Interreg Mediterranean
BIODIVERSITY PROTECTION

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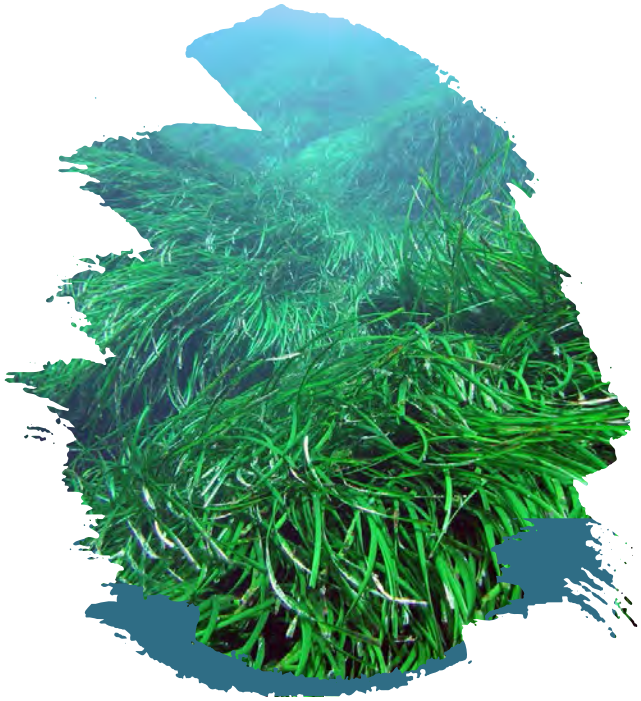

Mediterranean ecosystem

Restoration sites

UNITED NATIONS DECADE ON ECOSYSTEM RESTORATION 2021-2030

This report was led by the European Topic Centre on Spatial Analysis and Synthesis (ETC-UMA) in the frame of the Mediterranean Biodiversity Protection Community initiative (MBPC) co-funded by the EU Interreg Mediterranean programme and is the result of a close consultation with the FAO-led Task Force on Best Practices. This report is the result of the collaborative efforts of many institutional partners, projects and individuals that made available information on their experience on restoration practices across the Mediterranean for wider dissemination. For each practice, the contributor's name can be found as contact in the full annex description.

The images contained in this publication have been offered by each best practice provider.

CITATION
Mediterranean ecosystem restoration sites, Interreg Mediterranean Biodiversity Protection Community project, 2023

ILLUSTRATIONS
Rocio Gomez

DESIGN AND LAYOUT
Blueverde Studio - www.blueverdestudio.com

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Foreword

Conscious about the critical need to halt, present and reverse ecosystem degradation, and to effectively restore degraded terrestrial, freshwater and marine ecosystems across the globe, through Resolution 73/284, the United Nations General Assembly declared 2021-2030 as the United Nations Decade on Ecosystem restoration.

To support the implementation of the UN Decade on Ecosystem Restoration 2021-2030, a FAO-led Task Force on Best Practices was established. This task force focuses on shaping the knowledge component of the UN Decade, including capacity development efforts and capitalization as well as sharing and dissemination of good practices for restoration in all ecosystems.

In the frame of its strategic activities in the Mediterranean region, ETC-UMA as coordinator of the Mediterranean Biodiversity Protection Community (MBPC) has joined the Task Force on Best Practices on Ecosystem Restoration and committed to use its network of practitioners to extract regional best practices from the Mediterranean region to support the global process and to develop a Mediterranean wide ecosystem restoration Best Practices Catalogue.

This Ecosystem Restoration Best Practices Catalogue for the Mediterranean aims to respond to the urgent need to identify and spread Nature-based solutions and provide transferable best practices towards broader ecosystem restoration actions during the UN Decade on ecosystem restoration (UN/FAO).

Building on the endorsed pre-agreed standards set by the Task Force, the MBPC partners helped identify relevant Mediterranean practitioners from its wide network that have developed restoration practices fitting the set criteria.

After a feasibility analysis on the information collected, eleven case studies have been retained to be part of this publication. They highlight successful restoration activities implemented in the Mediterranean at various scales (between 5ha and 50000 ha of restored areas) in several Mediterranean forest, wetland, and coastal and marine ecosystems.

The selected best practices provide insights into the processes followed, lessons learned and conditions to make them transferable to other areas where restoration work might be foreseen. By sharing and disseminating these practices and the knowledge generated relevant to Mediterranean ecosystems in danger, the MBPC community and the different authors aim at scaling up restoration efforts at all levels.

Restoration is one of the Nature-based Solutions essential to ensure more resilient ecosystems capable of providing ecosystem services and goods across the Mediterranean. And coupled with effective conservation and management, restoration can help build a healthier socio-ecological landscape for Mediterranean people.

We are glad to contribute to the UN Decade of Ecosystem Restoration and assist in the framing of broader ecosystem-based strategies to ensure that biodiversity conservation efforts are integrated in relevant sectoral policies and practices. Our final target is to stir a fundamental transformative change, being “a fundamental, system-wide reorganisation across technological, economic and social factors, including paradigms, goals and values” (IPBES, 2019) that shift our Mediterranean economies, policies, and mindsets to halt environmental loss and set nature on a path of recovery.

What is an ecosystem?

Ecosystems are the web of life on Earth.

An ecosystem comprises all the living organisms and the interactions among them and with their surroundings in a given space.

They exist everywhere, at different scales, from a grain of soil to the entire planet, in forests, rivers, wetlands, grasslands, estuaries and coral reefs. Cities and farmlands also contain important human-modified ecosystems.

Healthy ecosystems have priceless benefits. They provide a stable climate and breathable air; they store and supply water, food and materials of all kinds; they protect us from natural disasters and disease.

Natural ecosystems are also important for our physical and mental health, and for our cultural identity. They are home to precious wildlife.

Ecosystems are the habitats and species that together make possible to live on this planet, us included.

Why is ecosystem restoration important?

Restoring ecosystems means protecting their biodiversity and ecological interactions, so that they can keep delivering benefits for people and nature. It means using ecosystems on land and in the oceans in ways that strengthen their natural resources and processes, and therefore improve the socioecological conditions of the communities that benefit from them.

Ecosystem restoration means assisting in the recovery of ecosystems that have been degraded or destroyed, as well as conserving the ecosystems that are still intact. Healthier ecosystems, with richer biodiversity, yield greater benefits such as more fertile soils, bigger yields of timber and fish, and larger stores of greenhouse gases.

Restoration can happen in many ways – for example through actively planting or by removing pressures so that nature can recover on its own. It is not always possible – or desirable – to return an ecosystem to its original state. We still need farmland and infrastructure on land that was once forest, for instance, and ecosystems, like societies, need to adapt to a changing climate. This is particularly true in the case of the Mediterranean, where different cultures and practices have for centuries modified the ecosystems.

All kinds of ecosystems can be restored, including forests, farmlands, cities, wetlands and oceans. And restoration initiatives can be launched by almost anyone: governments and development agencies, businesses, communities and individuals. As the causes of degradation are many and varied, and so action at all levels can have an impact at different scales.

Restoring ecosystems, large and small, protects and improves the livelihoods of people who depend on them. It also helps to regulate disease, control carbon emissions and reduce the risk of natural disasters.

Overview of Mediterranean restoration practices

Forest ecosystems

1 Forest landscape restoration in Lebanon

Wetland ecosystems

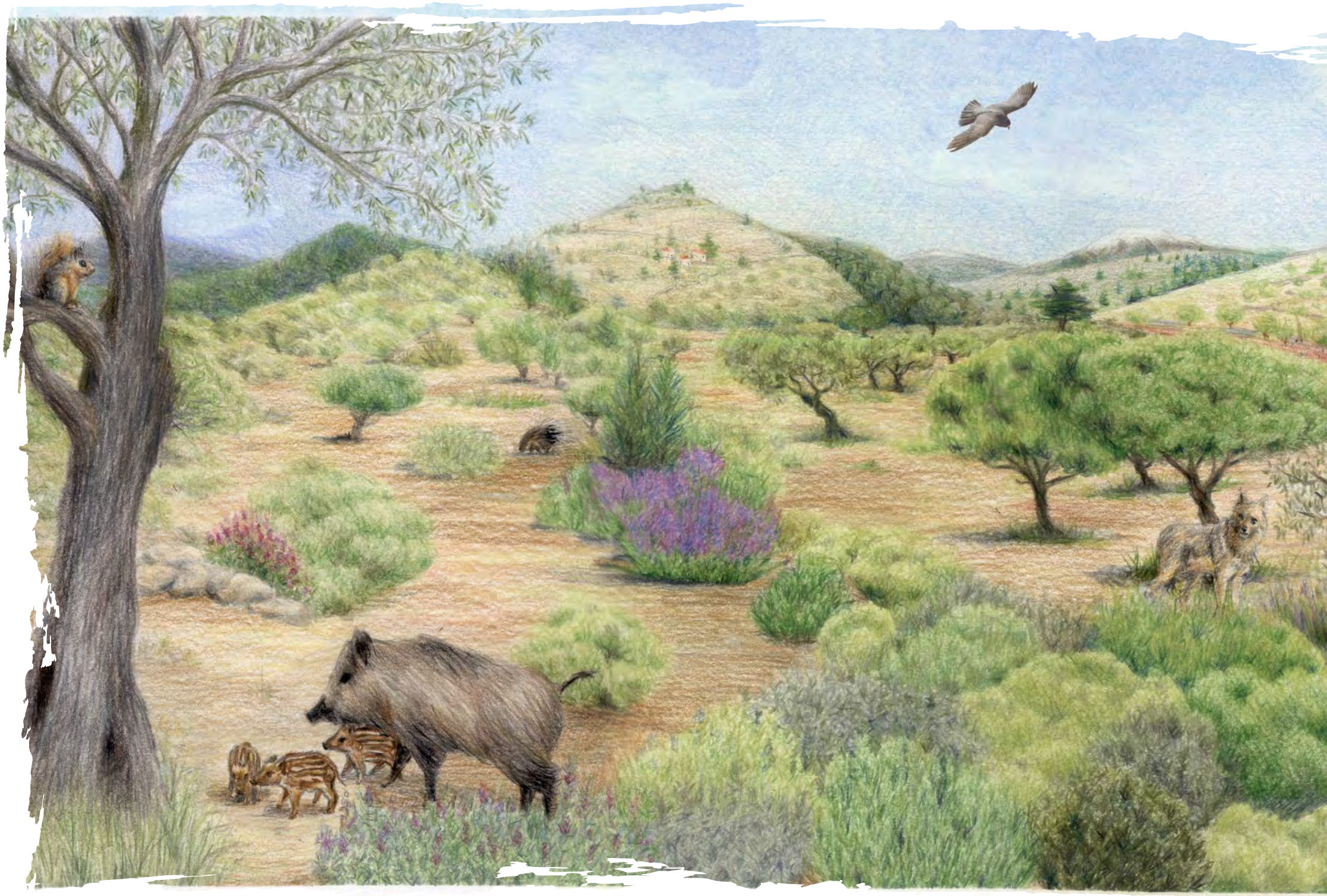
2 Adaptive management of saltworks in France
3 Improving wetlands networks in Spain
4 Reinstalling a special nature reserve in Montenegro
5 Water interventions for the European eel in Italy and Greece

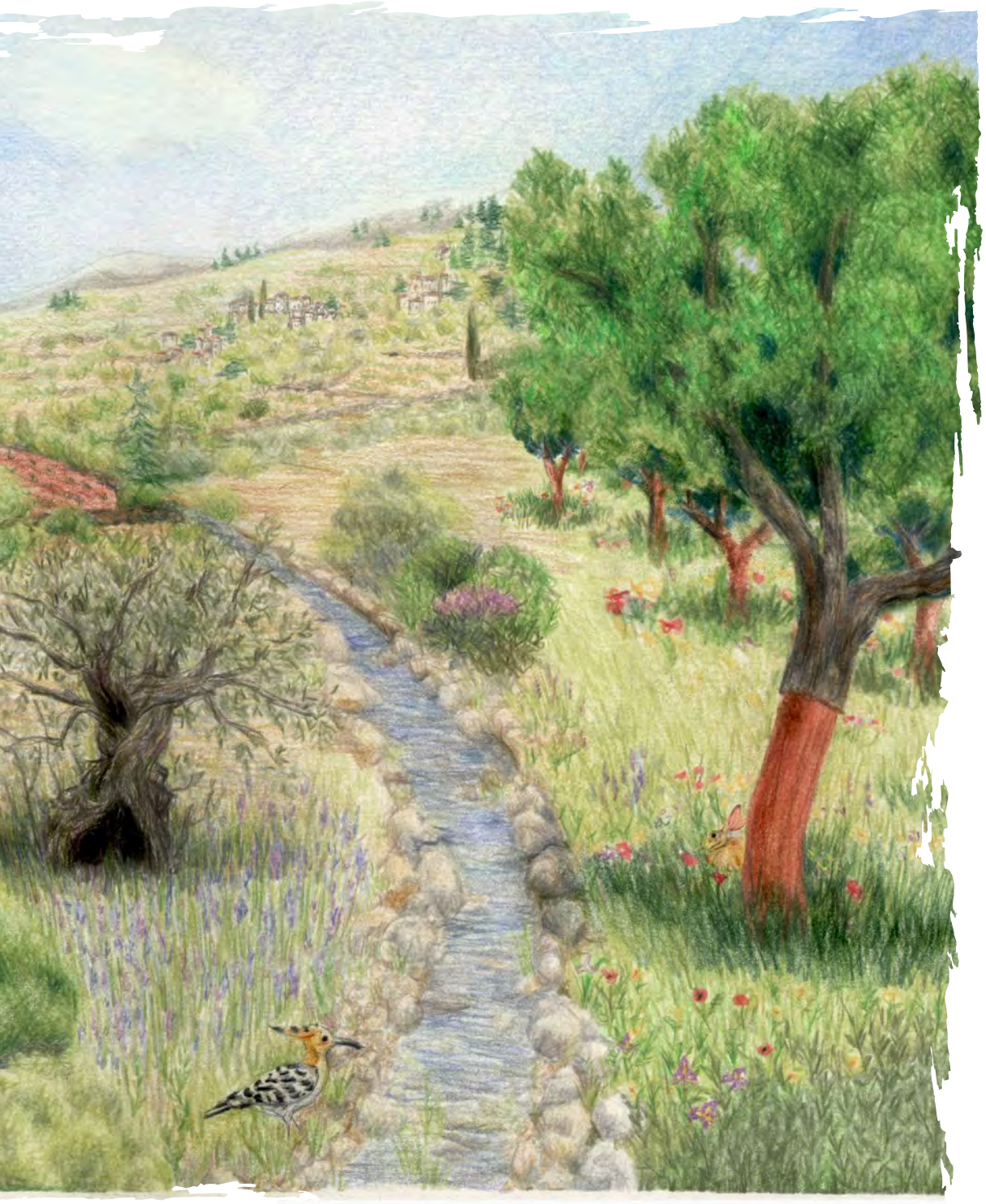
Coastal and marine ecosystems

6 Reconstructing coastal dunes against erosion in Italy
7 Deconstructing to build back nature in Spain
8 Artificial reefs and reserves to enhance fishing in France
9 Restoration of orange coral (*Astroides calycularis*) based on recruitment enhancement
10 Assisting orange coral colonies in Spain
11 Restoration of Mediterranean macroalgal forests in Spain

* Click on the name of the initiative to download a summary poster

Find your restoration site poster here:
https://biodiversity.uma.es/site-stories/#restoration





Forest ecosystems

Forests and trees provide us with clean air and water, capture vast amounts of climate-heating carbon and are home to most of Earth's biodiversity. They supply food and fodder, fuel and materials, and support the livelihoods of billions of people.

But forest ecosystems face intense pressure from our rising population and hunger for land and resources. Vast areas of tropical forest are being cleared for commodities like palm oil and beef. Remaining forests are degraded by logging, firewood cutting, pollution and invasive pests. Trees outside forests are fast making way for houses, infrastructure and more intensive farming.

In the Mediterranean, the increasing temperatures leading to desertification and forest fires are seriously affecting the habitat of many endemic species, some of them at the risk of extinction.

Restoring forest ecosystems involves returning trees to formerly forested land, including settlements and agricultural areas, better management, and improving the condition of degraded forests.

Successful forest restoration practices must help achieve biodiversity and climate change adaptation targets while providing economic and social benefits. These practices imply a consideration for the suite of species incorporated into restoration with the aim of moving toward more stress resistant and competitive forest communities.

Forest

Forest landscape restoration in Lebanon

© djedj / Pixabay

General information

LEBANON

Organisation
Shouf Cedar Reserve

Type of organisation
Local or subnational NGO or Community-Based Organisation (CBO)

Contact person
Nizar Hani
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Website
http://shoufcedar.org/

Site location

Latitude
33° 41’ 23.54” N

Longitude
35° 42’ 4.57” E

Implementation area
50 000ha

Hiking trails
+ 250 km

Duration time
Jan 2012 → Ongoing

Scan the code for full description

> We are farmers. Two brothers from Ain Zhalta, one of the villages of the Shouf Biosphere Reserve. Despite trying our best, we had a very modest income and could barely make ends meet. Since we started working with the Shouf Biosphere Reserve some 4 four years ago, we have developed a very successful business in agriculture and agritourism. The team came to us with practical and theoretical knowledge related to sustainable agriculture. We learned how to produce our own seedlings using original species that proved to be resilient to diseases and we are now doing our own compost using any remains from agriculture or cleaning forests, in addition to animal manure from our own animals. We learned that the forest surrounding us and our farm are one entity. We have visitors who want to see our work, so we are engaged in agritourism. We have farmers who want to learn and share experiences and the SBR established a "Sustainable Farming School" on our premises. And we now have a nice hall to use for the workshops and for receiving our visitors. We have been able to earn a decent living and look forward to an even better future.
>
> *Ramzi and Wajdi Abou Saab*

Type of restoration intervention

- Assisted natural regeneration
- Tree planting
- Fencing
- Livestock control (grazing plans)
- Soil restoration by mulching
- Soil restoration by green manure
- Silvicultural practices
- Integration of timber or fruit species on cropped fields (agroforestry)
- Introduction of wildlife
- Value chain development
- Development of production protocols for high quality seeds and seedlings of a wide range of native trees, shrubs and herbs.

Main drivers of degradation

- Grazing land management
- Croplands and agroforestry management
- Forests and tree plantation management
- Non-timber natural resource extraction
- Fire regime changes
- Extractive industry development
- Infrastructure and industrial development and urbanisation
- Demographic
- Economic
- Science, knowledge and technology
- Institutions and governance
- Cultural

BACKGROUND

The Shouf Biosphere Reserve (SBR) is a mountainous landscape extending from about 1100 to 1900 meters in the southern extension of Mount Lebanon. The climate of this area is characterized by a bio-climatic gradient from the Supra-Mediterranean type at the lower altitudes, with fresh to cold temperatures and sub-humid conditions, to the Oro-Mediterranean type at higher altitudes, characterized by sub-humid to humid conditions and cold to very cold temperatures. In the eastern slopes of West Beqaa there are drier conditions with less annual rainfall.

The average annual temperature is 13.6 Celsius knowing that climate change has become evident in recent years, with a 0.7 Celsius increase.

Like other forest landscapes in Lebanon, it is mainly threatened by the extractive industry (quarries), urbanization, forest fires, overgrazing and uncontrolled extraction of forest resources, wildfires, and an outdated legal framework matched with poor law enforcement, all exacerbated by climate change.

The area has been facing significant land-use changes related to the application of traditional cultural practices, the intensification or abandonment of such practices, and in the case of cedar forests, the exploitation of its timber since ancient times. As a result, the current landscape comprises a series of land cover types and subtypes linked to different uses and their degree of use or abandonment in different areas.

The social context of SBR is very complex; the area hosts more than 170,057 inhabitants, many of whom depend on agricultural activities as an additional source of income to have a decent living. The trend is towards a downscaling of traditional agricultural activity due to an ageing population, poor marketing strategies, soil degradation, and high production costs (e.g. excessive use of pesticides and fertilizers). Security issues and political instability have also marked impacts on people's livelihoods. The 2006 war, in particular, was a breaking point, and economic activity has not yet returned to pre-war status. The lack of employment opportunities has led to increased migration, and residents are heavily dependent on remittances from Lebanese who live and work abroad.

The SBR hosts some Syrian refugees registered by the UNHCR in Lebanon. On average, about half of the refugees' household members are engaged in agricultural activity, which was the predominant employment sector.

The SBR is a multicultural region with a mosaic of religious communities. The Cedars of Lebanon are an important part of the national cultural heritage, preserving existing religious practices and rituals.

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Goals

Restore the ecological, socio-economic and cultural resilience of the Shouf Biosphere Reserve landscape. The participatory Forest and Landscape Restoration (FLR) planning for the SBR landscapes, has formulated the following long-term vision: “A highly diverse and functional SBR landscape that is internationally recognized as the repository of a rich cultural heritage linked to its natural resources and emblematic species - especially the national symbol *Cedrus libani* - that sustains healthy ecosystems and viable populations of biological species resilient to climate risks, and whose restored ecosystem services support the economic, social and cultural needs of the multiple stakeholder groups”.

Forest

WHAT IS THE PRACTICE ABOUT

- Nursery production of climate-adapted, high-quality seedlings from a wide range of multi-purpose native tree, shrub and herbal species, and locally-adapted crop species and varieties
- Effective, climate-adapted, field restoration interventions to increase soil water availability and seedling survival without the need to irrigate
- Planting interventions in degraded forest, pasture land and restored terraces, have included seeds and/or seedlings from up to 20 species
- Establishment of fenced plots with seed/seedling planting of a wide range of native species to create woodland islets in large pasture/ shrubland areas

- Reintroduction of the Nubian ibex in the core zone of the SBR to enhance biodiversity and to restore ecosystem functioning and food webs
- Application of an integrated climate change adaptation and mitigation strategy through the combined management of agriculture waste and wood from coppice oak and pine forest thinning, for bioenergy and compost production.
- Diversified organic production in restored agriculture terraces following conservation agriculture principles
- Effective governance of short-distance transhumance in the restored landscape areas
- Value chain development to achieve socially beneficial and long-term economically viable FLR interventions
- Development of nature trails linked to the integrated forest-pastoral-agriculture restoration interventions
- Participatory process at the municipality level to clearly define and agree with landowners (both private and public) about the boundaries and use designation in the buffer zone of the Reserve
- Demonstrative pilot actions of natural resource management and forest restoration welcomed, through organised visits, different public and private stakeholders concerned, and contributed to open debates and concrete results of law reform or inadequately designed restrictive regulations
- Design of participatory and simple “adaptive management” monitoring methods to evaluate/adjust the performance of the FLR interventions and their environmental, social and economic impact.
- Equal support of women and men in all planning, decision-making, training, development and monitoring interventions, with special focus on unemployed youth and refugees.

ACHIEVEMENTS AND IMPACT

- Successful restoration of 200 hectares of degraded forests and pastures, making use of high-quality seeds and seedlings from about 50 native plant species;
- demonstration of the possibility to implement forest restoration without additional field water supplies, achieving on average 70% of survival rate, a great success towards the adaptation of restoration interventions to climate change impacts, the reduction of restoration costs and a major contribution to the improvement of the forestation guidelines defined by the Lebanese government in its National Forestation Programme;
- decrease of forest restoration costs from USD10 per planted seedling to USD 2.5-3, thanks to accurate plant production protocols avoiding the unnecessary consumption of inputs; equipment used for soil preparation (auger machine); empowerment and professionalisation of the staff involved in plant production and field planting; and the avoidance of watering for the maintenance of restored sites. It is expected that the improvement of work performance and lower cost of seedlings will further decrease restoration costs per hectare up to USD 1.5-2 in the short- to medium term.
- Bioenergy production: Reduction by ⅔ of the energy cost of locally produced briquettes compared to regular fuel, with a positive effect on the consumption and savings of the local population and in pollution reduction and less health problems.
- Fire-risk reduction: reduction of the forest fires due to the decrease in the number of farmers who burn stubble and pruning remains. Control of biomass through livestock grazing in pruned/thinned forest corridors throughout high fire risk areas in the landscape matrix.
- Soil fertility: Production of about 400 tons per year of high-quality organic compost from the shreds of forest pruning, supporting sustainable farming practices in the agriculture terraces.
- Agriculture production: 250 hectares of restored terraces were put into organic production including a diverse set of local crop species and varieties and wild useful plant species. The restored terrace systems maintain higher levels of indicator farmland habitats/plant species than the controlled low-intensity and high-intensity managed terraces, increasing incomes and the adaptive capacity of farmers.
- Value chain development: New green enterprises and cooperatives for the production, processing and marketing of bioenergy and edible products, and for eco-tourist services were established in the landscape.
- More than 250 km of hiking trails were established and equipped, connecting sites of high ecological value in which the different natural ecosystems and semi- natural agro-silvo pastoral areas of the landscape are represented, as well as sites of high cultural value where historical monuments are maintained. This has generated local employment opportunities and increased income opportunities for community members involved in local food and tourism from the villages linked in the area.

Wetland ecosystems

Wetland ecosystems supply food, water and energy to billions of people, protect us from droughts and floods, and provide unique habitatS for many plants and animals, including one-third of all vertebrate species. These ecosystems are particularly degraded. They face pollution from chemicals, plastics and sewage as well as overfishing and over extraction of water. Unsustainable transport and urban development and agricultural practices degrade them further.

The continuous drainage of wetlands across the last centuries resulted in a global loss of 87% of these ecosystems wiped away with one out of three freshwater species threatened with extinction. Furthermore, in the Mediterranean climate change is exacerbating desertification and drought periods which, together with the increasing demand for water supplies and growing population, makes wetland restoration, protection and management a priority for the region.

Protecting and restoring wetland ecosystems can mean improving water quality, controlling how these ecosystems and nearby lands are used, and stopping or reversing human modifications to natural processes.

Restoring wetland ecosystems involves the manipulation of degraded wetlands' physical, chemical, or biological characteristics to return its natural functions. Successful wetland restoration practices means the re-establishment or rebuilding of former wetlands and the rehabilitation, repairing the functions of degraded ones, which helps achieve biodiversity and climate change adaptation targets as sustainable development goals.

Effective wetland ecosystem restoration ensures maintaining critical habitats and species, securing natural buffers that soak up and store a significant amount of floodwater, ensuring carbon sinks by capturing and storing atmospheric carbon dioxide and contributing to socio-economic well-being by providing water, food and natural recreational areas.

Wetland

Adaptive management of saltworks in France

© Pfüderi / Pexeles

General information

FRANCE

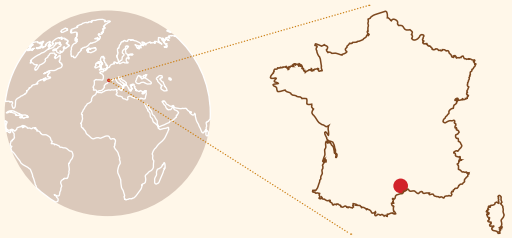
Organisation
Tour du Valat

Type of organisation
International or regional organisation, network or initiative Research or academia (incl. tertiary education)

Contact person
Lisa Ernoul/ Brigitte Poulin / Marc Thibault
ernoul@tourduvalat.org
poulin@tourduvalat.org
thibault@tourduvalat.org

Website
https://tourduvalat.org/

Site location



Latitude
43°24'17.3"N

Longitude
4°37'21.0"E

Implementation area
5 000ha

Public cost reduction
13-17 M €

Restoration started
2011

Scan the code for full description

> The restoration project has made it possible to reinforce the wilderness of the site and therefore its landscape value for welcoming the public, while allowing hydro-biological exchanges favorable to migratory fish and strengthening the buffer role of coastal wetlands against the sea level rise.

Marc Thibault,
Ecosystem management-restoration project manager at the Tour du Valat
and co-manager of the former Camargue saltworks site

Type of restoration intervention

- Natural regeneration
- Assisted natural regeneration
- Channel reconstruction
- Reconnecting water bodies, reshaping water paths in a natural way, restoring the natural hydrological functioning of coastal lagoons, restoring sandy coastlines, salt steppes and saltmarshes
- Control of invasive alien species

Main drivers of degradation

- Infrastructure and industrial development and urbanisation
- Alteration of the natural hydrological functioning of coastal ecosystems
- Economic interests
- Alteration of vegetation

Wetland

BACKGROUND

The former saltworks restoration project in the Camargue is an example of how humans can help reverse human-made degradation of ecosystems through adaptive restoration until nature can regain its functionality and restore its resilience.

The former salt works (5,000 ha of lagoon, salt marsh and dunes), are located in the Rhône delta, in the Camargue Regional Nature Park. This site belongs to a vast coastal area of 6,542 ha located in the communes of Arles (Salin-de-Giraud) and Les Saintes-Maries-de-la-Mer. Formerly developed for salt production from 1950 to 2008, the site is characterised by a strong artificialisation of the water cycle and a disconnection of the lagoons which served as basins for salt preconcentration. The former salt works are located in a regional nature park, next to the Camargue and Tour du Valat Nature Reserves. They all contribute to site management and restoration.

The former salt exploitation left as legacy:

- Highly controlled water levels and salinity in every pond
- Inverted natural cycles of water levels: high levels in summer and low in winter
- Simplified aquatic communities as a result of high salinities
- Limited biological exchanges among lagoons
- General disconnection from the Rhône river and the sea as a result of polderisation.

Goals

Restoration of the natural characteristics and processes of the ecosystem to ensure connectivity among different water bodies, increase natural resilience and reduce the effects of climate change and risks of natural disasters.

Interventions have been implemented according to the Nature-based Solution (NbS) approach and have included the restoration of gravitational water flows and abandonment of seafront dykes, leading to the creation of a natural littoral.

WHAT IS THE PRACTICE ABOUT

The main goal was to restore the area through the creation of a buffer zone which contributed to a broader strategy (including dyke adaptation and consolidation further inland) to mitigate flood risks.

This buffer area together with the inland dyke, contribute to protecting the Camargue from marine submersion. This creates a more sustainable and less costly alternative from an ecological and economic point of view, than maintaining or rebuilding a seawall and other coastal defence-related infrastructures along the coastline.

On this 5,000 ha site, mainly made up of former salt pans, major hydraulic works have been carried out in order to re-establish the hydrobiological connections between the various lagoons on the site, the sea and the peripheral sub-catchment areas. Artificial islets have also been created to encourage the reproduction of Greater flamingos and colonial laro-limicolous birds. Ecological monitoring of the site is carried out in order to monitor its evolution and evaluate the effectiveness of the restoration actions. Faced with the rapid evolution of the site in recent years, due to changes in its management, coastal dynamics and sea-level rise, interdisciplinary and prospective workshops have been initiated to better apprehend collectively the dynamics underway, both from a geomorphological and socio-economic point of view, in order to feed an adaptive and integrated management process for the site.

ACHIEVEMENTS AND IMPACT

- Natural formation of a moving barrier beach, helping to reduce the risks of erosion and flooding at a lower cost;
- Improvement of the ecological status of part of the lagoon environment;
- Contribution to the development of fish stocks at sea and in the lagoons;
- Increase in the number of colonial breeding gulls and shorebirds;
- Recolonisation of bare soil by Salicornia and Limonium, habitats of community interest in decline in the Camargue;
- Gain in quality, diversity and naturalness of the landscape; and
- Diversification of uses (ecotourism, beach tourism, fishing, hunting, etc.).

Wetland

Improving wetlands networks in Spain

General information

SPAIN

Organisation
SAV. Servicio de Conservación de Ambientes Acuáticos/Devesa-Albufera

Type of organisation
Cooperatives, Small and Medium Enterprise (SME) or private sector entity

Contact person
Pablo Vera
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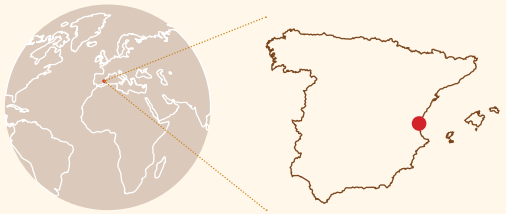
Website
https://www.sav.es/areas-de-negocio/conservacion-de-espacios-naturales-protegidos/

Site location



Tancat de la Pipa
39°21'49.8"N, 0°20'46.6"W

Tancat de la Ratlla
39°19'38.1"N, 0°23'39.9"W

Tancat de Milia
39°18'28.0"N, 0°21'17.8"W

Tancat de Burriel
39°21'52.4"N, 0°20'25.3"W

Tancat de l'Illa
39°16'41.6"N, 0°17'29.5"W

Implementation area
105 ha

Coastline
17 km

Restoration started
2006

Scan the code for full description

Type of restoration intervention

- Natural regeneration
- Assisted natural regeneration
- Removal of contaminants
- Assisted water management

Main drivers of degradation

- Croplands and agroforestry management
- Drainage (wetlands)
- Alteration of vegetation

BACKGROUND

L'Albufera de València is a coastal wetland, protected on a regional (Natural Park) and international (Natura 2000, Ramsar convention) scale due to the occurrence of a wide variety of habitats and species of high conservation value.

The main habitats it comprises are a shallow freshwater lagoon, a vast extension of rice fields, mature coastal forest, dunes and other transitional littoral habitats. The shallow lagoon, c. 3,000 hectares, is surrounded by a narrow border of marshy vegetation and small islands mainly composed of calcareous peat bogs' habitats. Twelve thousand hectares (12,000 ha) of rice fields surround the lagoon, which are drained by a complex network of canals and ditches, in which intensive cultivation is carried out.

Along the 17 Km of its coastline, long stretches of natural beaches with mobile and fixed dune formations occur with flooded interdune depressions, and it is considered one of the best examples of mature coastal forests that survive today in the Mediterranean.

The main pressures for biodiversity conservation come from water management. There has been a dramatic decline in water input to the system over the last 30 years, and significant diffuse pollution input produced by nutrients derived from agriculture, especially phosphorus and nitrogen. In addition, throughout the year, water input management in the wetland is mainly aimed at rice production, which produces long periods of drying and hydric stress in the aquatic habitats between these uses.

The main economic activities are the cultivation of rice, together with fishing and gastronomy. The wetland is surrounded by 13 urban areas with more than 1,5 million people, and a wide network of road infrastructure and industries. In the last two decades, the effects of climate change on biodiversity and on agricultural yields have increased. The origin of these impacts is found in the increase in salinity, due to both marine intrusion enhanced by large port infrastructures that have changed the coastal dynamics, and an increase in salinity in the contributions of freshwater from the wetland basin and the reduction of overall water inputs.

Goals

The objective of the successive restoration projects is contributing to overcoming two of the main problems for the conservation of biodiversity in l'Albufera: bad quality of water and the scarcity of permanent flooded habitats and marshlands.

Wetland

WHAT IS THE PRACTICE ABOUT

Restoration projects have been developed on former rice paddies by restoring constructed wetlands and small patches of aquatic habitats.

The artificial wetlands have been restored by public bodies. They are located on the edge of the Albufera lagoon. The strategic location has promoted the colonisation and connectivity of fauna and flora from the bordering areas, accompanied by a design that contemplated the creation of temporary flooding lagoons and marshland habitats mosaics. The artificial wetlands receive water with a high nutrient load from agriculture through irrigation channels, which is circulated by plots with natural vegetation that work as green filters. The improvement in water quality also promotes the attraction of endangered biodiversity that requires permanent, shallow, good quality waters, which is one of the habitats with the most unfavourable status in the wetland. The Tancat de la Pipa management is carried out through land stewardship agreements with environmental NGOs that develop participatory management involving research centres and local and regional public entities. This scheme has allowed the establishment of management protocols based on an integrated approach, scientific evidence and settlement of common goals.

The regional government developed the restoration actions of small-sized rice fields. These actions allowed ecological functions to be recovered through a strategic design that restored extinct habitats in the wetland and reintroduced species of threatened flora. The management of these small wetlands (5-10 ha) is carried out through a co-management model and an environmental NGO, in which the success of the implementation measures is monitored. In both cases, the management plans include experimental measures for water management, such as the use of renewable energies and close communication with the farming communities.

ACHIEVEMENTS AND IMPACT

All of the restored areas have quickly become biodiversity hotspots in l'Albufera for the presence of flora and fauna of conservation concern at a regional, national or international scale. The evaluation of the impact of these areas on the conservation status of the wetland has highlighted that, although restored areas represent a low percentage of the total surface of Albufera, it has still has triggered the colonisation of new species linked to coastal lagoon habitats, as well as an increase in the population and habitat surface of biodiversity targets identified for them, and for targets included in Birds and Habitat Directives. It is not only birds, but also reptiles, fish and arthropod diversity that have been boosted in these restored areas.

Water quality monitoring has shown the use of constructed wetlands as surface green filters. According to scientific monitoring data, nutrient load and chlorophyll are reduced as water flows through the green filters, as a consequence, water outputs have bigger zooplankton loads and smaller loads of phytoplankton, which is of paramount interest for lagoon conservation.

These experiences have provided evidence of the need to go further in implementing restoration projects in Albufera, especially in the rice fields surrounding the lagoon. Also, smaller-scale projects have demonstrated that the use of small restoration projects focused on concrete, specific and functional ecological restoration, increases connectivity of the wetland and strengthens the network of restored areas.

In the past 12 years, almost 50,000 people have visited the restored areas. Tancat de la Pipa has become the second most visited attraction in Albufera de València and is a doorway to discover marshland habitats and species, as well as linkages with cultural heritage such as farming, fishing and sailing.

The economic valuation of the provision of ecosystem services in one of the areas after its restoration has been estimated at more than € 20 million.

Wetland

Reinstalling a special nature reserve in Montenegro

General information

MONTENEGRO

Organisation
Javno preduzeće za upravljanje morskim dobrom Crne Gore – Public Enterprise for Coastal Zone Management of Montenegro - JPMDCG

Type of organisation
National government

Contact person
Dijana Došljak
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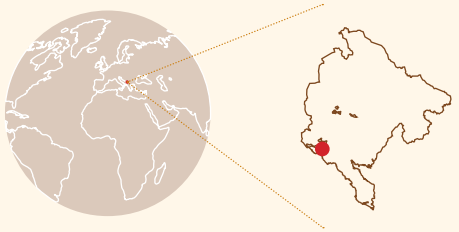
Site location



Latitude
42°23’36.59”N

Longitude
18°42’54.56”E

Implementation area
150 ha

Annual budget
50-100 k €

Visitors per year
3000-3500

Scan the code for full description

Type of restoration intervention

- Natural regeneration
- Fencing
- Channel reconstruction

Main drivers of degradation

- Drainage (wetlands)
- Alteration of vegetation
- illegal hunting and fishing activities

BACKGROUND

The location of “Tivatska Solila” Special Nature Reserve is a historical one. For more than a millennium, these lowlands at the southwestern end of the Bay of Kotor were valuable salt pans, providing a stable livelihood for the local population. Even in relatively modern times several hundred families were harvesting salt until in 1960 the production finally ceased and Solila fell into oblivion. What was once a place of civic and community importance fell derelict and became a dumping ground for debris from human and construction activities. Although the area of Solila deteriorated over the time, specific biodiversity developed and as it was the rare natural area in the middle of urbanized and industrial settlements, it became a refuge for numerous animal species. On the other side, the location became interesting for construction development threatening to destroy the last coastal wetland area in this part of Montenegro. The once pride of the area turned into a dump over the years. Solila became a derelict area, filled with various types of waste, from common rubbish to excavated earth, construction debris and septic tank contents.

Nevertheless, half a century after the last salt harvest, the significance of Solila became recognized; this time not for salt extraction, but rather as one of the most significant bird and halophyte vegetation habitats in the region of former Yugoslavia.

In 2008, upon the initiative of the Municipality of Tivat, the 150 ha in the area of Solila was protected at a national level as Special Nature Reserve “Tivatska solila” due to its exceptional natural values and habitat for halophytic vegetation and ornitofauna. Since 2013, the management activities of the Public Enterprise for Coastal Zone Management (JPMD) improved the area and changed it into an attractive nature “getaway” that is only minutes away from the town of Tivat. The walking trail with information boards about the natural and cultural values of Solila is popular for morning recreation and evening family walks throughout the year, and birdwatching from the towers is an attraction for visitors from other towns and abroad.

Goals

The practice of natural restoration in the Special Nature Reserve “Tivatska solila” was addressing primarily the environmental challenge, however it also included a social aspect, which, over time, became an important factor for its success.

Wetland

WHAT IS THE PRACTICE ABOUT

The earliest interventions in the reserve included deep clean-ups of the area from the waste deposited over decades, clearing the canal to restore water circulation, and placing fences in a section of the site to prevent further dumping and biodiversity disturbances. After JPMD had become the site manager, they started allocating €50,000 - €100,000 annually for further development, remediation, monitoring, education and promotion of the site.

The 12 bridges along the existing road dating back to Austro-Hungarian times, were fully reconstructed connecting the path across the Nature Reserve. The rehabilitation of additional embankments of the former saltpans became a 2 km-long recreational path equipped with infopoints, wildlife observation towers, benches, information boards and garbage bins. To prevent motor vehicles from entering the site, gates were placed at both entrances. In cooperation with NGO CZIP, the first activities to promote the site took place, where JPMD established an Information Centre, and NGO CZIP provided a part-time education expert guide for the Special Nature Reserve “Tivatska solila”. Based on the positive experiences from this pilot project, JPMD introduced a new post into the workforce plan and employed a permanent staff member in charge of information, monitoring and control of the site.

JPMD has continued to invest substantial funds yearly to develop the infrastructure. So far this has included: Two bird-watching towers, a vantage point, a first floodgate to control the water level, information boards about the Nature Reserve including rules for visitors and eight educational boards along the hiking/cycling paths. These spots are at the same time eight interactive audio-guide points (izi.TRAVEL).

Between 2013 and 2019, a total of 350,000€ has been invested in site infrastructure. Apart from the comprehensive infrastructure development, further funds are allocated yearly to restore the site to its original state, as well as for the scientific monitoring of the flora and fauna, which is seen as a matter of great importance.

Considering that apart from birds (routinely monitored by NGO CZIP), there was not much information about biodiversity at the Solila, JPMD hired experts to conduct research within the reserve and make species inventories for fish, crustaceans, insects, amphibians, reptiles, mammals, fungi and plants, which led to the collection of significant new data.

ACHIEVEMENTS AND IMPACT

The research implemented gave as result a checklist of vascular flora at Solila including 470 species/subspecies, four of which are endemic for the Balkan Peninsula, while research into fungi revealed the presence of 20 different types. Research has also taken stock of 10 species of reptiles and 19 species of mammals. Among the amphibians, five species are present, one of which is listed as an endemic species for the Balkan Peninsula. Further, a total of 145 species of insects were recorded with 16 of them endemic.

Monitoring bird species showed excellent results of the restorative works and good management of the Nature Reserve. The number of identified species increased from 114 in 2008 to 185 in 2020. An increased occurrence of rare birds resting during spring and fall migrations (cranes, storks, spoonbills), as well as the return of flamingos to the Nature Reserve and the registered nesting of black winged stilts in 2021, the most important confirmation of successful management, were also recorded.

In 2017, the international project “Cultural Indicators” implemented by JPMD in cooperation

with the Mediterranean Wetlands Initiative (MedWet) and Mediterranean Wetlands Observatory (MWO), assessed that the site was visited by 1,500 nature lovers of which for the first time 57 foreign and 100 domestic visitors were surveyed between May and November, . In 2018, approximately 2,700 individuals and 500 organised (groups) visited the site. This increased in 2019 with 3,500 individuals and 700 organised (groups) visits. Unfortunately, the number of visitors in 2020 and 2021 decreased due to the measures enforced during the COVID-19 pandemic.

Wetland

Water interventions for the European eel in Italy and Greece

General information — ITALY GREECE

Organisation
Emilia-Romagna Region

Type of organisation
Local or subnational government, including field extension services

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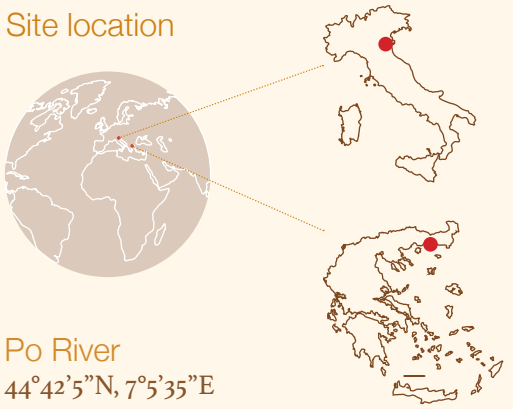
Site location



Po River
44°42'5"N, 7°5'35"E

Nestos
40°50'51"N, 24°48'15"E

Implementation area
71,000 km²
Po basin

Implementation area
5,184 km²
Nestos river

Ongoing until
2024

Scan the code for full description

> "To counteract the dramatic loss of biodiversity we are facing in the last decades we need to make our responses quicker and more effective. While restoring the European Eel population in our rivers, Lifeel also contributes to the free flowing of rivers as a basic frame for the aquatic biodiversity and resilience. Integration in policies, collaboration, knowledge are the key features of our project, to help dealing with the climate change impacts while searching for a balance between humanhood and nature."
>
> *Alessio Mammi,*
> *Regional Councillor, Emilia-Romagna Region*

Type of restoration intervention

- Assisted natural regeneration
- Introduction of wildlife
- Rivers flows restoration / fostering and improve
- artificial reproduction of endangered species to restock wild populations

Main drivers of degradation

- Infrastructure and industrial development and urbanization
- Science, knowledge and technology
- Institutions and governance
- Drainage (wetlands)
- Reintroduction of stock of endangered species *Anguilla anguilla*)

BACKGROUND

Concrete interventions directed on the environment and the species are taking place on the Rivers Tresa, Ticino, Panaro, Po, and in the areas of the Po Delta and the Comacchio Valleys. The practice involves three administrative regions – Lombardia, Veneto and Emilia-Romagna – and also the Swiss portion of the Po basin, extended in the Canton Ticino, also being able to count on the financial support of the Cantone for the entire project. The second area involved is located in Greece focused on the territory of the National Park of Eastern Macedonia and Thrace, including the Nesto River basin and a lagoon system that represents more than 24% of the lagoons present in Greece. Concrete conservation actions involve the Nesto River and the lagoons.

This practice is the first conservation project for the species *Anguilla anguilla* (LIFEel) which is structured and conceived at the Po River basin scale. With the goal to increase and maintain the species wild population, a severely endangered migratory fish species which travels overseas throughout its life, this project addresses the main threats to its survival:

- fragmentation of the free river flows which hampers the reproduction dynamics
- fishing pressure on breeders for human consumption and on juveniles for aquaculture
- difficulties of reproduction in captivity
- lack of institutions collaboration and awareness about the importance of the species as a biodiversity pillar at a worldwide scale
- and disinformation and misinformation about one of the most mysterious fish species since the dawn of research.

The restoration project relies on an innovative, disruptive, shared and participative approach, and aims at transposing good practices and scientific innovative knowledge in other Eastern Mediterranean areas where the same approach could be applied.

Goals

The practice's overall objective is to support the biodiversity heritage of the Po River basin through the conservation of one of the most emblematic species for the Po River basin and the National Park of Eastern Macedonia and Thrace: the European eel. The project-specific objectives are operational objectives, designed in response to specific threats.

WHAT IS THE PRACTICE ABOUT

Action 1 Reopening of migration routes for eel can address environmental issues

Action 2 Protection of the adult specimens

Action 3 Support to the survival of juveniles (which has and environmental goal but also add economic value as it restores the fish stock crucial for the local economies)

Action 4 Raising public and stakeholder awareness is in itself a transversal objective and addresses therefore all the challenges

The practice is structured according to a precise scheme of actions which include: a package of preparatory actions for the actual conservation actions, indicated by the letter "A"; a package of conservation actions "C", which includes all the concrete interventions put in place by the project for the conservation of the target species Anguilla; a set of "D" actions to monitor the effectiveness of the conservation actions carried out by the project, for the verification of the actual results achieved; an "E" action group of dissemination, education and involvement of the various target groups and stakeholders identified by the project; an "F" group of actions to manage and coordinate all work and partnership. The actions of the LIFEEL Project are:

- A1 Start of the project
- A2 Protocol for the selection of the best breeders
- A3 Designing eels passages
- A4 Analysis and guidelines to favour the downstream migration to the sea in the Po basin
- A5 Plan of priority measures to restore river connectivity for eel
- C1 Release of selected silver eels into the wild
- C2 Development of a captive breeding program for eels larvae and release into the wild
- C3 Realization of eels passages for upstream migration of young eels
- C4 Implementation of a deterrence system for downstream migration of eels
- D1 Monitoring the effectiveness of selected silver eels releases
- D2 Monitoring the effectiveness of the passages built in Action C3 and monitoring of the deterrence system
- D3 Monitoring of the results of the breeding programme for juvenile stages of eel
- D4 Monitoring of the overall impact of the project
- E1 Information and awareness raising activities
- E2 Technical dissemination and networking

ACHIEVEMENTS AND IMPACT

The project leads to the production of different protocols for selection of best breeders, implying the involvement of fishermen and fish farmers in its application and validation, leading to an increase of awareness of these stakeholders.

The results of action A5 (Plan of priority measures to restore river connectivity for eel) have as consequence an improvement in environmental quality of rivers, in terms of defragmentation and connectivity of rivers in the Po basin. The completion of this action implies the involvement of many stakeholders.

Coastal and marine ecosystems

Oceans and seas cover more than 70 percent of the Earth. The Mediterranean sea covers 2,500,000 km^2 surrounded by an overpopulated coast in most cases. These coastal and marine ecosystems regulate our climate and generate most of the oxygen we breathe. They underpin key economic sectors, such as tourism and fisheries. And they harbour biodiversity from whales to plankton, in habitats from sun-lit reefs to polar oceans.

But oceans and coasts face huge threats. Millions of tonnes of our plastic waste are harming creatures, including seabirds, turtles and crabs. Climate change is damaging coral reefs and we are clearing mangroves for fish farms and other activities. Maritime traffic and overfishing threatens fish stocks, nutrient pollution is creating dead zones, and we discharge nearly 80 percent of our wastewater without treatment.

We can restore oceans and coasts by reducing the pressures on them so they can recover, both naturally and with our help. We need to make these ecosystems and communities more resilient in the face of global change.

Restoration of coastal and marine degraded ecosystems can benefit society by improving biodiversity conservation, improving human livelihoods, empowering local people, and improving ecosystem productivity.

Marine ecosystem restoration is an emerging field that aims to achieve substantial recovery of ecosystem integrity and native biota. Marine restoration activities go beyond remediation, or rehabilitation with the aim of initiating or speeding the recovery of marine ecosystems after disturbance. Restoration activities may also be designed to reestablish natural disturbance regimes.

Effective restoration of coastal and marine ecosystems ensures maintaining critical habitats such as seagrasses or sediment bottoms that deliver significant benefits, including for climate change mitigation.

Coastal & marine

Reconstructing coastal dunes against erosion in Italy

General information

ITALY

Organisation
Region of Tuscany

Type of organisation
Local or subnational government, including field extension services

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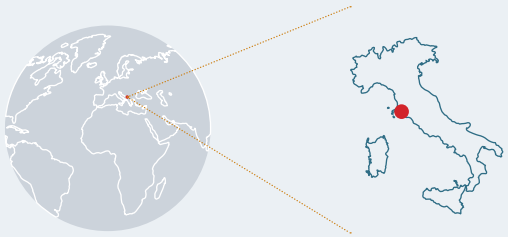
Site location



Latitude
43°57'17"N

Longitude
10°38'14"E

Implementation area
23ha & 7 km
of coastline

Restoration started
2012

Herbaceous & shrub planted
16 000

Scan the code for full description

The positive effects on the NBS designers have certainly been those of the acquisition of a competence that is difficult to achieve in theory/desk. For the intervention of Sterpaia having dedicated many years (almost 14 from 2009 to today) from the analysis phase of the problems and values, to the project design/translation, to the comparison/discussion with local stakeholders, to the construction phase and to the subsequent monitoring of works, has given individual designers/coastal managers significant experience, which has been then enhanced in the subsequent recent implementation, design and execution of the most advanced interventions following the extreme meteoric events of recent years.

This experience of professional involvement, not common in terms of duration and intensity, has certainly had positive effects on the ability to design new interventions, enhancing the benefits and understanding errors, the ability to deal with multidisciplinary problems (ecological, geomorphological, socioeconomic and in particular tourism economies), the need for close dialogue with local stakeholders (in particular the concessionaires of bathing establishments); certainly a useful experience to address the issue of climate change in coastal areas, characterized by coastal erosion, mean sea level rise, intense meteorological events, subsidence, high tourist load, invasive alien species, etc.

Finally, an important aspect was the integration of engineering and naturalistic skills, with a multidisciplinary and multi criteria approach, of fundamental importance to obtain a result optimized on different objectives, namely defence and set-up hydrogeological and ecosystem protection and conservation.

This practice/experience made us (designers and me as coastal manager) understand the importance of in-depth analysis. Complex issues cannot be answered with simple and pre-packaged solutions. It is necessary to invest in time and professionalism in the analysis of complexity, in the verification of errors and in the identification of new solutions to be tested through prolonged monitoring over time. Then, surely, this type of experience gave, to those lucky enough to participate, the satisfaction of creating useful works, which have important territorial and landscape effects and which try to give answers to current problems and largely linked to the theme of climate change, the protection of biodiversity and the sustainability of economic activities. And these are also useful answers at the level of the European Union and in particular of Communities that live thanks to the economic activities linked to the delicate transition ecosystems between the sea and the land.

In addition, for us technicians and designers it certainly has been a growth, as well as professional, in terms of the method of teamwork and interaction between different skills at local, regional, national and international level. On the end-users side we noticed a widespread satisfaction about the practice, deriving both from the decorative effect of the works with respect to the pee-intervention situation characterized by severe erosion and degraded vegetation, and from the feeling of wise management attention by the bodies in charge of future maintenance.

Type of restoration intervention

- Natural regeneration
- Assisted natural regeneration
- Tree planting
- Control of invasive alien species

Main drivers of degradation

- Introduction of invasive species
- Alteration of vegetation
- Impact/pressure of summer tourism, climate change, coastal erosion, land subsidence, saline wedge intrusion in the freshwater aquifer

BACKGROUND

The intervention area is located within a municipal protected area of public property called “Sterpaia Park”. It is a coastal protected area (ANPIL ex L.R. n. 56/2000), managed by the Municipality of Piombino, characterised by high naturalistic and landscape values (relict coastal dune vegetation, plant and animal species of conservation interest) but with high anthropogenic pressures (for example coastal tourism, coastal erosion, artificialization of the coast). The coastal zone is characterised by a narrow dune belt, with a maximum thickness of 50 m, with shrubby herbaceous dune vegetation and relict pine forests. The dune belt provides important protection for some humid areas behind the dunes (lying below m.s.l.) and for important agricultural areas (Val di Cornia) of a subsiding coastal plain. The landscape values are protected by the presence of a landscape asset established by a Ministerial Decree (D.M. 20/09/1962) and by the protections of the Tuscany Regional Landscape Plan (L.R. n. 37/2015).

The area is also subject to landscape constraints and is located adjacent to an important Regional Nature Reserve named “Padule Orti Bottagone” (L.R. n. 30/215) and Wetland of International Importance (Ramsar Convention 2/2/1971).

Goals

increasing the resistance and resilience of coastal ecosystems, counteracting the strong process of coastal erosion, mitigating the effects of the summer tourist load and redeveloping the areas degraded by the presence of alien and invasive plant species.

WHAT IS THE PRACTICE ABOUT

The protection of the coastal dune system was implemented through a combined/integrated strategy of controlled accessibility, information/ environmental education and active defence using nature-based solutions. The latter have been developed in an innovative way for the site in question and consists of:

- Vertical bundles of heather wood in chestnut wood structure,
- Horizontal bundle in coconut roll,
- Coconut roll filled with sand,
- Pile of pine lumber blocked with vertical and horizontal chestnut wooden stake,
- Dune reconstruction through sand layers protected with coconut net and felt and external erosion protection with pine twigs fixed with chestnut wooden stakes, and
- Dune external protection with coconut net and felt, and *Posidonia oceanica* leaves.

All the materials used are natural and most of them come from local or regional sources (all except coconut net and felt).

Vertical fascine bundles proved to be particularly efficient in reducing the wave erosion and induced sand accumulation on the dune, because they decrease incoming wave energy. However, the protection is designed to not completely prevent water flux through it (permeable). The wood structure and the bundles are partially buried in order to resist wave action.

Coconut net/felt protection has been realised with a three layer composed and pre-assembled material: two layers of high weight net and one layer of felt. This material has been developed specifically for coastal application, for its structural resistance; its greater durability to UV rays and marine aerosol; and its capability to contain sand. It was used both for external erosion protection and to structure the dune that needed to be rebuilt, similar to reinforced soil, but with natural materials.

Other works were found to be efficient in favouring the accumulation of sand in areas reached by the low-energy wave motion.

The intervention involved the planting of 600 trees, 16,000 herbaceous and shrub plants, the closure of 130 paths on the dune and the opening of 50 environmentally sustainable accesses.

Twenty information panels were also created, training/environmental education courses were organised for bathing establishments operators and guidelines for sustainable cleaning of the beaches were edited.

ACHIEVEMENTS AND IMPACT

- Plant survival of herbaceous and shrub species: 70%. Significant values for *Juniperus macrocarpa* (98%); *Agropyron junceum* (80%).
- Alien plant species coverage *Carpobrotus acinaciformis* ante intervention: 82.5%, post intervention: 0.0%.
- Psammophilous herbaceous species coverage before intervention: 2%, post intervention: 20%.
- Overall, 9,623 specimens of mastic (*Pistacia lentiscus*), 2,694 specimens of female cistus (*Cistus salvifolius*) and 282 specimens of prickly juniper (*Juniperus oxycedrus* subsp. *Macrocarpa*) have been planted.
- The average survival rates by species show values that vary between the first and last survey for the mastic from 61% to 42%, for the cistus from 68% to 50%, and for the juniper, from 90% to 80%. Overall, the average survival rate was 61% in 2014, 49% in 2015 and 42% in 2016.
- The redevelopment of dune habitats involved the construction of 70 plant cells of herbaceous species of 16 m^2 each with planting of *Pancratium maritimum*, *Ammophila arenaria*, *Elymus farctus*, *Eryngium maritimum*. Overall, the survival of the total specimens of the four planted species was 68% in 2014, 54% in 2015 and 42% in 2016. The species that showed the lowest survival values is *Ammophila arenaria* (55% in 2014 , 30% in 2015 and 20% in 2016).

Coastal & marine

Deconstructing to build back nature in Spain

General information

SPAIN

Organisation
Parc Natural del Cap de Creus, Catalunya, Spain

Type of organisation
Local or subnational government, including field extension services

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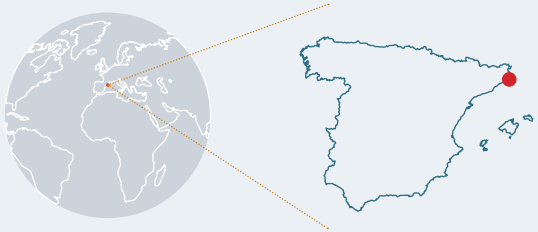
Site location



Latitude
42°19'17.6"N

Longitude
3°17'51.7"E

Implementation area
40 ha

Restoration started
2009

Scan the code for full description

Type of restoration intervention

- Natural regeneration
- Assisted natural regeneration
- Tree planting
- Control of invasive alien species

Main drivers of degradation

- Infrastructure and industrial development and urbanization
- Cultural

BACKGROUND

The sea coast above Cap de Creus in Spain remained untouched by the transforming hand of man until the middle of the last century, one of the last completely unspoiled stretches of Catalan coastline. The tourist boom of the 1950s/60s led to the construction of the Club Mediterranee, a “holiday village” with a series of facilities (bungalows, warehouses, swimming pool, bar and restaurant, etc.) in the Tudela area. From 1962 until June 2004, the club operated its facilities as a tourist establishment. The Club ended its economic activity in 2003, as it was an obsolete tourist model that was not economically viable and not socially accepted due to its location in an environment of great value and protected as a Natural Park since 1998.

In December 2005, the Ministry of Environment of Spain acquired the Tudela property, including the entire urbanised area of the Club Med, for 4.5 M€ to incorporate it into the Public Maritime Terrestrial Domain. In 2007, the Ministry started a project to restore the beaches in the area, which were covered with concrete by Club Mediterranee as they were rocky and some of the activities were not possible, such as sunbathing.

With the approval of the Special Plan for the Natural Park in 2006, the drafting of the restoration project of Tudela-Culip area (Club Mediterranée) began. The project aimed to carry out the integral restoration of the natural environment, in the whole urbanised area, which would allow its integration into the integral Nature Reserve, making this restoration compatible with public use and contributing to the knowledge and appreciation of this space.

Goals

The Special Plan for the Natural Park included the deconstruction of the whole Club Med facilities, and restoring and planning the area for visiting. The practice was mainly addressing environmental challenges to recover natural habitats (fauna, flora, soils, beaches…)

WHAT IS THE PRACTICE ABOUT

The practice involved the following actions:

1. Deconstruct almost all the buildings, paved areas, levelled areas and roadways ; the deconstruction of beaches (removal of accesses and concrete platforms, breakwater, and buildings in the initial Maritime Terrestrial Zone) of Cala Agulles, Tudela, Francalus, Cullar and Culip, the deconstruction of the existing buildings on the site of the former Club Mediterranée in the municipality of Cadaqués (Girona) by the Ministry of the Environment, Rural and Marine Affairs
2. Eliminate invasive plants and restore native habitats and plant communities, and
3. Enable accessibility and visits in the framework of public use management of Natural Integral Reserves.

A business collaboration agreement was implemented between the Department of the Environment and Housing of Catalunya (public) and the company, Gestora de Runes de la Construcció S.A. (public-private), which financed and executed the environmental restoration project.

ACHIEVEMENTS AND IMPACT

- Elimination of invasive exotic vegetation on an area of approximately 56 ha.
- Rearrangement of the road system and organisation of public use.
- 16,020 m^2 of tot-U paving, asphalt and paving of the main road.
- 3,419 m^2 of paving of the coves and beach. 65 % (2,233 m^2) of concrete.
- 38,659 m^3 of rubble to be managed:
- 32,383 m^3 of construction and urbanisation rubble.
- 3,232 m^2 of tot-U and country stone.
- 3,043 m^2 of country stone walls.

In the area, some activities did not fit in very well with a “Natural Integral Reserve”, as there was free and indiscriminate access for a long time. After becoming a “Natural Integral Reserve”, it can only be visited and requires land use planning (parking areas, visitor centres, itineraries...), generating indirect economic income, mainly from tourism. This area can be now visited throughout the year, not only in summer and is an interesting area for a new target group (eco-tourists).

Although numerical data is lacking, the recovery and colonisation of native species began very quickly, especially for two endangered plant species: *Seseli farrenyi* (strictly endemic to the Park) and *Limonium tremores*. In the first year after the works, many of them had already begun to appear in the park. These species, linked to the coastline, have a colonising strategy as they are adapted to the periodic disturbances of the sea, wind, etc.

On the other hand, the management of invasive exotic species is still ongoing, and that from this point onwards actions have been implemented for their eradication throughout the Cap de Creus Integral Nature Reserve. It has also been the precursor of other actions, such as the management of invasive alien species on coastal cliffs.

Coastal & marine

Artificial reefs and reserves to enhance fishing in France

General information

FRANCE

Organisation
Côte Bleue Marine Park (PMCB)

Type of organisation
Local or subnational government, including field extension services

Other community or local level interest group: Artisanal small scale fishers

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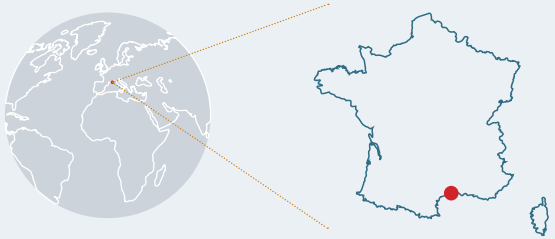
Site location



Latitude
43°20'05.4"N

Longitude
5°10'22.2"E

Implementation area
295 ha

Restoration started
1983

Scan the code for full description

Type of restoration intervention

- Natural regeneration
- Assisted natural regeneration
- Artificial reefs (5.000m³), i.e. production and protection artificial reefs (concrete cubes deployed in chaotic heaps, alveolar reefs, breeze blocks, anti-trawling reefs),
- Two integral marine reserves of 295 ha.

Main drivers of degradation

- Infrastructure and industrial development and urbanization
- Demographic
- Economic
- Science, knowledge and technology
- Others: Harmful fishing practices such as bottom trawling allowed beyond 3 nautical miles (approx. 5,5 Km).

BACKGROUND

The Côte Bleue Marine Park is located in the south east of France on the Mediterranean coast.

The Park benefits from high biodiversity on its coasts, with two well developed main habitats of major ecological interest: (i) the *Posidonia oceanica* meadows, the largest seagrass bed of the area (1050 ha) at the scale of the department of Bouches-du-rhône, and the latest up to the Spanish border; (ii) coralligenous reefs, a biotic construction host a rich biodiversity (222 ha).

The coastal and marine ecosystems are typically Mediterranean and host a highly diverse fauna (e.g. 251 species of fishes) and flora. Biogeographic conditions are unique. An upwelling system and nutrients of the Rhone river contribute to a high productivity and richness of exploited resources and fisheries.

The socio-economic conditions are very linked to tourism and small-scale fisheries in this area.

The main challenges faced are the high fishing pressure on coastal resources, both artisanal and recreational, with the same amount of catches, and the location between the urbanised area of Marseille and the industrial area of Fos-sur-Mer, an important maritime traffic route.

The main goals of the two reserves in the marine park are marine conservation/protection, fisheries management, education/ knowledge sharing and scientific research.

Goals

The artificial reefs are “active restoration” tools intended to improve and promote small-scale coastal fishing and limit excessive harvesting of resources from trawlers, to reduce damage to the *Posidonia* meadow and to encourage small-scale net fishing, much more selective and therefore more respectful to the resource.

The two marine reserves within the park constitute “passive restoration” which are no-take zones and where all kinds of fishing, anchoring, scuba-diving and dredging are forbidden. These no-takes reserves are strictly enforced, with a high level of surveillance by park rangers (>2,400 hours/year).

The combination of both measures (active and passive restoration) have demonstrated their contribution to improving the environmental and socio-economic conditions of the PMCB.

WHAT IS THE PRACTICE ABOUT

Since the creation of the first marine reserve in Carry in 1983, artificial reefs have been used to ensure the sustainability of fish populations which small scale fisheries depend on through several phases of deployment between 1983 and 2004.

The two integral reserves (Couronne and Carry-Le Rouet)) and the artificial reefs used as a complementary tool, foster and protect an active artisanal fishing sector which produces 60 tons of fish per year on the coastal band (140 t in total). On the biodiversity side, the two reserves have led to an increase in number of species (x 1,3), fish abundance x 3 and fish biomass of target species x 6 with a clear ”reserve effect” (more fish and bigger, return of rare species).

In the Couronne’s reserve, experimental fishing operations conducted every 3 years show a spectacular increase of yields, multiplicated by 7 times (from 1.1 kg/100 m of net in 1995 before the reserve creation to 7.1 kg/100 of net in 2019).

The mean weight of a fish is multiplied per 2.6 (111 g In 1995, 287 g in 2019).

The Côte Bleue Marine Park and their partners are in charge of surveillance and enforcement (2,400 h of enforcement/year), scientific monitoring for measuring the reserve effects (thirty five scientific monitoring protocols, e.g. fish visual census; sea-urchins; red coral; *Posidonia* meadows;, fishing and activities monitoring; frequentation; and perception studies and enquiries.

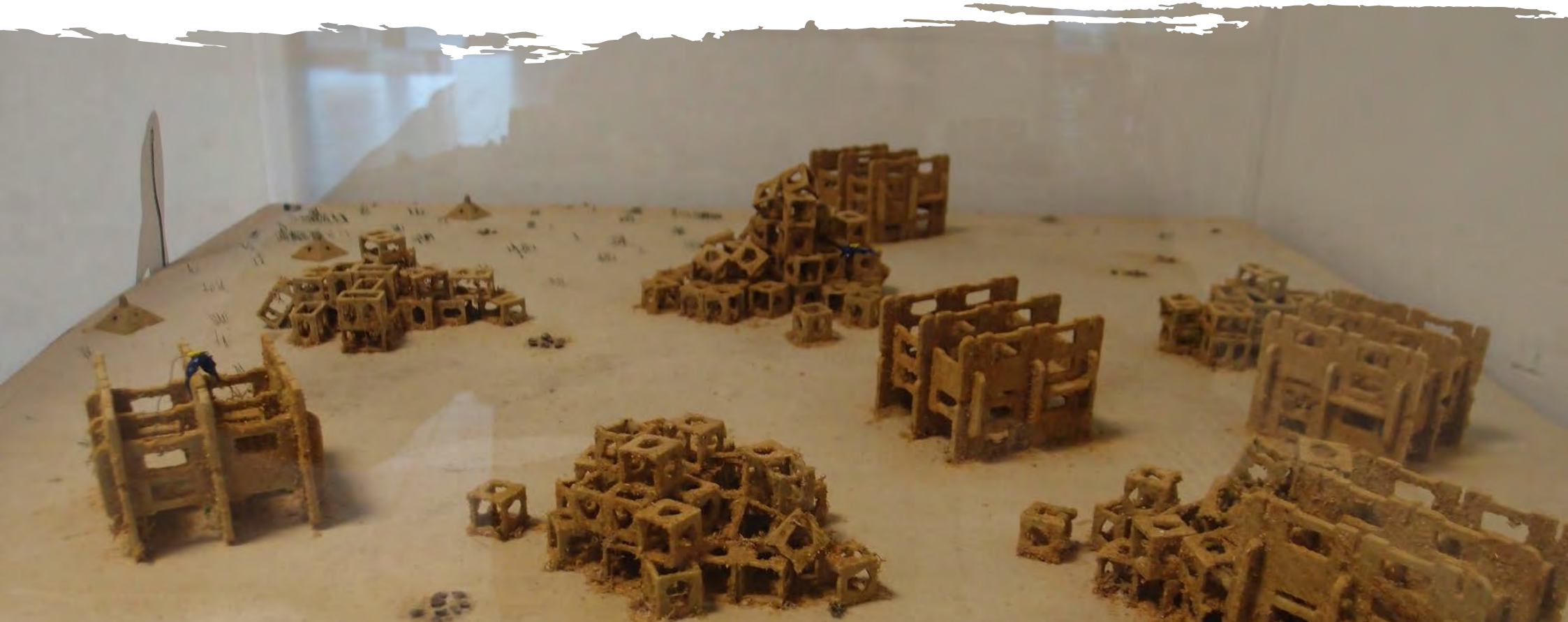
ACHIEVEMENTS AND IMPACT

In terms of environmental benefits, no-take reserves showed a greater number of species, more and bigger and the return of rare/scarce species like groupers and brown meagre. The biomass exportation is effective, with a clear spill over effect (fishing yields CPUE are multiplicated x 2.5 on the borders of the two reserves than in the rest of the park).

Perceptions of stakeholders concerning no-take reserves were studied during a vast enquiry done by the Côte Bleue Marine Park to both recreational (1795 fishers, 689 scuba divers, 311 snorkelers) and professional (18 artisanal fishers, 17 diving centre) users showed very positive results as per the following questions:

- What is the effect of reserves on the environment? 69% showed a positive effect
- What is the effect of reserves on your own activities? The answers are very positive for professionals (fishermen 88%, diving centre 82%, see figures below).

Concerning artificial reefs, in terms of environmental benefits, the evolution of fish biomass on artificial reefs of the Couronne reserve shows that the total estimated biomass went from 2.2 kg in 1995 to 100.7 kg in 2004. The number of species present in the reserve went from seven in 1995 to 29 in 2004. The artificial reefs produced variable yields depending on their shape and design, from 0.15 to 0.35 kg/m^3 outside reserves to 0.89 up to 3kg/m^3 inside reserves.



Coastal & marine

Assisting orange coral colonies in Spain

General information

SPAIN

Organisation
HyT (Hombre y Territorio).
MedCoral Program

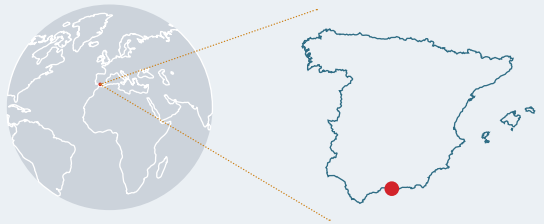
Type of organisation
National Non-Government Organization (NGO)

Other community or local level interest group: scientists, marine protected area managers, divers, public administration officers, naturalists.

Contact person
Alejandro Terrón Sigler
David León Muez
proyectos@hombreyterritorio.org

Website
https://hombreyterritorio.org/

Site location



Maro-Cerro Gordo MPA
36°44'47.0"N, 3°46'54.0"W

Punta de la Mona Cliffs
36°43'25.7"N, 3°43'36.9"W

Implementation area
1654 ha

Scan the code for full description on Maro-Cerro Gordo MPA

Corals planted
590

Scan the code for full description on Punta de la Mona Cliffs

> We believe these studies and initiatives have contributed to a better knowledge of orange coral and its importance as a species and also as a habitat among the different stakeholders we have work with. Also, when finished, results will be able to be transferred to local, regional and national authorities, MPA managers of the whole Mediterranean basin and IUCN Mediterranean Red List Office, through a proved tool to conserve coral species. The implementation of networking monitoring programmes and new routes for diving immersions will facilitate the application of targeted conservation actions to protect the species and their habitats.

Type of restoration intervention

- Assisted natural regeneration
- Control of invasive alien species

Main drivers of degradation

- Introduction of invasive species
- Climate change
- Infrastructure and industrial development and urbanization

BACKGROUND

The Mediterranean is a biodiversity hotspot with 15,000 to 25,000 species, 60% unique, one third endemic (IUCN). Corals are widespread on it, although human impact has made them largely disappear. Global warming, marine litter, organic contamination, are seriously affecting them.

For a few years, a new threat is devastating the Mediterranean: *Rugulopteryx okamurae*. This macroalga, originary from northwest Asia, was first recorded in the Strait of Gibraltar (2015), suggested from the ballast waters of ships. Since then, its expansion represents an unprecedented case of bioinvasion in European coasts. The species is capable of covering nearly 100% of substrates, both vertical and horizontal, from surface to deep zones, usually in rocky but also in sandy rocky bottoms, killing many species, including coral and its habitats. The excessive productivity generates huge heaps derived from loose stems, creating problems to supralittoral species, collapsing fisheries and creating problems in tourism. In 5 years, it has reached 600 km from the Strait of Gibraltar, and models estimate the expansion to continue for the whole Mediterranean. Estimates are that near 60% of coral disappearance, and other habitats and species, is because of the invasion.

Maro-Cerro Gordo Marine Protected Area and Punta de la Mona Cliffs on the Mediterranean coast of Spain host well conserved populations of the orange coral in its westernmost distribution. The orange coral *Astroides calycularis* is internationally protected due to its narrow distribution, its sensitivity to environmental changes and anthropogenic disturbance. The available models refer to the expansion of *R.okamurae* to be huge and durable in all the Mediterranean Sea, so actions promoted in any of the primary invasion areas seem to be interesting for the rest, because of the status of the species and its distribution, widely fragmented. Spain (exclusively in Andalusia), Italy, Malta, Croatia, Morocco, Tunisia and Algeria are the countries with presence of this species, so results of the project would be useful for them.

Coastal & marine

Goals

Andalusia in Spain has been the first European region to be affected by *Rugulopteryx okamurae*, and through these actions, restoration tools for coral species related to marine protected areas can move forward. This project aims to be a referent for other areas both at regional, national and Mediterranean scale.

WHAT IS THE PRACTICE ABOUT

- HyT works with the orange coral since 2008 through the MedCoral Program. Several studies regarding its distribution, genetics, life cycle and threats have been developed.
- All this information has made it possible to generate several tools to restore their populations, if necessary.
- The Rescue and Rehabilitation (RNR) is based on the recovery and relocation of detached colonies from the bottom to their original substrate. This is a really effective and easy technique that allows to reduce the mortality rate when falling.
- The Harvesting and Seeding Larva (HSL) is an exclusive technique developed by MedCoral with the Seville Aquarium support for the species. It is based in the larval collection for a subsequent seeding. This technique generates new colonies with a unique genetic pool.
- These two techniques are being implemented both in natural and artificial substrates, using artificial reefs as reservoirs for the species.

ACHIEVEMENTS AND IMPACT

- Several techniques have been tested and published with the University of Seville support.
- These techniques could be used in other marine protected areas (MPAs) in the Mediterranean, as tools to fight the invasion of Rugulopteryx okamurae.
- More than 500 colonies (about 30.000 polyps) have been rescued and recovered in both areas.
- About 700 larvae have been harvested and seeded both in natural and artificial substrates, also in controlled conditions.
- A better knowledge around the importance of corals and interaction with the local communities have been accomplished.

Coastal & marine

Restoration of Mediterranean macroalgal forests in Spain

©Xavi Calsina

General information

SPAIN

Organisation
Centre d'Estudis Avançats de Blanes, (CEAB-CSIC)-Spain.
University Napoli Federico II - Italy.
University Politecnica delle Marche - Italy.
Université Côte d'Azur, Nice - France.
Hellenic Centre for Marine Research – Greece

Type of organisation
Research or academia
(incl. tertiary education)

Contact person
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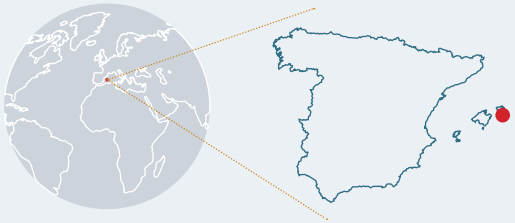
emma@ceab.csic.es
simonetta.fraschetti@unina.it

Website
http://afrimed-project.eu/
http://www.marineforest.com/
http://www.merces-project.eu/

Site location



Latitude
39°52'47.6"N

Longitude
4°18'28.2"W

Scan the code for full description

Implementation area in 2011
~20 m²
(4 patches of ~5m²)

Restored area in 2021
2093 m²

Impact
Restoration of associated biodiversity and ecosystem functions

Method
Recruitment enhancement or provision of new recruits

Main drivers of degradation

- Impaired seawater quality, due to the dumping of urban and industrial sewage.
- Infrastructure and industrial development and urbanization

BACKGROUND

Macroalgal forests dominated by species of the genera *Cystoseira sensu lato*, (including *Ericaria*, *Gongolaria* and *Cystoseira*; order Fucales), represent one of the most productive and biodiverse marine coastal ecosystems, directly or indirectly supporting and regulating, ecosystem and cultural services.

Macroalgal forests are severely threatened under the pressure of multiple stressors acting at local to global scales, including pollution, habitat destruction, eutrophication, sedimentation, overgrazing, marine heatwaves and ocean warming. As many other habitat-forming macroalgal species worldwide, *Cystoseira s.l.* forests have been declining in the whole Mediterranean basin during the last decades, and natural recovery has been recorded only occasionally. Indeed, only along the 8'000 km of Italian coasts, the local extinction of 371 populations of 19 different species of *Cystoseira s.l.* was documented across several regions, since 2000. Although preserving such complex and highly productive habitats represents a priority to maintain the associated biodiversity and ecosystem functioning, restoration of macroalgal forests has been largely neglected compared to other marine-coastal habitats.

This pilot action in the Mediterranean Sea had different objectives (1) to design new non-destructive restoration techniques (facilitating recruitment) for these species, and (2) to recover not only the extinct population of *G. barbata* (structural species) but also to facilitate the return of the great diversity of associated species that characterize this habitat.

WHAT IS THE PRACTICE ABOUT

- Given the threatened and critical conservation status of many populations of *Cystoseira s.l.*, adult transplants from remaining populations are undesirable and less invasive techniques are required.
- The applicability of several non-destructive techniques based on recruitment enhancement for macroalgae restoration has been experimentally explored; however, these techniques have been less effectively applied to restore forest-forming fucoids.
- Successful restoration of a population of *Gongolaria barbata* (i.e., to self-maintaining populations) in areas from which they had completely disappeared at least 50 years ago using recruitment-enhancement techniques.
- Publication of a roadmap for the restoration of Mediterranean macroalgal forests to assist researchers and stakeholders in decision-making. This roadmap provides guidelines for an optimal selection of the site to restore, the target species, the donor population and the most effective methods and complementary actions in terms of cost-effectiveness (see figure 1).
- Elaboration of a complete conceptual framework of the “Best practices for the restoration of Mediterranean macroalgal forests (*Cystoseira s.l.*)”. The framework consists in a simple stepwise decision tree with additional information about key elements (restoration implementation, success evaluation and long term adaptative management) to be considered around a restoration action (see figure 2).

ACHIEVEMENTS AND IMPACT

- After 6 years, the densities and size structure distributions of the restored populations were similar and comparable to those of the natural reference populations, highlighting that the restored populations were self-sustaining and mature.
- After 10 years, the restored patches extended their surface by two orders of magnitude, reaching an area of 2093 m^2, and species diversity and composition of the restored locality were similar to those found in reference macroalgal forests, showing the recovery of the forest ecosystem.

1- Selection of restoration sites

- Historical presence of the target species, assessed through published and/ or grey literature and/or local knowledge
- Evaluation of abiotic factors
- Evaluation of biotic factors
- Evaluation of technique requirements

2- Selection of target species

- Ecological relevance
- Knowledge of ecology and life-history traits
- Baseline knowledge / feasibility of manipulation

3- Selection of donor sites

- Large availability of target species (extension, cover)
- Population in good conservation status
- Genetic variability

4- Selection of restoration technique

- In situ seedling or Ex situ cultivation depending on the herbivory pressure and hydrodynamic conditions.
- Consider the use of complementary techniques.

5- Complementary actions

- Provide supplementary substrate for settlement of
- Herbivory management

Figure 1. Conceptual model of the crucial steps to guide the restoration of macroalgae forests. The knowledge and main factors and processes that must be considered for an optimal selection of restoration sites, target species, donor sites, restoration techniques, and the use of complementary actions are detailed and explained below. Figure modified from Cebrian et al 2021 Front. Mar. Sci. 8:709219.

A- Restoration decision tree

- Forest presence and historical assessment
- Site local condition assessment and impact mitigation
- Choice of action

B- Restoration implementation

- Competence
- Society & Support
- Finance
- Governance

C- Success Evaluation

- Target species level evaluation
- Ecosystem level evaluation

D- Long Term adaptive Management

- Plan long-term adaptative management
- Monitoring implementation
- Consider MPA establishment

Figure 2. Summary of the conceptual framework to assist in the restoration decision-making process and management. This macroalgal conceptual frame consists of a restoration decision tree (A), the key considerations (around the four pillars of society, competence, governance and finance) that need to be considered before implementing a restoration project (B), and the steps that need to be taken during the restoration success evaluation (C) and the long-term adaptive management (D). Figure modified form Smith and Verdura et al., submitted in Front. Mar. Sci.

Conclusions

The Mediterranean region contains a wide variety of ecosystems, many of them modified along the centuries, and is considered a biodiversity hotspot facing the cumulative impacts of climate change and human activities. The restoration of critical ecosystems can play an important role to achieve the current protection and conservation targets established for the region.

The review of the best practices collected in this publication shows certain common success factors in the restoration efforts implemented at various levels and in different countries across the Mediterranean.

- A multidisciplinary approach to ecosystem restoration can empower public, private and civil society actors in the community by facilitating a dialogue and fostering a mutual understanding on what needs to be restored, why, and how.
- Restoration practices can create new jobs while raising awareness of the values of ecosystems and the services and goods they provide.
- Restoration practices can lead to a better socio-economic environment in natural areas, protected or not, by incorporating green and blue infrastructures to secure a good use of the natural heritage and cultural identity.
- Degraded ecosystems can be restored by engaging public authorities, scientists, and ecosystem users and highlighting the benefits in services and goods provision.
- Restoring ecological connectivity is a key success factor for larger scale restoration targets.
- Restoration takes time, but final beneficiaries become the strongest defenders of the practices after proving the benefits, for nature and for people.

Annexes

Forest ecosystems		
1	Forest landscape restoration in Lebanon	Lebanon
Wetland ecosystems		
2	Adaptive management of saltworks in France	France
3	Improving wetlands networks in Spain	Spain
4	Reinstalling a special nature reserve in Montenegro	Montenegro
5	Water interventions for the European eel in Italy and Greece	Italy and Greece
Coastal and marine ecosystems		
6	Reconstructing coastal dunes against erosion in Italy	Italy
7	Deconstructing to build back nature in Spain	Spain
8	Artificial reefs and reserves to enhance fishing in France	France
9	Restoration of orange coral (*Astroides calycularis*) based on recruitment enhancement	Spain
10	Assisting orange coral colonies in Spain	Spain
11	Restoration of Mediterranean macroalgal forests (*Cystoseira s.l.*)	Spain

The Mediterranean Biodiversity Protection Community

MBPC is a collaborative Mediterranean community representing around 300 institutions that are bringing together their work to identify the most effective mechanisms to manage and protect Mediterranean biodiversity.

The results of MBPC projects (ACT4LITTER, AMARE, CONFISH, ECOSUSTAIN, FISHMPABLUE2, MEDSEALITTER, MPA-ADAPT, MPA NETWORKS, MPA ENGAGE, PHAROS4MPAS, PLASTICBUSTERSMPAS, POSBEMED, TUNE UP, WETNET) are being streamlined to offer holistic solutions that bridge science, practice and policy to priority environmental challenges through an action roadmap implemented by several working groups.

The overall aim of the Biodiversity Protection Community is to increase the current understanding, knowledge and awareness of multiple environmental threats and promote best practices and Ecosystem-based Management tools as a response to address cumulative pressures and impacts affecting protected areas and functional ecosystem units in the Mediterranean.

https://biodiversity-protection.interreg-med.eu/

The information collected by the MBPC community is available from the Mediterranean Biodiversity Protection Platform at **biodiversity.uma.es**, including this publication and spatial data on Mediterranean ecosystems mentioned herein.

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