing ecological and social resilience to environmental change (Keenleyside et al., 2012).

Native species in ecological restoration

A restored ecosystem provide four important benefits (Bozzano et al., 2014):

- ☐ It contributes to conservation of the species themselves and their genetic diversity.
- ☐ If planting material represents not only a native species but originates from seed sources local to the planting site, it will have evolved together with other native flora and fauna of the area. It should be well adapted to cope with the local environment and should support native biodiversity and ecosystem resilience to a greater extent than would introduced (exotic) planting material.
- ☐ Native species may be less likely either to become invasive or to succumb to introduced or native pests than exotic species.
- ☐ Native species may correspond better to the preferences of local people, and chances are higher that local people hold ethnobotanical and ethno-ecological knowledge of these species, which may facilitate their successful use in restoration projects.




Project "Ensuring the survival of endangered plants in the Mediterranean"

Aims and scope of the project

- ☐ To intensify seed conservation collaboration across the Mediterranean Basin;
- ☐ To develop and implement a Mediterranean Basin seed collecting plan that prioritises critically endangered species;
- ☐ To conserve 900 plant *taxa* that are prioritised for urgent conservation in seed banking;
- ☐ To research and disseminate data on the 900 plant *taxa* collected for conservation and restoration activities;
- ☐ To improve the skills and knowledge base of conservation staff on Mediterranean islands;
- ☐ To sensitize public awareness on the issue of the conservation of endangered plants and habitat;
- ☐ To ameliorate the cooperation between research institutions involved in the project.

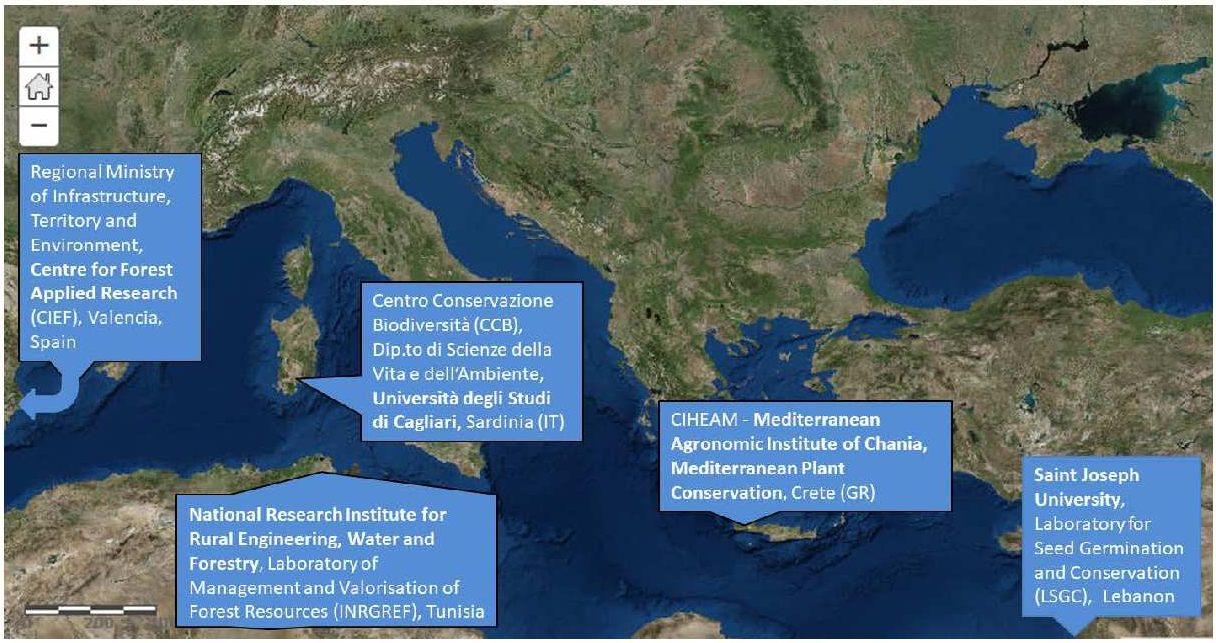
EcoplantMed

ENPI CBCMED
CROSS-BORDER COOPERATION IN THE MEDITERRANEAN

ECOPLANTMED project

ECOlogical use of native PLANTs for environmental restoration and sustainable development in the MEDiterranean region

The project ECOPLANTMED is a joint Mediterranean initiative based on the collaboration among seed banks, research institutes and institutions dealing with native plant conservation and management.



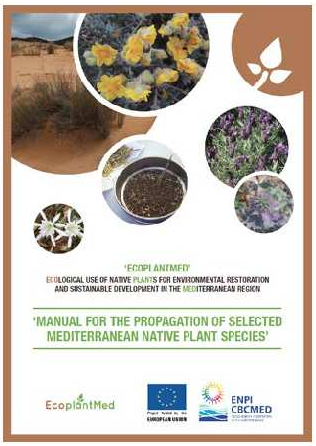
EcoplantMed

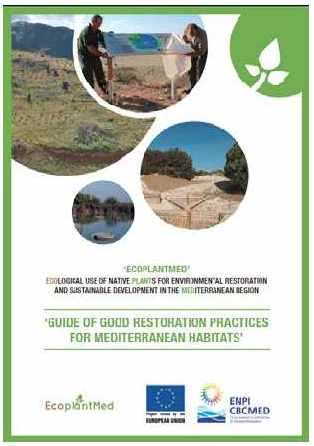
ECOPLANTMED project

ECOlogical use of native PLANTs for environmental restoration and sustainable development in the MEDiterranean region

Main results:

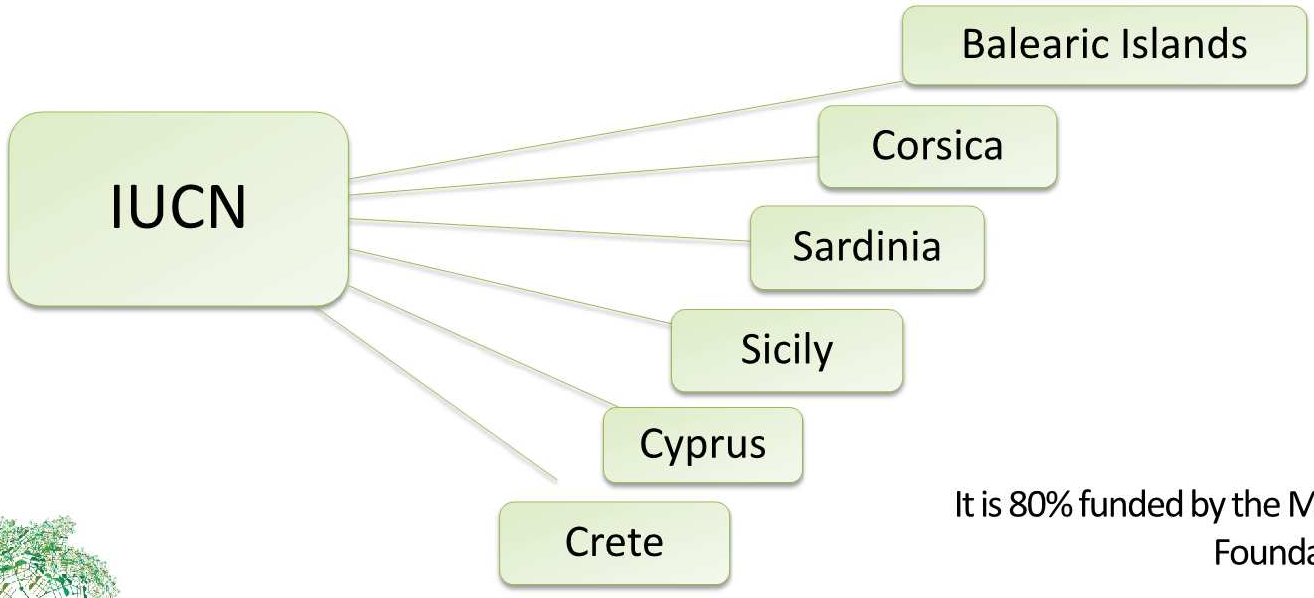
- ☐ Manual for the propagation of selected Mediterranean native plant species
- ☐ Guide of good restorarion practices in Mediterranean habitats (download for free in the ECOPLANTMED website)
- ☐ Restoration of 13 hectareas in Tunisia and Lebanon
- ☐ Creation of a Germplasm Bank in Tunisia





CARE-MEDIFLORA project

CARE-MEDIFLORA, "*Conservation Actions for Threatened Mediterranean Island Flora: ex situ and in situ joint actions*", is a project implemented by institutions of six Mediterranean islands and the IUCN/SSC Mediterranean Plant Specialist Group.



It is 80% funded by the MAVA Foundation

CARE MEDIFLORA

MAVA FONDATION POUR LA NATURE

CARE MEDIFLORA project

Objectives

Main aim is improving knowledge and conservation of threatened island plants representative of the entire Mediterranean Basin.

In situ conservation of some of the most endangered plant species of the Mediterranean islands through *in situ* management actions.

Ex situ conservation of the most endangered plant species through the collection, seed banking and duplication of accessions representative of the overall diversity of selected *taxa*.

The reinforcement and enlargement of the 'GENMEDA-Network of Mediterranean Plant Conservation Centres' connecting the scientific institutions involved in the project.

IPAMed Network

Technical training on ex situ conservation

Training for ex situ conservation by CARE-MEDIFLORA partners in collaboration with IUCN-Med

IPAMed project (Important Plant Areas of the Mediterranean Region)

CIHEAM Mediterranean Agronomic Institute of Chania (**MAICh**) in Crete and Hortus Botanicus Karalitanus (**HBK**) in Sardinia have offered to representatives of 11 partner institutions from 7 countries of the South and East of the Mediterranean practical trainings on the application of *ex situ* conservation techniques.

As part of the CARE-MEDIFLORA project.

CARE MEDIFLORA

Native species in ecological restoration: *some examples*

Reintroduction of *Gentiana lutea* subsp. *lutea*







CARE-MEDIFLORA project

Native species in ecological restoration: *some examples*

Reintroduction *of Ribes sardoum*

LIFE projects: PROVIDUNE

The LIFE PROVIDUNE project **"Conservation and restoration of habitats dune in five Site of Community Importance (SCI) areas of the Provinces of Cagliari, Matera and Caserta",** financed by the European Union for the years 2009-2014, was aimed to protect and restore the priority coastal dunes habitat with ***Juniperus* ssp. (2250*)** and other related habitats characterizing the Mediterranean sandy coasts.

P R O V I D U N E

PROVIDUNE

Native species in ecological restoration: *some examples*

“Recovering Endangered HabitatS in the Capo Carbonara MARIne Area, Sardinia”

RES MARIS (2014-2018) aims at conservation and recovery of marine and terrestrial ecosystems of the emerged and submerged beach system, in particular of priority habitats (DIR. 92/43/EEC):

☐ 1120* "*Posidonia* beds (*Posidonion oceanicae*)"
☐ 2250* "Coastal dunes with *Juniperus* spp."
☐ 2270* "Wooded dunes with *Pinus pinea* and/or *Pinus pinaster*"



Recovering Endangered HabitatS in the Capo Carbonara MARIne Area, Sardinia

Conservation actions:

- ☐ Collection, testing and multiplication of germplasm of species characteristic of the habitats *2250 and *2270;
- ☐ Implementation of interventions to control and/or eradicate of invasive alien species, restoration and renaturation of the dunal vegetation relative to the habitat *2250 and *2270;
- ☐ Installation of mooring facilities and interventions of recovery and restocking in sensitive areas habitat of the habitat *1120.

MANY THANKS FOR YOUR ATTENTION!

Contacts

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