



Handbook of good practices and guidelines for the correct enjoyment and management of natural habitats in the beach system

LIFE 13 NAT/IT/000433 RES MARIS



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Authors of the texts

Metropolitan City of Cagliari:

Alessandro Bordigoni, Maria Giuseppina Liggi, Alberto Sanna

Municipality of Villasimius - Marine Protected area of Capo Carbonara:

Maria Francesca Cinti, Francesca Frau

University of Cagliari - Centre for the Conservation of Biodiversity:

Gianluigi Bacchetta, Francesca Meloni, Martino Orrù, Lina Podda

Association for trans-regional, local ed european cooperation:

Laura Lentini

Graphics and layout: Alessandro Bordigoni

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1. Presentation

This handbook came into being with the intention of providing the basic indications necessary to find guidance on a particularly complex issue as that of the coastal strip, the management of which requires different types of skills, legal-regulatory, technical and environmental.

It does not therefore aim to be a “technical handbook” setting out definitions, rules and/or solutions, for which reference should be made to specialist texts for a more in-depth treatment. It aims instead to represent an opportunity for reflection by administrators and users, all of whom have the chance, through their conduct, to positively or negatively impact on the “beach system”.

It is in fact important to bear in mind that beaches represent an environmental asset of inestimable value, an asset belonging to all, and it is with that awareness that it should be viewed and enjoyed.

The authors

1.1 The LIFE RES MARIS project

RES MARIS “*Recovering Endangered habitats in the Capo Carbonara MARIne area, Sardinia*” (LIFE13 NAT/IT/000433) is a project cofinanced by the European Union under the Programme LIFE+ “Nature and Biodiversity”.

The project has a duration of four years (from June 2014 to May 2018) and a total budget of some EUR 1,500,000 (with EU contribution covering 74.23% of the budget).

The Coordinating Beneficiary is the **Metropolitan City of Cagliari**.

Associated Beneficiaries are the **Municipality of Villasimius - Marine Protected area of Capo Carbonara** (scientific partner for marine actions), the **University of Cagliari - Centre for the Conservation of Biodiversity** (scientific partner for actions on land) and the **TECLA Association** (management and administration).

The project is also supported by the Autonomous Region of Sardinia - Regional Ministry of the Environment, by Federparchi (the Italian Federation of Nature Parks and Reserves) and by the business Consortium “Villasimius per il turismo”.

The project's objectives are **the conservation and recovery of coastal beach ecosystems, including their marine and land environments**, in particular priority habitats such as posidonia beds, coastal dunes with juniper and dunes with pine forests.

2. Description and evolution of the beach ecosystem and of its main characteristics

2.1 Definition of beach, submersed and emerged

We can define the beach in various manners depending on which aspect we wish to focus upon, geological, geomorphological, hydraulic, biological, being specific aspects for which reference should be made to specialist texts to get a “scientific” treatment of the beach.

In the common perception, instead, the beach is that space comprised between the water (shoreline) and the dunal area behind it, rocky or otherwise, used by swimmers, on which the so-called seaside activities rest.



Photo 1 - Simius beach, (Villasimius, Sardinia)

It mainly consists of sediments, sand, albeit of different granulometry and colour, as well as of pebbles and, more seldom, silts and clays; oftentimes, in the Mediterranean, even of the remains of *Posidonia* seagrass (the much annoying “algae”) in the form of leaves, root systems, leafy fragments and aegagropiles (the so-called seaballs).

The beach narrowly understood and the dunal systems altogether make up the emerged beach. Its limit is represented by the ideal line in which the characteristics of the beach undergo a change, and might be natural or artificial in the presence of such infrastructures as roads, coastal defence works, inhabited centres and so on.

The submersed beach is instead that part of beach that is submerged under the sea level and is characterised by three zones (starting from the farthest one from the shoreline): 1) lower, where the waves interact with the bottom; 2) intermediate, where the waves crash; 3) upper, where the waves arrive at high speed on the water edge.

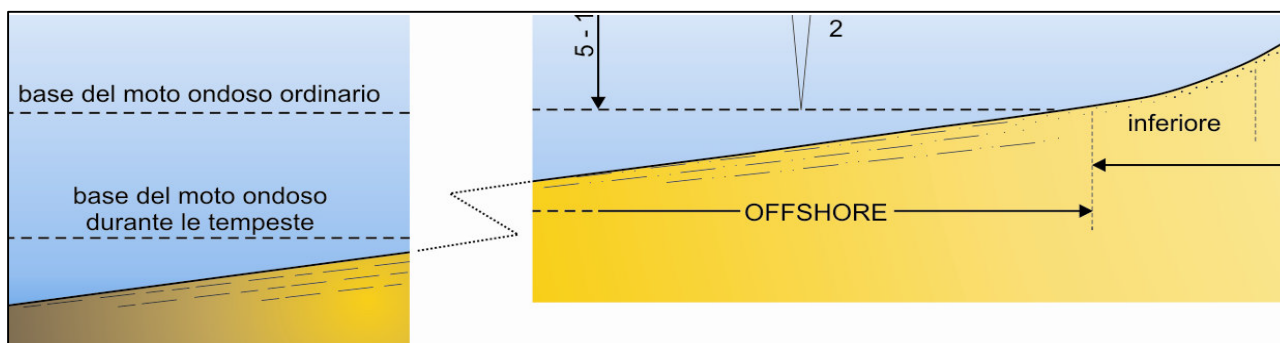


Fig. 1 - Beach profile, Walker & Plint, 1992

The beach as we normally understand it, therefore, is the product of the ongoing evolution/transformation of a complex dynamic system consisting of the emerged and submersed beach.

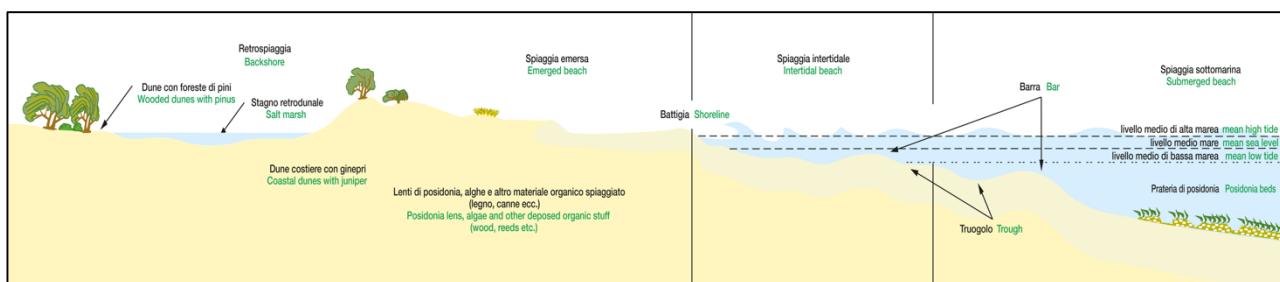


Fig. 2 - Beach profile (Life Providune) – <http://www.providune.org>

The sedimentary contributions from the sea and from the hinterland, consisting of beach, vegetable material, soils, clays and silts carried by the sea, by rivers and by rainwaters, as well as their movement, ensure that profiles of beaches vary considerably in the short term as well (seasonally) modifying, both structurally and morphologically, their three-dimensional appearance: width (breadth), length and height, vis-à-vis the shoreline. Everyone has in fact been able to see and observe that several (emerged) beaches undergo changes up to the point that, in some instances, they disappear to reappear the next year.

Many beaches currently owe their survival solely to sand contributions from the sea (submersed beach), given that a large part of the waterways that used to feed them have been intercepted for various reasons, mainly to create reservoirs for water reserves, sometimes without ensuring the minimum vital outflow, with obvious negative repercussions on these delicate environments. The natural evolution and transformation of these environments, which should have been best left unchanged, has instead been extensively altered in various guises by the action of man; one of the aspects that has entailed profound changes, besides the execution of such works as harbours, roads

and infrastructures, is linked to the fact that beaches represent an important source of income, especially in the summer period, in particular for Sardinia that can boast approximately 1.900 kilometres of coasts, about 600 of which sandy.

The anthropic load these beaches are subjected to has grown enormously over the last decades, aided both by the reduction in airfares and by the advent of Internet, factors that have made it possible to promote, create awareness in and cause a large number of persons to reach localities poorly frequented in the past.

This sudden change, however, was not followed by a clear regulation of use and by the determination, for each individual beach, of the characteristics, the critical areas and the carrying capacity of the environment in the sense of maximum permissible load per persons/day.

Beaches are also a place, as stated earlier, of enjoyment, hence, after acknowledging that it is currently impossible to leave them to their natural evolution, the problem remains of how to make them enjoyable, limiting as much as possible the damages that might then jeopardise their existence. The damages caused by improper use are not often appreciable at once, but their effects, if left unchallenged, will probably be such as to lead to the disappearance of the beach after some hundreds of years (an extremely narrow timeframe if we reason on the evolutionary scale).

Sitography

1) Guidelines for integrated beach management – Autonomous Region of Sardinia – Coast Conservation Agency 2013 -

<http://www.sardegnaambiente.it/index.php?xsl=612&s=246771&v=2&c=5126&idsito=23>

2) Integrated planning of the marine-coastal strip Quarterly Journal of the Territorial Planning Sector – ISPRA (Higher Institute for Environmental Protection and Research)'s Defence of Nature Department 2015 - <http://www.isprambiente.gov.it/it/pubblicazioni/periodici-tecnici/reticula/reticula-n.10-2015-numero-monografico>

3) Guidelines for the protection of the coast from erosion effects and from the effects of climatic changes – National round-table on coastal erosion MATTM (Ministry of the Environment and Protection of the Territory and the Sea)-REGIONS with ISPRA's technical coordination 2016 - <http://www.erosionecostiera.isprambiente.it/linee-guida-nazionali>

4) Inventory of the sandy coasts of Sardinia REGIONAL LANDSCAPE PLAN Regional Law No. 8 of 25 November 2004 First homogeneous context – Coastal area Attached to Regional Council Resolution No. 1136/7 of 5 September 2006 - <http://www.sardegnaterritorio.it/j/v/1123?s=6&v=9&c=7424&na=1&n=10>

5) Integrated management of coastal landscapes in Italy state of the art and applications in the Italian scenario Bertolini Ispra - <http://www.isprambiente.gov.it/contentfiles/00004900/4925-bertollini.zip/at.../file>

- 6) Establishment and management of the *Posidonia oceanica* banquettes on the sandy shores ISPRA - <http://www.isprambiente.gov.it/it/pubblicazioni/manuali-e-linee-guida/formazione-e-gestione-delle-banquettes-di>
- 7) Life and coastal habitats European Commission - <http://ec.europa.eu/environment/life/publications/lifepublications/flippingbook/coastalhabitats/HTML/files/assets/basic-html/page-1.html>
- 8) LIFE Natura NAT/IT/000519 “PROVIDUNE” (2009-2014) - <http://www.providune.org>

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WALKER R.G., PLINT A.G., 1992. Wave- and storm-dominated shallow marine systems. In: Walker R.G., James N.P., Eds., *Facies Models: Response to Sea Level Change*, Geological Association of Canada, Newfoundland: 219-238.

2.2 Integrated management of the coastal strip or area

The topic of management of the coastal strip is no doubt central and strategic for Sardinia, inasmuch as the coastal strip is a *“strategic territorial system for the development and safeguard of culture and the other local resources, to be managed with the necessary precautions keeping in mind the sustainability and fragility of the ecosystem”*, as set out in the Regional Landscape Plan.

The first document in which reference is made to the implementation of the Integrated Coastal Area Management (GIZC) in Europe is the Recommendation of the European Parliament and of the Council dated 30 May 2002.

This recommendation, in its preambles, clearly stipulates that it is: *“...of fundamental importance to implement an environmentally sustainable coastal area management, economically fair, socially responsible, and culturally sensitive, to protect the integrity of this important resource while simultaneously paying regard to the traditional local activities and habits that do not pose any threat to the natural sensitive areas or to the state of preservation of the wild coastal species of fauna and flora.”*

Within a Mediterranean context, at supra-national level, the main regulatory source consists in the Protocol on integrated Mediterranean coastal area management, signed in Madrid on 21 January 2008. The Madrid Protocol represents a document implementing the 1976 Barcelona Convention for the protection of the Mediterranean Sea as well as other essential common lines of protectionist action, including the one aimed at establishing protected marine areas. Article 2 of the Protocol provides us, first of all, with a definition of Coastal Area Integrated Management (*«a dynamic process for the management and sustainable use of coastal areas, which simultaneously takes into account the fragility of the coastal ecosystems and landscapes, the diverse activities and uses, their interactions, the maritime vocation of some of them, and their impact on the marine and land components»*).

The ICZM Protocol, together with the Marine Strategy Framework Directive 2008/56/EC of the European Parliament and of the Council and the Maritime Spatial Planning Directive 2014/89/EU of the European Parliament and of the Council, of 23 July 2014, trace the guidelines of the EU integrated maritime policy with the aim of ensuring the sustainable development of the marine-coastal areas.

Branching out of these guidelines are then a multitude of national laws and regional recommendations, documents, action plans, that allocate functions to different subjects in different fields: authorising, prescriptive, monitoring, disciplinary in the environmental and town planning field, which make it particularly difficult and complex to correctly operate when it is precisely the coastal strip that is involved.

Italian legislation is essentially based on Law No. 979/1982 that entrusts to the Ministry of Mercantile Marine the task of implementing a political action aimed at the protection of the marine environment and the prevention of harmful effects to the resources of the sea and the marine coasts.

Thereafter, through the establishment of the Ministry of Environment, this Ministry was the recipient of partly overlapping and supplementary powers in the field of planning the protection of the sea and the marine coasts from pollution and the safeguard of the marine environment.

More specifically, Article 1 of Law No. 394/1991 (so-called framework Law on protected areas) stipulates that the Ministry of Mercantile Marine, jointly with the Regions, is tasked with elaborating a general plan for the protection of the sea and the marine coasts from pollution and the safeguard of the marine environment.

The primary aim of the plan is to coordinate the interventions and the activities on protecting the sea and the marine coasts from pollution and safeguarding the marine environment.

It is therefore seemingly clear that to facilitate and standardise the action of local administrators, especially the Municipalities, it would be necessary to embark on a regulatory and technical reorganisation leading to the elaboration of a sort of “consolidated text” setting out all the indications for a correct coastal strip management.

Many studies on the coastal strip, general and specific, have already been undertaken, but they probably need to be gathered, systematised and made available. By taking care to constantly supplement and update them, it would then be possible to identify the different critical areas for each beach, to be subsequently able to specifically define, on an informed basis, save for some rules of a general character, how to intervene in terms of accessibility, concessions, waste management, information, management of the posidonia beached, etc.

The Regional Landscape Plan already comprises a detailed list that identifies and classifies Sardinian beaches and that surely represents a starting point to then update knowledge via studies and monitoring steps, with a view to learning what are their characteristics, their evolution, the anthropic load they are subjected to and, accordingly, their critical aspects.

We might therefore eventually define the maximum permissible load for each individual beach, a measure which seems to be, as repeatedly asserted in any event by scholars and experts, the only true solution to adopt in order to safeguard the Sardinian beaches.

One of the most debated topics, moreover, concerns the management of posidonia beached, a constant bone of contention between those who contend that no intervention should be made to remove it and those who instead deem the posidonia an element of disturbance limiting its enjoyment and accordingly damaging the tourism sector.

Referring, as regards the regulatory aspects, to resolution no. 40/13 of 06/07/2016 headed “Guidelines on coastal area management” by the Autonomous Region of Sardinia, which contains the “operational guidelines for managing deposits of posidonia beached on the shores”, it is clear that to be able to decide which solutions to adopt it is in fact necessary to know the characteristics and critical aspects of each individual beach.

As stated earlier, all of this entails, firstly, both a regulatory and technical reorganisation and the definition of a multi-level governance system allocating precise functions and responsibilities on the part of the administrators, as well as of all those who “use” the beaches in any capacity.

The slow definition and adoption of such essential regulatory tools as Municipal Urban Plans and Seaboard Use Plans, which very few municipalities already have in force, slows down and complicates the launch of a uniform policy of coastal strip management.

The local administrators are in any event entitled to impact on the protection and safeguard of the coastal strip by issuing specific ordinances: by way of illustration, the municipality of Stintino has enacted the prohibition of smoking and use of towels on the Pelosa beach, while the municipalities of Domus de Maria and Villasimius have issued specific ordinances for the protection of dunes.

In this regard, it was decided to draw up in this handbook a draft ordinance of the Municipal Council to tackle a topic, deemed very important by the European Commission, such as the introduction of alien species and the protection of biodiversity.

Sitography

INTERNATIONAL

Barcelona Convention - <http://www.isprambiente.gov.it/it/temi/biodiversita/convenzioni-e-accordi-multilaterali/convenzione-di-barcellona-convention-for-the-protection-of-the-marine-environment-and-the-coastal-region-of-the-mediterranean>

EU

1) Recommendation of the European Parliament and of the Council, dated 30 May 2002, concerning the implementation of the integrated coastal area management in Europe - <https://eur-lex.europa.eu/legal-content/IT/TXT/?uri=CELEX:32002H0413>

2) Integrated Coastal Area Management - <http://www.minambiente.it/pagina/cose-la-gestione-integrata-delle-zone-costiere>

3) Protocol on the integrated coastal area management in the Mediterranean (ICZM) - <https://eur-lex.europa.eu/legal-content/IT/TXT/?uri=CELEX:32002H0413>

4) Spatial Maritime Planning
- http://ec.europa.eu/maritimeaffairs/policy/maritime_spatial_planning/index_en.htm#_blank

5) Marine strategy
http://ec.europa.eu/maritimeaffairs/policy/maritime_spatial_planning/index_en.htm#_blank

NATIONAL

1) Law No. 979/1982 Provisions for the protection of the sea - <http://www.minambiente.it/normative/1-31-dicembre-1982-n-979-disposizioni-la-difesa-del-mare-gu-18-gennaio-1983-n-16-so>

2) Law No. 394/1991 Framework law on protected areas -

<http://www.isprambiente.gov.it/it/temi/biodiversita/normativa/nazionale/legge-6-dicembre-1991-n.-394-legge-quadro-sulle-aree-protette>

SARDINIAN REGION

1) Regional Law No. 8 of 25 November 2004 - Urgent provisional safeguard rules for landscape planning and protection of the regional territory -

<http://www.regione.sardegna.it/j/v/80?v=2&t=1&c=72&s=1538>

2) Regional Landscape Plan, approved by Regional Council Resolution No. 36/7 of 5 September 2006 - <http://www.sardegna.territorio.it/paesaggio/pianopaesaggistico2006.html>

3) Regional Law No. 9 of 12 June 2006 – Allocation of functions and tasks to Local Authorities -

<http://www.regione.sardegna.it/j/v/80?v=2&t=1&c=2133&s=25505>

4) Regional Council Resolution No. 10/28 of the 2015 Guidelines for drawing up the Seaboard Use Plans for tourist-recreational purposes -

<https://www.regione.sardegna.it/j/v/66?s=1&v=9&c=27&c1=&id=46582>

5) Regional Council Resolution No. 40/13 of 06/07/2016 Urgent guidelines on coastal strip

management - <https://www.regione.sardegna.it/j/v/66?s=1&v=9&c=27&c1=1360&id=53504>

2.3 Structure and functions of the *Posidonia* meadow

Posidonia oceanica is a marine plant endemic to the Mediterranean Sea that colonises the submersed seabeds starting from a few metres from the surface of the water down to 30 – 40 metres deep, forming developed meadows (Photo 2) that characterise the habitat (code 1120* in terms of Habitat Directive 92/43/EC).



Photo 2 - Habitat 1120*: *Posidonia oceanica* meadow (*Posidonion oceanicae*)

Its characteristics are those of the higher plants, with a vegetative apparatus differentiated into specialised organs (leaves, rhizomes, roots) (Photo 3) and a distinguishable reproductive system, the flower, from which the fruits develop (Photo 4). The plants occupy the illuminated submersed area where the light is sufficient for photosynthesis and for the entire life cycle, pollination included.



Photo 3 - specialised organs (leaves and rhizomes)

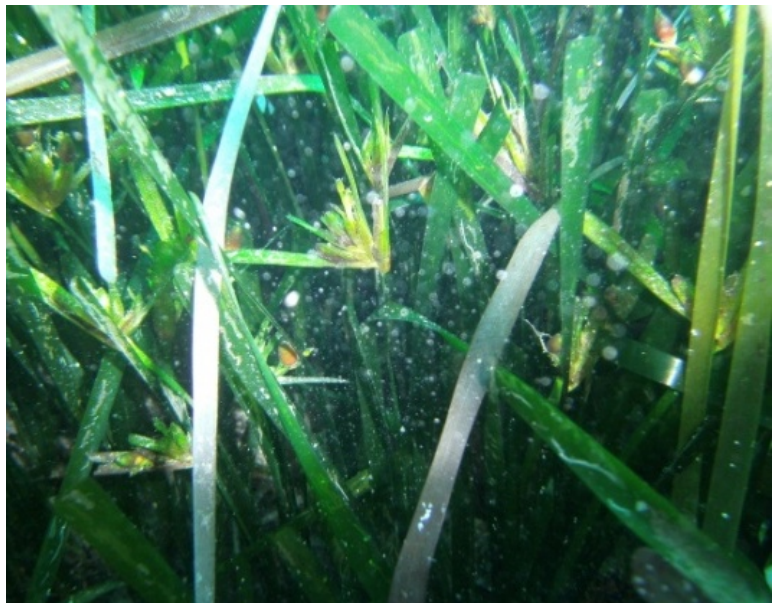


Photo 4 - Reproductive system (flowers and fruits)

The successful development of the habitat is linked to a peculiarity of the plant that concerns interaction with the implantation substrate: the rhizome, i.e. the stem of the plant, is dimorphic, meaning that it takes on a dual form and can grow both horizontally and vertically. The horizontal rhizome (or plagiotropic rhizome) is a modified and creeping stem that penetrates into the substrate, on which, close to the nodes, the new roots and subsequently the new stolons are formed. The function of the plagiotropic rhizome is thus to anchor the plant to the substrate and enable its horizontal advancement, thereby forming the so-called meadows. The vertical rhizome (or orthotropic rhizome), instead, allows the plant to grow vertically and thus overcome such adverse conditions as those due to burial by part of the sediment.

Both types of rhizomes can switch from one form to the other: an orthotropic rhizome can become plagiotropic when the vertical growth ends, while a plagiotropic rhizome can become orthotropic. The rhizomes are also distinguished by the different elasticity, the vertical ones being flexible and adaptable to the water movements, and the horizontal ones tending to lignification.

The growth rate of *P. oceanica* is very low, both vertically and horizontally; as regards horizontal growth, it can reach maximum 7 cm per year (Caye et al., 1983). If we additionally take account of the fact that the successful propagation of this species through sexual reproduction is limited, we can state that it has a low recovery ability (Delgado et al., 1999). Due to this, the meadows are highly vulnerable to anthropic impacts. Even then, the capacity this marine plant has to recolonise the substrate after the disappearance of the obstacle that caused its regression is substantial, as evinced by several studies (Pergent-Martini et al., 2002).

The plant can colonise both the sandy and the rocky substrate, and when it settles upon sand, it is capable of erecting a special construction known by the French term “*matte*”.



Photo 5 - Matte of *Posidonia oceanica*

Thanks, in fact, to the capability for orthotropic growth of the rhizomes, together with the continuous accumulation of sediments inside the meadow, the *matte* structure (Photo 5), consisting of a thick interweaving of mainly old roots and rhizomes, on which the plants keep on growing, is eventually formed, with the result that the plants generate a rise in the bottom of up to several metres.

The meadows are of considerable importance, owing to the multiple functions they perform: oxygenation, stabilisation of the seabeds, production of organic matter, source of food, fish reproduction area (nursery) and shelter for several organisms.

The *P. oceanica* meadow is host to an extremely diversified fauna (Photo 6) and flora: a fauna capable of moving around, such as fish, as well as organisms with a limited movement (echinoderms,

molluscs) and organisms fixed on the leaves (epiphytes) or on the rhizomes (bryozoans); the flora consists instead of epiphyte algae on the leaves and the rhizomes.

The meadow accordingly hosts an important part of Mediterranean biodiversity, making the *Posidonia oceanica* species an essential one for the protection and management of the Mediterranean marine environment.



Photo 6 - *Pinna nobilis* and *Ophidiaster ophidianus* in habitat 1120*

The *P. oceanica* meadow, thanks to the density of its leaves (over a thousand for m²), retains large quantities of sediments transported by the currents, and performs an essential role for the protection of coasts; the long leaves are in fact

capable of softening the intensity of the wave motion and slowing down the sea bottom currents, facilitating sedimentation and slowing down the transport of suspended solids. Moreover, the dead leaves carried by the currents reach the beaches and, piling up on the water edge, give rise to special formations called *banquettes* (Photo 7), capable of retaining the sand and reducing the coastal erosion processes.



Photo 7 - Banquette of *Posidonia oceanica*

Posidonia oceanica, hence the habitat, too, is sensitive to all forms of pollution, as understood in its broadest sense, and is accordingly an excellent indicator of the state of health of the sea and the quality of the marine-coastal waters (Legislative Decree No. 152/2006; Water Framework Directive, 2000/60/EC).

The degradation of the meadows can mostly be traced back to a consequence of anthropic activities (Montefalcone et al., 2010) and to their reiterated and synergistic development over time.

There are multiple causes; one of the most current ones is the coastal development at sea, such as the construction of bridges, dams, breakwater barriers and their like, which can modify currents and waves and, therefore, the transport of sediments. A large quantity of sediments can cause the burial

of the meadow and accordingly facilitates its erosion; a substantial transport of sediments can also cause a rise in the turbidity of the waters, which by reducing the penetration of the light impacts negatively on the growth of the plant. Urban and agricultural water discharges and the polluting substances coming from ports or ships pollute the sea and entail an increase in nutrients that facilitate the proliferation of the phytoplankton and thus a rise in the quantity of organic substance in suspension. This facilitates the growth of some epiphytes, i.e. organisms that live on the leaves of the plants making up the meadow; these organisms can grow until they cover both sides of the leaves, precluding the *P. oceanica* plant from carrying out photosynthesis and surviving the winter.

Likewise, a high intensity of free moorings of boats and recreational craft negatively impacts on the seabed; in this case, when the mooring is carried out on the meadow (a disallowed practice), it is engraved (marked) by the work of the anchors and by the rubbing of the chains against the leaves, engendering a “ploughing” effect on the *Posidonia oceanica* meadows, thereby laying bare the *matte*, which when deprived of the live plant takes the name of “*dead matte*”.

The meadows of some coastal areas have disappeared or have in any event undergone important fragmentation changes. Generally speaking, we can notice the multiplication of *inter-matte* canals, that might combine with each other to form wide non-vegetated areas, and a decrease in the density of stacks. In extreme cases, the meadow is entirely replaced by dead *matte* (Boudouresque et al., 2006), i.e. the “terrace” made up of the interweaving of old roots, rhizomes and the compacted sediment between them that remains bereft of leaves after the death of the plant. The dead *matte* is colonised by different species of algae, including those belonging to the *Caulerpa* genus: on the Italian seas, people have observed both the native species *Caulerpa prolifera* and the two non-native native species *Caulerpa taxifolia* and *Caulerpa cylindracea*, which find it difficult to invade the meadows in a good state of health, whereas they proved far more aggressive in respect of meadows showing signs of regression or weakening.

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2.4 Structure and functions of dunal vegetation

The coastal development of Sardinia, consisting of nearly 1900 kilometres of coasts, some 24% of them sandy, is the main one among Italian regions and represents approximately one-quarter of the national total. The dunal systems of high conservational value stretch for about 88 Km (Onori, 2009), ranking fourth among the Italian regions for linear extension after those of Puglia, Tuscany and Sicily. In these environments, vegetation is dominated by psammophilous plants (from the Greek *psammos* = sand and *filòs* = friend) that display a marked peculiarity: no typical sand species can be found in continental environments (typical hinterland environments), and extremely rare are the instances of continental species capable of surviving on beaches. Thanks to this bond, the dune plants can be deemed fully-fledged bio-indicators strongly linked to their peculiar habitat, important for the interpretation of quality (Géhu et Biondi, 1994; Acosta et al., 2003) and characterisation of the environment (Izzi et al., 2007).

In dunal environments, we can recognise a neat distribution (zonation) of vegetation, in which the communities of plants succeed one another in accordance with similar characteristics of a floristic, physiognomic (posture and structure) and ecological type, arranging themselves in bands more or less parallel to the coastal line (chain series) (Photo 8).

The chain series of vegetable communities found in the dunal systems of Sardinia (Photo 8, Fig. 3) is defined as “Sardinian psammophilous geosigmatum” and comprises typical vegetable associations grouped in specific vegetation units of higher hierarchical order (*Cakiletea*, *Ammophiletea*, *Crucianellion maritimae*, *Malcolmietalia* and *Juniperionturbinatae*) (Bacchetta et al., 2009)



Photo 8 - Dunal system of Simius beach (SCI “Isola dei Cavoli, Serpentara, Punta Molentis e Campulongu”)

corresponding to habitats of community importance codified by the EU (Attachment I to Directive 92/43/EEC) (Acosta et Ercole, 2015) according to the scheme:

1) Psammophilous thereophytic halo-nitrophilous vegetation – Annual pioneer communities that grow on the beach area flooded in winter, on which the storm surges leave substantial deposits of organic substance, especially remains of *Posidonia oceanica* (example of association: *Salsola kali-Cakiletum maritimae*); the species of this community are often succulent, or show structures like the leaves or the stems capable of storing water reserves.

Indicator species: *Cakile maritima*, *Salsola kali*, *Euphorbia peplis*, *Calystegia soldanella*, *Polygonum maritimum*.

The habitat of community importance codified as **1210 “Annual vegetation of the marine deposit lines”** refers to these communities.

2) Psammophilous geophytic and hemicryptophytic vegetation I and II – Perennial communities typical of mobile dunes dominated by specialised plants, ascribable to the same higher vegetation units (*Ammophiletea* class), but occupying different environments, influenced by a decreasing gradient of salinity and an increasing one of dunal evolution and distance from the sea, as well as by the different granulometry of the substrate:

I – (examples of associations: *Sporobolium arenarii* in the first stretch of emerged beach, *Echinophoro spinosae-Elymetum farcti* and endemic Sardinian-Corsican *Sileno corsicae-Elymetum farcti* on embryo dunes). The typical species of these communities are especially perennial grasses (geophytes) which, thanks to their root structure, are effective in the construction of dunes.

Indicator species: *Elymus farctus*, *Sporobolus virginicus*, *Eryngium maritimum*, *Achillea maritima* subsp. *maritima*, *Cyperus capitatus*.

The habitat of community importance codified as **2110 “Mobile embryo dunes”** refers to these communities.

II – (examples of associations: *Echinophoro spinosae-Ammophiletum arundinaceae* and *Sileno corsicae-Ammophiletum arundinaceae* on the white dunes). Thanks to the species of these communities, the dunal consolidation process is more pronounced: the substantial growth of *Ammophila arenaria* and the development of its root systems erects a barrier to the sand carried by the wind, which settles between the stems increasing the height of the dune. This area receives the direct impact of the wind heading from the sea, and the plants act as screen protecting whatever is in a backward position.

Indicator species: *Ammophila arenaria*, *Anthemis maritima*, *Echinophora spinosa*, *Medicago marina*, *Euphorbia paralias*.

The habitat of community importance codified as **2120 “Mobile dunes of the shorelines with presence of *Ammophila arenaria* (white dunes)”** refers to these communities.

3) Psammophilous camephytic vegetation – Behind the mobile dunes, in the consolidated dunes, where the strength of the wind is by now mitigated, a sheltered area is created with modest elevations and conditions more conducive to vegetation. The plants that settle there are mostly camephytic, i.e. perennial plants with buds not far from the ground, which provide a higher contribution of organic substance preparing the soil for entrenchment of the forest vegetation of fixed dunes (examples of associations: *Crucianelletum maritimae* and *Crucianello-Helichrysetum microphylli*).

Indicator species: *Crucianella maritima*, *Pancratium maritimum*, *Helichrysum italicum* subsp. *microphyllum*, *Lotus cytisoides* subsp. *conradiae*.

The habitat of community importance codified as **2210 “Fixed dunes of the *Crucianellion maritimae* coast”** refers to these communities.



Photo 9 - priority habitat Dunes with juniper *2250 “Coastal dunes with *Juniperus* spp.”.

4) Psammophilous terrophytic vegetation – Shaped as mosaic with the types of perennial vegetation of embryo dunes, mobile and fixed, of the coast, we find communities of annual late winter-spring phenology plants classifiable under the *Malcolmietalia* order (I) and, more rarely, the communities

of the *Brachypodietalia* order (II). The latter are located in the dryer and more stable part of the dune and are dominated by perennial grasses together with the annual spring-cycle plants.

I – Indicator species: *Malcolmia ramosissima*, *Matthiola tricuspidata*, *Medicago littoralis*, *Pseudorlaya pumila*, *Silene niceensis*.

The habitat of community importance codified as **2230 “Dunes with *Malcolmieta* meadows”** refers to these communities.

II – Indicator species: *Trachynia distachya*, *Aira elegantissima*, *Anagallis arvensis*, *Tuberaria guttata*.

The habitat of community importance codified as **2240 “Dunes with *Brachypodietalia* meadows and annual vegetation”** refers to these communities.

5) Psammophilous phanerophytic vegetation – In the consolidated fixed dunes, a juniper scrub vegetation, which is the most widespread woodland aspect of the sandy coastal strip, settles in. This community represents the first forest stage in the sandy areas, performing an important stabilising function of the coastal dunes (example of associations: *Pistacio lentisci-Juniperetum macrocarpae*).



Photo 10 - habitat prioritario 2270* Wooded dunes with *Pinus pinea* and/or *Pinus pinaster*

Indicator species: *Juniperus macrocarpa*, *Juniperus phoenicea* subsp. *turbinata*, *Pistacia lentiscus*, *Rhamnus alaternus* subsp. *alaternus*, *Rubia peregrina*, *Asparagus acutifolius*.

The priority habitat of community importance codified as **2250 “Coastal dunes with *Juniperus* spp.”** refers to these communities (Photo 9).

In the innermost and stabilised parts of the dunes in contact with the juniper habitat, it is quite common to find communities of shrub-like plants that form a bush or, in case the latter degrades, a scrubland (consisting in the main of small discontinuous pad-shaped shrubs).

Indicator species: *Cistus monspeliensis*, *Cistus salvifolius*, *Erica multiflora*, *Halimium halimifolium*, *Rosmarinus officinalis*, *Lavandula stoechas*.

The habitat of community importance codified as **2260 “Dunes with sclerophyll vegetation of *Cisto-Lavanduletalia*”** refers to these communities.

This type of communities also comprises the pine groves planted and subsequently naturalised. This vegetational type is dominated by various species of Mediterranean thermophilous pine (*Pinus halepensis*, *P. pinea*, *P. pinaster* subsp. *pinaster*) accompanied by the typical species of juniper groves. They are formations facilitated by man, which occupy the innermost and most stable sector of the dunal system.

The habitat of community importance codified as **2270 “Dunes with forests of *Pinus pinea* and/or *Pinus pinaster*”** (Photo 10) refers to these communities.



Fig. 3 – Transept of the dunal system (diagram of the position of communities of the chain-like psammophilous series compared to the sea): 1. Dunes submerged with the *Posidonia oceanica* meadows. 2. Area devoid of vegetable life (afitoic zone). 3. Embryonic dune area. 4. Mobile dune area. 5. Mobile white dune area. 6. Inter-dunal area. 7. Stable dune area. (Atzeni et al. 2014)

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2.5 Communication and environmental education within a coastal context

Within the scope of environmental safeguard and protection policies, actions and projects, communication plays an essential role, long recognised as such. Already in 1972, Article 19 of the Stockholm Declaration stated that: “Education on environmental problems, carried out among youth and adults alike, paying due regard to the less affluent persons, is essential to expand the base of an informative opinion and to inculcate in individuals, societies and communities the sense of responsibility for protecting and improving the environment in its full human dimension. It is likewise essential that the media should avoid contributing to the deterioration of the environment. On the contrary, they should disseminate educational information on the need to protect and improve, to thereby empower man to develop and progress in every respect.”

This role finds an important confirmation in the 1998 Aarhus convention (in force since 2001), which stipulates not only the right of citizens to gain access to information in the environmental field (and, on the other end of the spectrum, the duty resting on public authorities to divulge such information), but also the right to “participate in the elaboration of environmental plans and programs within a transparent and fair framework”.

The LIFE regulation itself prescribes a series of compulsory activities related to communication, from the presence of a website to the creation of publications, from poster designing on site to networking with other projects.

From this viewpoint, the communication and environmental education of a LIFE project have the two-fold role of

- informing stakeholders and the public of the actions undertaken, the results achieved, the critical aspects faced and the future strategies;
- promoting the adoption of virtuous conduct and discouraging those practices that harm the environment.

Within a coastal context, given the very strong anthropic impact on a large number of areas, sensitising the public, especially tourists, has direct positive and sometimes measurable consequences on the concrete conservation actions themselves. Nor should we forget that in many coastal areas the tourist presence represents an important share of the local economy, essential to the survival of the community.

Leaving aside the borderline cases, we can state that environmental communication within a coastal context is characterised by an extreme heterogeneity of stakeholders. We could cite among them the resident population, the tourists (who can in turn be distinguished – to adopt a far from technical terminology – into “daily” and “resident” depending on the length of their stay), the students and school pupils, the companies, the associations (sports and environmentalist first and foremost), and the public and local administrations.

This heterogeneity enjoins the use, next to the global communication tools, of a plurality of communication tools and products, of varying degrees of effectiveness depending on the reference target.

When choosing the tools, we must pay regard, besides the consolidated models in the literature, to the frequently radical evolution of some tools deemed essential. For example, the website (let us re-emphasise, obligatorily present in any LIFE project) has partly transformed, in the current model of network use by the public, into broadcasting tool (the communication from a broadcasting source towards a plurality of recipients), a repository of contents: a container, indeed, in which to procure information that is needed or towards which a curiosity has already been generated. The first contact with a project seldom occurs through the website; we should resort to other channels better suited to contact those with whom some connection exists. A conscious presence on the main social networks could represent one of those channels, provided however that the non-universality of the target be borne in mind. As regards tourists, direct contact and the distribution of informational material (better still if accompanied by the distribution of gadgets) are undoubtedly effective.

Aside from an accurate study of the target and of the strategies and tools to reach it, it is worth remembering that one thing is planning and another is implementing a project.

It is unavoidable, no matter how much care and commitment are lavished on the planning, that the execution of the project actions will highlight divergent results, to a variable extent, from the expected ones, thereby necessitating remedial actions founded on the premise of a painstaking monitoring along the way.

Given in fact the impossibility of ensuring beforehand the effectiveness of an action or a communication product (the more so in respect of innovative products or experimental actions), the ability to “stay on top of the situation” will represent the difference between an action that has underlined surmountable difficulties and an action that ended with a negative outcome.

In conclusion, continuity seems to be the winning solution: continuity in the production of contents, continuity in informing the public, continuity in internal communication and the monitoring of results, always keeping in mind that what is at stake is not only the success of a project, but also the broader public’s right we spoke about in the foreword.

3. Good practices for beach system management

3.1. Positioning of the mooring structures to protect the *Posidonia oceanica* Meadows habitat 1120*

Introduction

The context which the action refers to is the marine habitat 1120* *Posidonia* Meadows (*Posidonium oceanicae*), a widespread and characteristic habitat of the Mediterranean coastal areas, essential for the ecological and physical balance it supports vis-à-vis the coastal system.

The areas with *Posidonia oceanica* sea floors are vulnerable to the direct action of the anchors that might provoke the destruction of the leafy *canopy* (eradication of the whole bundles), laying bare the *matte*, the typical substrate made up of roots, rhizomes and trapped sedimentary particles. This enfeeblement might facilitate the progression of other vegetable species, especially those algae that tend to spread quickly, such as *Caulerpa cylindracea*.

More specifically, recreational boating is deemed one of the main factors of disturbance for the biological communities, mainly due to the mechanical impact of the anchors.

Problems tackled

The impact areas thus generated by the mechanical impact of the anchor might cicatrise if the vitality of the meadow is good and if the impact is not repetitive (high anchoring density and frequency).

If the impact persists and, especially, if the recovery ability of the plant is low, the degradation process might engender long-term effects: for instance, the partition of the meadow (progressive extension of the dead *matte* surface and fractioning of the meadow into scrubs and/or islands) and the destruction of the *matte*.

In particular, the erosion of the *matte* entails a massive release of sediments trapped during its construction and a re-suspension of the fine sediment fraction.

The regression of a *Posidonia* meadow does not only represent the disappearance of one of the most important Mediterranean ecosystems, as it might also give rise to heavy consequences for the environment in general.

Objectives

The general objective is to maintain the *Posidonia oceanica* Meadows habitat by deploying measures that avoid the fragmentation of the habitat due to mechanical causes..

Methodology

The methodology consists in launching on-site studies to identify the areas; the studies are diversified depending on knowledge of the area and target biological and other components. They thus comprise studies on the morphology of marine seabeds, sedimentology, hydrodynamics and the like.

The mapping of sea floors through surveys by instruments and the theme-based cartography produced represents one of the key points of the proposed intervention/action; the surveys are supplemented by monitoring video investigations and/or scuba diving.

These investigations serve to identify and characterise the habitats and populations potentially sensitive to the impacts of recreational boating.

Of fundamental importance to planning are the investigations aiming to quantify the impact level through the frequent use of recreational boating: assessing the characteristics of the boats and identifying the most widely used anchoring sites.

Prospects

The maintenance of the proposed intervention takes place through expedients relating to maintenance of the buoys, with the periodic control and replacement of some structural mooring elements; the withdrawal of the buoys when the first winter storm surges appear.

The first such action is to sensitise users about good anchoring practices, with the main recommendation not to drop anchor on the *Posidonia* meadows and lend preference to the sandy areas.

Here are some good practices:

- searching for the sandy, lighter areas;
- using the buoys on site, where they exist, inside the protected marine areas and follow the operators' recommendations;
- positioning the boat, with the help of the engine, in such a manner as to recover the anchor on a vertical line with the boat, substantially reducing the damages on the meadow;
- using the DONIA application (<http://www.donia.fr>), which provides free-of-charge access to the map of the seabed and thus to the position of sensitive habitats..

Assessment

The action is important wherever the need arises to locally manage *Posidonia oceanica* seabeds in areas subject to significant nautical attendance. The arrangement of mooring structures reduced the impact generated by the mechanical action of the anchor on the habitat.

Projects that implemented the good practice

Life Posidonia Andalusia - Conservation of *Posidonia oceanica* meadows in Andalusian Mediterranean Sea (LIFE09 NAT/ES/000534).

Posidonia Balears - Protection of *Posidonia* grasses in SCIs of Balears (LIFE00 NAT/E/007303).

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3.2. Repopulation interventions in habitat 1120* Posidonia Meadows

Introduction

This action develops for the sake of recovering the priority habitat 1120* Posidonia Meadows (*Posidonium oceanicae*), often subjected to different pressures and threats that jeopardise conservation, such as improper free anchoring, illegal trawling, and the presence and spread of invasive alien species.

Problems tackled

The *P. oceanica* meadows are currently in deep regression throughout the Mediterranean countries, even though they are protected by several national and international rules and their ecological importance is internationally acknowledged.

As already explained, *Posidonia oceanica* is extremely sensitive to all environmental modifications and decreases, or even disappears, when the pollution level is too high. Main regression causes of the meadows are anthropic pressure on coasts, due to the direct introduction of pollutants or atrophy substances, the building of manufactured goods, such as harbours, piers and dams. altering the hydrodynamic coastal system, the not regular free anchoring and the use of trawling equipment (Boudouresque et al., 2006). These causes often act synergistically and it is not easy to separate them and selectively analyse their effects.

In places characterised by intense human activity, the impacts on habitat 1120* Posidonia Meadows can be characterised by a certain degree of fragmentation, more or less pronounced, such as to jeopardise their health and survival.

Objectives

The main objective is to restore the priority habitat 1120* wherever partially undermined or degraded through man's direct or indirect action.

Methodology

The whole of the geomorphologic, physiographic, sedimentological and hydrological descriptors of the chemical-physical characteristics of the water column contributes to the characterisation of the site and of the meadow colonising it. Through the mapping of the seabeds and "truth at sea", i.e. point surveys of direct assessment, the degraded areas of the 1120* habitat are identified.

Once the degraded areas on which to intervene have been identified and characterised, the suitable substrate is chosen (Mac Mat® mats, rhine mattresses, and *Mater-Bi* ray structures). Before proceeding with the positioning, accurate scuba diving checks must be conducted to precisely define the installation depth, of the adequate dimensions (in the case of geomats) and of the needed quantities. The positioning of the growth substrate has to be done by qualified staff, able to carry out scuba diving activities (OTS, scuba technical operator) and in order to ensure the best adherence to the seabed. After the positioning, planting can follow; this one, together with all preceding phases, such as collection and selection of cuttings, has to be performed by specialised figures, who have been trained to carry out scuba diving activities for scientific purposes, as scientific scuba operators (OSS).

The harvesting equipment continues to come above a substrate. Poi... The creation of nuclei formed by a given number of cuttings per square meter is recommended (at least 20/30 cuttings/sm); it seems indeed that the reduction of the light deriving from the covering of the meadow could limit the photosynthesis and thus the growth of invasive alien species such as *Caulerpa cylindracea* (L. MarinGuirao et al., 2015).

An anthology of methodologies and procedures partly mentioned above is found in the handbook/guidelines titled “Conservation and management of the naturalness of marine-coastal ecosystems. The transplant of *Posidonia oceanica* meadows” ISPRA, MLG 106//2014.

Prospects

At least in the first period after the intervention, it is crucial to continue the controls seasonally to monitor the stability and survival of the marine hydrodynamics of the positioned structures and to verify the adaptability capacity of *P. oceanica* to the selected materials. In the long term it is recommended to continue with yearly monitoring to fully understand the effects of the action.

Assessment

The strength of the proposed intervention is the collection and use of cuttings naturally dug out onsite in order to protect the *P. oceanica* meadow by removing by removing the collected part of the meadow, as well as the choice to recover an adequate site and on a small scale (Piazzi et al., 1998).

Use of the MAC-MAT® geomat substrate is a weak point, since the materials making it up are not biodegradable, consisting in fact of a metal mesh reinforced by polymer (polypropylene).

To date, this type of geomats represents the best substrate for a mat-type seabed, inasmuch as they ensure a greater hold over time, when facing surge storms and/or strong currents, lending cuttings a better chance to take root and colonise the degraded area.

Projects that implemented the good practice

The Capo Rizzuto Protected Marine Area project headed “Reforestation intervention, protection of marine seabeds and creation of an experimental nursery through the use of *Posidonia oceanica*” envisaged recourse to cuttings naturally dug out by the heavy winter storm surges and already partly detached from the meadow due to decomposition of the *matte*.

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3.3. Manual cleaning of the beach

Introduction

The use of mechanical means for cleaning the beach, especially in the area most extensively used by swimmers, located between the water edge and the embryo dune, causes different harms to the entire dunal ecosystem. In particular, a strong risk is posed to the terophitic plant communities, such as those of *Cakile maritima*, *Salsola kali* and *Chamaesyce peplis*, all of them pointers to habitat 1210 “Annual vegetation of the marine deposit lines” that play a central role in facilitating dune-formation processes. Likewise exposed to substantial risk are the *Charadrius alexandrinus alexandrinus* habitats (Kentish plover, a mud-dwelling shorebird that nests in a dunal environment) and the *Caretta caretta* one (common sea turtle, that exploits the embryo dune area to lay the eggs).

Problems tackled

The strong anthropic pressure associated with tourism and the marine weather conditions (currents, tides, surge storms and/or storms) facilitate an excessive presence of different types of waste responsible not only for ecological problems linked to the degradation and burial of the same, but also for a disfigurement of the natural beauties and a different way of perceiving, living and respecting the ecosystem on the part of beach users.

Objectives

The main objective is to remove the different types of waste found on the beaches so as to limit the ecological and visual impact on the coastal ecosystem.

Methodology

Through daily inspections to conduct before and after enjoyment of the beach by swimmers, the various types of waste, whether arising from marine weather events and/or carelessness on the part of swimmers, must be manually removed rather than through the use of mechanical means.

The waste must be differentiated and subsequently carried and stored in the nearest ecological centres.

Prospects

The waste collection and differentiation should be carried out throughout the year to avoid its accumulation both in the periods characterised by the most forbidding marine weather conditions and in those where used by swimmers is at its peak.

In order to minimise the work of municipal ecological operators and environmentalist associations, different types of containers will be placed along the entire beach. In addition, to avoid possible waste abandonment phenomena on the edges of roads and/or close to the beaches, ecological islands open 24 hours a day should be created on the main arterial roads connecting to tourist resorts.

Assessment

The work undertaken by municipal ecological operators and different volunteer teams represents a quick and effective way to avoid the piling up of waste that might be covered and buried by the sand.

The involvement of municipal ecological operators, associations and all the tourist operators active on the beach should facilitate a process of ecological maturity and awareness by all the users who might emulate the example. Besides, the process might likewise be facilitated by the presence of differentiated waste collection bins and the presence of ecological islands open 24 hours a day in summer.

Projects that implemented the good practice

They are usually not typical project practices, but rather good socio-environmental practices implemented by the individual municipal administrations.

3.4. Eradication of invasive alien species

Introduction

Coastal ecosystems are among the environments most heavily hit by the invasions of alien species due to the greater anthropic pressure engendered by tourist activities. These activities increase the introduction rate of alien species and, consequently, the spread of invasive alien plants in natural environments, especially in coastal habitats. The invasive plants that pose the greatest danger to these habitats are those coming from other geographical areas with a climate quite similar to ours, of Mediterranean type, such as those belonging to the genera *Carpobrotus*, *Malephora*, *Mesembryanthemum*, *Lampranthus* (originally from South Africa), or to the genera *Acacia*, *Vachellia* (Australia or Southern Africa) or to the genus *Agave* (Central America) (Meloni et al., 2015; Podda et al., 2018). These species, finding the ideal environmental conditions for their survival and naturalisation, are capable of competing with the native species and taking their place in the habitat, causing their subsequent degradation and disappearance, with damages giving rise to huge mitigation costs. Eradication is a mitigation action, and to have higher chances of success it must be carried out together with such other good practices as prevention of new introductions, control and the simultaneous renaturation of habitats.

Problems tackled

When an invasive species has been introduced in nature, only damage mitigation actions (removal and/or control) are possible, and they always prove very costly and hardly susceptible of conclusive implementation other than through joint prevention and renaturation actions. The pressure from propagules is continuous in these habitats, as the cultivation of invasive species for ornamental use and the release in the environment of their pruning remains increases the risk of naturalisation with subsequent process of invasion of habitats by these plants. For this reason, it is important to envisage after the eradication the collection and disposal of the vegetable biomass removed.

Objectives

Reducing the presence of invasive alien species from coastal habitats until their final removal: The ultimate goal is to facilitate the recovery of the native species and the natural vegetation without causing damages to the local flora and fauna and averting the risk of erosion of the sensitive habitats in case we are acting in the dunal system.

Methodology

The interventions to uproot the invasive species are necessary to make room again for the native species, foster the recovery of spontaneous vegetation, and also facilitate, wherever the eradication has taken place, the reintroduction of native species through renaturation and naturalistic engineering interventions. The eradication interventions, when the invasive plant is inside a natural habitat, must be performed only by skilled and authorised staff, as they might damage the native species, both animal and vegetable. Various eradication practices, both manual and mechanical, are recommended. With regard to non-woody plants (genera: *Carpobrotus*, *Malephora*, *Mesembryanthemum*, *Lampranthus*) or of woody plants at their young stage (genera: *Acacia*, *Agave*, *Vachellia*), manual

eradication is possible. We must carefully grasp the plant, pulling it delicately from the soil and trying in the process not to extirpate the other plants as well (both the native ones if we are dealing with a natural environment and those cultivated in one's garden). As for adult specimens of woody species, the eradication can only be undertaken through mechanical means (saws, chainsaws). Wherever possible, we recommend cutting the plant at the base of the stem, followed by the full eradication of the plant from the ground. Should that not be possible, the base of the stem after the cutting will have to be covered with germination-inhibiting sheets to avoid discards and any regrowth from the roots of the plant as well. The ideal period to remove the plants is always prior to the blossoming/fructification to avoid new seed production. The fruits of some edible invasive species and various animal organisms (ants, birds, mice and other mammals) can contribute to dispersion of the seeds and to the spread of the plant. It is important not to leave any vegetable residue on the soil, since any part of the plant might re-vegetate and multiply under the hardest conditions as well; besides, the residues might contain allelopathic substances, i.e. substances that alter the pH of the soil, preventing the germination of other plants. Whenever visible, the seeds ought to be removed from the surface layers of the soil as well. If you are operating on the beach, fine-mesh sieves can be used to let the sand go through.

Prospects

In the years following the eradication interventions, a control is necessary to remove any regrowth of suckers and discards from the roots or from the cut stumps and new seedlings. There is a high risk of new germinations due to the permanent bank of soil seeds. The seeds of some invasive species remain vital for a long time (over 50 years as well) and germinate when environmental conditions (temperature, humidity, salinity, etc.) arise. Due to this, the eradication and control must be constantly repeated to avoid any new regrowth and subsequent re-colonisations.

Assessment

The eradication and control of invasive species represent a starting point for the reconstruction of degraded natural habitats. Without, in fact, the removal of invasive species, the native species cannot grow back and reclaim the space occupied, due to the strong competition they are subjected to.

The joint action, in the areas subjected to eradication, of renaturation interventions (planting and sowing of native plants) reduces the risk of soil erosion and increases the possibility of successful vegetative recovery of our species and, as a result, the recreation of the habitat.

Unfortunately, the costs of eradication and disposing of the invasive species are very high and entail a significant investment, especially if large areas are occupied by the invasive species. We must additionally foresee the maintenance costs with the control of interventions for at least 3 years from their implementation.

Projects that implemented the good practice

There are a great many projects that saw interventions to uproot invasive plants. A milestone for the eradication of *Carpobrotus* sp. pl. [multiple species] took the form in Spain of the "LIFE Nature: Conservation of areas with threatened species of the flora in the Island of Minorca

LIFE2000NAT/E/7355”. Other important LIFE projects in Italy consisted in the LIFE Natura NAT/IT/000416 “Puffinus Tavolara: Protection of the larger world population of *Puffinus yelkouan* and containment/eradication of invasive alien species” with removal of *Carpobrotus* sp. pl., and the LIFE Natura NAT/IT/000353 “MONTECRISTO 2010 – Eradication of invasive alien flora and fauna components and protection of species and habitats in the Tuscan Archipelago” during which both *Acacia* sp. pl. and *Carpobrotus* sp. pl. have been uprooted.

Even the LIFE Natura NAT/IT/000519 “PROVIDUNE” (2009-2014) project witnessed small eradication interventions and, simultaneously, sowing and naturalistic engineering interventions. At regional level, the APQ project headed “Interventi di eradicazione di specie vegetali ed animali alloctoni presenti in Siti di Importanza Comunitaria (Eradication interventions of vegetable species and allochthonous animals present in Sites of Community Importance)” is cited – sub-project 01 funded by the Sardinia Region with Framework Agreement with the Ministry of the Environment and Protection of the Territory and the Sea, during which the invasive plant *Carpobrotus acinaciformis* was uprooted on small areas (2010).

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3.5. Renaturation of dunal habitats through naturalistic engineering works

Introduction

This action is developed on psammophilous habitats, especially on the priority habitats 2250* Coastal dunes with *Juniperus* spp. (multiple species) and 2270* Dunal forests of *Pinus pinea* and/or *Pinus pinaster*; in addition to those linked to them. They often disclose a precarious state of conservation by virtue of anthropic pressures and threats: high foot traffic, coastal erosion, presence of invasive alien species.

Problems tackled

The marked anthropic pressure caused by high foot traffic, coastal erosion and presence of invasive alien species, jeopardises the presence of the native species and the dynamics of the vegetation and the natural habitats.

Objectives

The main objective is to facilitate the spontaneous processes of formation, growth and consolidation of the dunes via extremely localised interventions of naturalistic engineering, together with new implantations and densifying of pre-existing native species with a view to spontaneously reconstructing the functionality of the wind dynamics and the conservation of the relevant habitats: 2250* Coastal dunes with *Juniperus* spp. and 2270* Dunal forests of *Pinus pinea* and/or *Pinus pinaster*, as well as those linked to them.

Methodology

The preliminary geobotanical assessment of the ecological state of the relevant habitats and the future interventions of removal of alien species will have to help identify the areas on which to perform naturalistic engineering works. They will be carried out by resorting to such natural biodegradable materials as wood, vegetable fibre nets, reeds and ropes, whereby the impact on the ecological balance of the dunes and on the floral-vegetational component is minimised, together with the visual impact on beach users.

The following might be selected among the naturalistic engineering interventions:

- a) Sand capturing and trapping systems implemented through two types of structures: triangular primer nuclei (2 m on each side) and windbreak barriers (of quadrangular shape, 3 m on each side) that can be set up in the embryo dune sectors, i.e. in the areas of potential development of the psammophilous chain succession of the coastal vegetation habitat. In both instances, the structures will be placed consistently with the current beach dynamics.
- b) Stabilised dune protection systems (normally colonised by the Phoenician Juniper and Prickly Juniper [*Juniperus oxycedrus*]) consisting of vegetable fibre bionets, whose purpose is to protect the sides of those dunes where the effects of wind erosion and digging produced by foot traffic are prominent. This system furthermore facilitates the deposit and accumulation of sand in the interstices between the reeds and the bionet meshes, consolidating the foot of the dune and improving, with the

passage of time, the edaphic conditions of the sandy substrate, thereby ensuring the recovery of vegetation on the dunes.

Prospects

The naturalistic engineering works are made of biodegradable materials, and their natural deterioration and integration in the landscape with the reconstruction of the dunal profile is accordingly envisaged.

Assessment

The naturalistic engineering works represent the most successful dunal interventions when it comes to facilitating the spontaneous processes of formation, growth and consolidation of the dunes thanks also to the initial effect of colonisation of pioneer species and to their subsequent vegetational dynamics. These types of intervention present a high initial cost, mainly due to their implementation rather than to the unit cost of the individual materials. Besides being easy to procure, in fact, they have the dual advantage of being biodegradable and a very low ecological and visual impact.

Projects that implemented the good practice

Most of the ecological restoration projects in the dunal systems use naturalistic engineering works, as exemplified by the projects set out in the “Manual de restauración de dunas costeras”, especially as regards the El Saler (Valencia) project and the Restoconlife, June coast and Providune LIFE projects.

Moreover, the PROVIDUNE Life project (2009-2014) (Durán et al., 2016; Pinna et al., 2015, 2017) was the first project to make use of bionets for the protection and repopulation of the stabilised dunal systems used until then in mountain environments

References

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3.6. Renaturation of dunal habitats by sowing and planting with native species produced from locally harvested seeds

Introduction

This action is developed on psammophilous habitats, especially on the priority habitats 2250* Coastal dunes with *Juniperus* spp. (multiple species) and 2270* Dunal forests of *Pinus pinea* and/or *Pinus pinaster*, in addition to those linked to them. They often disclose a precarious state of conservation by virtue of anthropic pressures and threats: high foot traffic, coastal erosion, presence of invasive alien species.

Problems tackled

The marked anthropic pressure jeopardises the presence of the native species and the dynamics of the vegetation and the natural habitats.

Objectives

The main objective is to facilitate the presence of the typical species of psammophilous habitats, thereby promoting the recovery of natural vegetation and the stabilisation of the dunal system.

Methodology

A floristic-vegetational study leads to the identification of the main species of structural and functional importance of the habitats found in the dunal system. Based on the phenological calendar of the single species and of international protocols, it is possible to plan and harvest the germplasm (seeds).

Both the sowing and the planting are undertaken in the autumnal season. The sowing of embryo dune species can take place inside naturalistic engineering structures (primer nuclei and barriers) with a view to facilitating the creation of embryo dunes, whereas the juniper cones and those of other species typical of mature dunes can be sowed on the bionets so as to reconstruct the environments behind the dunes and/or stabilise the existing dunes.

To be able to move onto the planting of species produced from local germplasm, they must be necessarily multiplied in a nursery structure without using either fertilizers or pesticides, and cultivated in water stress conditions readying them for the dunal environment. They must then be planted keeping in mind the original habitats, possibly in the shadow cone of the already existing vegetation and in small groups (3-5 individuals together).

Prospects

The species multiplied in the nursery structures prove to be more susceptible to water stresses compared to those planted by seed, for which dry farming and/or water saving techniques might be devised and implemented.

The sowing in the different structures is subject to constant monitoring, carried out monthly and scheduled for two years subsequently to the end of the project, with a view to understanding the effects of the actions.

Assessment

The strength of the project is the fact that it uses locally procured material in order to retain the local genetic diversity.

The implementation of manual sowing allows us to get seedlings more suited to dunal conditions than planted ones, which prove instead to be subject to a dual stress, namely, the one caused by their growth in forced environmental conditions (greenhouses or shade canopies) and the one due to their subsequent implantation in dry environments.

The joint action of manual sowing and implantation of vegetable material multiplied in the nursery gardening structures enhances the possibility of the species to succeed and, therefore, that of the dune to recover and be protected.

Projects that implemented the good practice

Most of the dunal system reinstatement projects use plants produced in nurseries: examples of that are provided by the several LIFE projects implemented in Valencia in the Albufera Matural Park (<http://albufera.valencia.es/es>) and the LIFE RESTOCONLIFE and JUNICOAST projects.

The LIFE PROVIDUNE (2009-2014) project was the first one to use manual sowing of the structural species inside and outside the naturalistic engineering structures (nuclei, barrier and bionets).

3.7. Positioning of services (waste collection, parking areas, toilets) with suitable localisation

Introduction

Access to the beaches and the services linked to their use represent one of the most important aspects for safeguarding them.

The greatest danger to their existence, in fact, especially as regards dunal systems, is associated with the anthropic impact produced by foot traffic.

The disorderly access in more than one point, particularly in beaches with a long development parallel to the coastal line, can cause damages of such magnitude as to undermine the natural reaction ability to reinstate an original state of balance (*resilience capacity*) on the part of the beach-dune system.

Problems tackled

The marked anthropic pressure caused by excessive foot traffic undermines the natural sediment flows from the dune to the beach and vice versa, both transversally and longitudinally, creating incisions in the dunes and simultaneously preventing vegetation from facilitating their consolidation.

Objectives

The main objective is to facilitate the spontaneous processes of formation, growth, consolidation and protection of the dunal systems by channelling the access points and suitably positioning the services, all of that for the sake of their conservation and that of the relevant habitats: 2250* Coastal dunes with *Juniperus* spp. and 2270* Dunal forests of *Pinus pinea* and/or *Pinus pinaster*; as well as those linked to them.

Methodology

The first aspect to evaluate concerns the study of the beach and the area behind the dunes.

The purpose is to identify the critical aspects and the most extensively undermined areas, and accordingly identify the areas where it is possible to put up, unless already in existence, the parking spots and the services (waste collection and toilets). Thereafter, the access points to the beach must be created.

The parking spots must be necessarily placed in areas not too close to the beach, and the access points must be such as to ensure people to easily reach the beach, an essential condition for using the same.

The access routes must be restricted and channelled through light pole-rope-pole delimitations and with hanging boardwalks in the stretch of relevance to the dunal and sandy areas.

The hanging boardwalks on wooden poles, not made to rest on the ground, discharge the function not only to avoid food traffic but also to ensure sand circulation and avoid that huge quantities of sand sticking to shoes and feet be transported outside the beach and therefore no longer available.

Prospects

The naturalistic engineering works, boardwalks and delimitations must be subjected to constant control to be able to quickly implement ordinary and/or extraordinary maintenance interventions caused by the normal wear and tear of materials, by possible human damage actions or by extreme marine weather events.

Since the maintenance interventions are costly, special care ought to be lavished in the design stage both on the use of materials and on their positioning and linear development.

Assessment

The interventions aimed at the channelling of access points (parking spots, services, delimitations and boardwalks) are those that ensure the best results when it comes to facilitating the spontaneous processes of formation, growth and consolidation of the dunes.

They have the added advantage of enabling an estimate of the daily anthropic load by detecting the number of parked cars and use of the toilets, besides allowing the placement of people counter sensors, all of that with the aim of elaborating solutions for the proper use, safeguard and protection of beaches

Projects that implemented the good practice

LIFE RESTOCONLIFE, JUNICOAST, PROVIDUNE

3.8. Creation of informational and educational poster designing and signage

Introduction

Guaranteeing a correct information to users (tourists and locals) when entering the beach ensures on the one hand that the bans and prescriptions enjoined by the legislation and by the project are not perceived as pointlessly restrictive, and on the other hand brings immediately home the function and importance of the interventions undertaken. The poster designing is potentially capable of reaching all the beach users, and is always available to interested parties and curious persons.

Problems tackled

One of the main problems associated with the safeguard of habitats, especially coastal ones, stems from the high anthropic attendance at beaches, the dumping of waste, and the uncontrolled transit over the dunes with resultant erosion and damage to the vegetation accompanied by loss of biodiversity. Many interventions, in fact, such as the boardwalks or the pole-rope-pole delimitations, aim precisely at the avoidance of foot traffic and the improper use of dunes.

There is thus a need for a targeted and suitable action of informing users on the importance of the habitat where action is going to be performed and the correct methods of conduct.

Objectives

By placing specific informational poster designing and signage, the intention is thus to try to sensitise users to a more sustainable use of the areas, while simultaneously spreading the project objectives.

A better information enables users to perceive the beauty and importance of the habitat they are approaching, facilitates contact with nature, and brings the conservation policies into relief, allowing their action, of an interdicting type at times, necessary to a greater protection thereof, to be shared approvingly.

Methodology

The first aspect we need to specifically focus upon relates to the positioning of support structures so that the visitors are encouraged and empowered to read fully and once all the information therein contained. The structures must therefore be located in strategic, quite visible positions by the access points to the sea, along the routes crossing them or in the parking areas.

If the location selected falls within areas subject to restriction, the application for issuance of the necessary landscape authorisation must first be submitted to the competent authority, along with the technical documentation (technical report, landscape report and location of the structures with related rendering), as well as, if need be, the legal ground for execution of the works.

As regards the size of the structures, to be in harmony with similar structures found on Sardinian territory, effect has been given to the “Guidelines for setting up poster designing at the Natura 2000 Network” issued by the Department of Environmental Protection of the Autonomous Region of Sardinia. The selected type is that of a shed structure, approximately 150 cm wide, and some 250 cm

high above ground, two-pitch protection hut, capable of hosting an informational board in forex measuring 100 X 140 cm.

In the specific case of RES MARIS, since we are dealing with areas already partly dealt with by the previous LIFE PROVIDUNE project, the attempt was made to avoid positioning new structures in the same areas where those relating to the said project were already present: this would have in fact entailed a considerable visual impact (overcrowding due to the presence of multiple structures used for the same purpose in limited-extension areas), and the associated rise in maintenance costs. The identified solution was accordingly to use the pre-existing supports installed in the course of the LIFE PROVIDUNE project, installing new structures only if not yet in existence. It would have been possible to install new boards setting out information and images of both projects on the same supports, the pre-existing and the newly installed ones (for a total of seven structures).

As regards the contents of the boards, they must set out, for the sake of an effective and immediate communication, all the essential information allowing the site to be known. More specifically:

- claim that effectively transmits at once the message meant to be conveyed (in our case, “THE LIFE PROJECTS: LET US EMBRACE THE COAST FROM THE DUNES TO THE SEA”, having taken up the contents of both PROVIDUNE and RES MARIS)
- cartographic map, possibly using a standardised basis
- description of the Site of Community Importance area, territory, habitat and species present, to be protected or to be removed
- synthetic description of the project (partner, objectives, actions and results)
- rules of conduct to abide by in order to reduce damage to the habitats and disturbance to the species of community importance, including through simple language in the form of pictograms or illustrations and images
- logos and other elements (in the specific case, the QR codes linking to the web resources have been added for more in-depth information)

The more specialised information, such as that about species and environments, must be transmitted through a simple, clear and direct language, with a typically educational slant, supported by photographic images or by illustrations.

In the specific case, given that it is a product created through EU funds, it must always bear the words: “Made with the contribution of the EU LIFE financial instrument”.

As we are dealing, moreover, with high tourist vocation areas, the information must be set out in at least 2 languages, Italian and English.

Prospects

In the specific instance, the informational panels have been placed on wooden structures, and a constant maintenance is thus necessary due also to their positioning in areas close to the sea.

Assessment

One of the strong points of the action concerns the materials. In line with the principles of the action Plan for the environmental sustainability of public administration consumption (PAN GPP), the choice was made to manufacture the products in accordance with the “Minimum Environmental Criteria”. More specifically, the wooden components of the structures had to comply with the provisions laid down by Regulation (EU) 995/2010 and be made up of recycled wood and/or wood coming from woods/forests managed in a sustainable manner. The composition of the material supplied will have to be declared or attested by any trademarks or certifications held to that effect.

Another aspect concerns anchoring to the ground: wherever it was on sandy ground, it took place without using underground concrete plinths, using instead only specific technical expedients that enhanced its grip.

3.9. Implementation of activities aimed at the involvement of private subjects (citizens, tourists, economic operators)

Introduction

The involvement of private subjects, through a careful communication activity, represents one of the essential aspects in the implementation of interventions in such delicate contexts as those tackled in this handbook: the protection and conservation of the habitats demands in fact a broad involvement on the part of all interested players: from local authorities to economic operators, from school-age children to the public at large. Only by letting the goals of the interventions known and by fostering the participation and responsibility of stakeholders, it will be possible to ensure their effectiveness even past the conclusion of the same.

Problems tackled

The involvement of private subjects should not be underestimated or deemed an “acquired” element merely because certain activities are proposed. The different types of public must be analysed and a suitable strategy to reach them put forward.

For this reason, a correct communication strategy must envisage recourse to different channels and tools, adapted from time to time to the characteristics and to the needs of the various addressees: the new generations, the administrators, the economic operators or the citizens at large.

Objectives

There is a variety of objectives an effective involvement action has to reach. Firstly, it must succeed in channelling the important information about the specific issue dealt with, seeking to lend maximum visibility to the interventions carried out.

When, however, we are speaking of interventions in the environmental field, the main objective is to try to have a lasting influence on the conduct of users of the beach system, first and foremost that of the local community. In general, the citizen must be adequately informed and sensitised so that he can realise what are the problems associated with a proper conduct, while simultaneously instilling in him awareness about the priceless potential represented by a territory that must be protected and enhanced, adopting increasingly more sustainable and environment-friendly behaviour.

Methodology

There are various possibilities for involving private subjects: from the more “conventional” ones, such as the organisation of public events and discussion tables, the production of educational material, the activation of specific websites, or the establishment of temporary information points to approach a specific category of users, such as swimmers, etc. As stated earlier, the communication strategy must stem from a specific analysis of the target and the types of public involved.

By way of illustration, we want to set out hereunder one of the actions undertaken in the course of the RES MARIS project put forward, in this writing, as good practice of involving private subjects; the campaign for the removal of alien species in private areas and their replacement with native species - CLUB RES MARIS.

The eradication and re-naturalisation actions performed across the time span of the project have only concerned state-owned areas. The reference territory of RES MARIS, however, is characterised by the presence of a fair percentage of private areas, endowed with both gardens and, as regards condominiums and resorts, common green areas.

It is clear that the success of the concrete conservation actions, especially the eradication actions, might have been significantly influenced by the presence of the invasive alien species in the private areas, from which colonisation in the previously “cleaned up” areas might have resumed.

It was thus deemed necessary to involve private subjects (citizens and companies) so that they themselves (with the support of RES MARIS) could see to the removal of the invasive alien species and to repopulation with typical Mediterranean species. That is why the project has envisaged the purchase of new plants and compost bins to be supply to private subjects.

The action consisted in involving private citizens and companies in the project and convincing them to affiliate to CLUB RES MARIS, eradication the alien species from their lands or, if they owned none, supporting notification of the project by word of mouth and through their direct contacts. In exchange for their involvement, RES MARIS would have supplied them with typical plants to replace the uprooted ones, plus some small yet significant free gifts, first and foremost the compost bins.

As regards the promotion and activation of contacts, it is always useful to follow the traditional approach, i.e. broadcasting through paid advertisements on Facebook, combined with the distribution of informational material in paper form. In the specific case, however, following a more in-depth analysis of the target, a re-modulation of the action was opted for. Many of the private areas of relevance to the project consisted in fact, more than in habitual residences, in mainly seasonal tourism facilities or houses and condominiums set aside for summer holidays. In the near totality of cases, the owners or the administrators were inaccessible other than in the summer period. With tourism facilities, moreover, the summer period represents a moment of frenetic activity due to the extremely high flow of tourists, which renders administrators and managers scarcely available, due to sheer lack of time, for casual contacts not directly linked to their work.

A more effective approach was found in the search for a synergy between the Club objectives and the other actions underway: the Club and its objectives found room in the activities of technical round-tables, through demonstrative and good visibility actions, such as the eradication of alien species (and planting with typical species) in a public area, carried out by school students assisted by the FORESTAS Agency technicians.

Again for the sake of synergy, the regulations of the tourist sensitisation campaign for the 2017 season were amended so that the mandated firm might escort these activities by the direct contact, facility by facility, of tourist operators. The anticipated launch of the service (starting from June) has ensured that such contacts might be activated during a work yet not frenetic period, ensuring ideal conditions for a fruitful dialogue.

Prospects

All the communication actions must necessarily embrace the entire length of the activities and possibly continue even after their conclusion, following their evolution, adapting and reshaping their action over time.

As regards the LIFE projects, the maintenance actions represent the natural furtherance thereof. For this reason, a post-LIFE phase lasting at least 3 years is specifically envisaged, during which all the measures and actions necessary to retain over time the objectives achieved must be implemented. It goes therefore without saying that those communication actions that were particularly appreciated by users should be regularly proposed again and included in the usual schedule of the bodies involved.

Assessment

In the first place, it is important that the strategy adopted be represented by an easily recognisable unified and identity-shaping image traceable back to the specific intervention. Moreover, regardless of the channel or tool employed, leaflets, participatory meetings, use of social networks, etc., it is essential to resort to a readily intelligible, simple and communicative style. Direct encounter, personal as well, with users might often prove decisive.

Projects that implemented the good practice

Each project proposes and implements its own communication strategy that accompanies the unfolding and execution of interventions. Some of them, in fact, are born precisely with communication and sensitisation aims, representing the bulk of the project structure. As regards the LIFE projects, environmental sub-programme, a priority action sector is precisely the one relating to “Governance and information in the environmental field”.

While it is seemingly clear that such activities as seminars, discussion tables and info stalls are a common practice in most of the projects, as regards the specific action of CLUB RES MARIS it does not look as if, to date, a similar method has been resorted to.

4. Similar experiences in other projects

4.1. LIFE JUNICOAST – Actions for the conservation of coastal dunes with *Juniperus* spp. in Crete and the South Aegean (Greece)

LIFE07 NAT/GR/000296

The JUNICOAST project aimed to promote and enable the long-term conservation of ‘Coastal dune habitats with *Juniperus* spp.’ in Greece. The project conducted the first in-depth description and characterisation of the habitat ‘Coastal dunes with *Juniperus* spp.’ in four Cretan Natura 2000 sites. It also implemented the first concrete conservation and dissemination actions in the context of a specific geographic area. The conservation actions at all four sites included habitat demarcation, waste removal, enhancement of juniper regeneration, and the restoration of the floristic composition and structure of the target habitat.

Lessons learnt

Impact control measures

Since many people will continue to visit the habitats and since the economy of some local communities is based mainly on outdoor recreational activities, continuous efforts are needed to mitigate the visitors' impacts on those sites.

Impact control measures such those implemented by the JUNICOAST project (boardwalks, habitat and trails demarcation, sign posting and public education) would allow minimizing the adverse effects.

Management approach

Coastal dunes with *Juniperus* spp. are so popular for outdoor recreation which often causes difficult dilemmas in coastal dune management. On one hand, recreation is considered a legitimate and appropriate function of many areas. On the other hand, recreation can result in a loss of the natural qualities and, even worse, in a complete destruction of the area.

- Only through adequate management, nature-based tourism can be a compatible and a complementary land use.
- An adaptive management approach (regular monitoring, after-LIFE communication and conservation activities) should be implemented after the end of the project to secure its sustainability. Continuous efforts and collaborations between all stakeholders are needed in order to enable the long-term conservation of priority habitat 2250* in Crete and the South Aegean.

Planning and governance systems

Whilst substantial progress in dune conservation and management has been registered in many fields (notably including in habitat restoration and in the development of methods/techniques for habitat management), a number of weaknesses remain. Some of the more substantial of these relate to planning and governance systems.

- Processes such as Environmental Impact Assessment need to play a greater role in successfully predicting and mitigating against negative impacts on dune systems.
- Structures for informed decision-making need to be strengthened, particularly in cases where impacts result from the cumulation of several small projects, rather than from a single large-scale development.
- More research for the development of appropriate decision-making tools/methods is needed. It is certain that given that several dune management challenges are inextricably tied to wider socioeconomic- political trends, governance aspects need to be further addressed in future projects.

Future initiatives

Future dune conservation initiatives will likely need to address a number of existing and emerging challenges, including, but not limited to:

- the impact of climate change on dunal systems,
- the challenges of managing dunal systems based on a 'sediment cell' perspective,
- the successful integration of recreational and conservation interests, and the effective management of a range of threats (notably including urbanization, dune stabilization, nutrient deposition, and invasive alien species).

4.2. LIFE POSIDONIA ANDALUCIA – Conservation of *Posidonia oceanica* meadows in Andalusian Mediterranean Sea

LIFE09 NAT/ES/000534

The main objective of the project was to study and conserve Andalusian marine biodiversity by applying protection measures in one of the western Mediterranean's most mature and species-richness ecosystems, the *Posidonia oceanica* meadows (priority habitat 1120*: *Posidonia* beds). The project area included 9 marine SCI in Andalusia with well represented *Posidonia oceanica* beds.

Lessons learnt

Impact control measures

Illegal activities: trawling, anchoring, etc:

To strengthen the active and permanent surveillance in the SCI with *Posidonia* Meadows, a pilot experience of a video-surveillance and with the registration of artisanal fishing movements through satellite technology was implemented.

Installation of 41 ecological moorings in 4 SCI with *Posidonia* meadows, to reduce habitat erosion and the dispersion of invasive algae *Caulerpa cylindracea* (= *C. racemosa*) from free anchoring (action C2).

Installation of 2 artificial reefs in 2 SCI with *Posidonia* meadows, in order to reduce the impact by illegal trawling (action C3).

Invasive Alien Species (IAS):

Control: Eradication of the patches detected during the early detection. Only if the invasion was in a very early stage.

Prevention: The most vulnerable areas to invasions were identified in the 8 SCIs included in the project, thus making it possible to optimize the preventative measures to be performed by the Authorities (the Management Plans of the 8 SCIs are also deliverables of the project).

Update the map of the presence of IASs in the 8 SCIs included in the project to obtain the most accurate information to be included in the Management Plans.

Low perception of andalusian seagrass meadows among coastal productive sectors and within the general public:

Study of the socio-economic costs of an eventual loss of *Posidonia* meadows from the andalusian coasts.

Development of a network of volunteer divers for the monitoring of *Posidonia* meadows.

Redaction and edition of educational and dissemination materials, information panels, a webpage and videos about *Posidonia* meadows, 3 tours by sea and land along andalusian coastal cities with

Posidonia oceanica meadows in the nearby, with an itinerant exposition and specific workshops aimed to distinct social sectors and stakeholders.

Three annual festivals “Seas of *Posidonia*” each month of June, in a locality of the provinces with *Posidonia* meadows in Andalusia: Almería, Granada and Málaga.

Elaboration and publication of a digital library reuniting technical and scientific documents and information about andalusian seagrass meadows, of potential interest for managers and stakeholders.

To these original actions we have added a participation process to enrich the elaboration of management plans for the 9 SCI included in the project.

Management approach

The project aimed at to identifying, diagnose and mitigate the main threats to the ecosystem and its associated habitats (pollution, boat anchoring, uncontrolled trawling and traditional local fishing and the expansion of IAS), thus guaranteeing conservation of the species in Appendix II of the Habitats Directive and the priority species of the Birds Directive, to design a Management Plan for each of these natural areas in Andalusia. These documents will make it possible to plan a regulatory framework over time and in the future which will guarantee conservation and sustainable use of these areas and the species which they house.

Planning and governance systems

The project has an important long-term effect, having provided tools for a better management and conservation of 9 MPA with *Posidonia* meadows in Andalusia. First of all, the integrated cartography on the habitat 1120 and the socio-economic study of their environmental services and the approval of the Management plans for the Special Conservation Areas with *Posidonia* meadows in Andalusia, will settle the basis for an information-based management of this piece of the Natura 2000 network. It also gives the basis for a comprehensive analysis of the green/blue infrastructure in Andalusian coasts, and opens possibilities for new financing of the conservation of this natural capital. Taking into account that the Management plans will include proposals from coastal stakeholders, we believe that this will facilitate management of these areas and allow the harmonization between conservation and development. The ecological moorings are very much appreciated by dive centers, which are using them intensively. The CMAOT will contemplate their possible participation in mooring management in the future. The protective reefs to be installed will allow us to complete long-term protection of 2 *Posidonia* meadows, that have been very damaged by illegal trawling. The CMAOT is resolved to maintain -and if we get the support of diving centres and other stakeholders, enlarge- the networks for early detection of invasive algae, and the *Posidonia* monitoring network POSIMED Andalusia. Finally, the review of spatial protection of seagrasses in Andalusia, allowed us to detect candidate areas for expansion of the marine Natura 2000 network, as well as identify opportunities and needs to improve management of the existing network, which will be taken into account in the post-life plan.

Future initiatives

Future *Posidonia* meadows conservation initiatives must focused in:

Maintain the monitoring networks consolidated during the course of the project and continue efforts to detect and mitigate new threats and to monitor the project's results (reefs, moorings, video-surveillance).

Improve or complete the cartographic information on *Posidonia* meadows and on the three other marine phanerogam species of Andalusia outside the Natura 2000 network.

On top of this, there is a need to address the pressures and threats to *Posidonia oceanica* meadows (priority habitat 1120 in the Natura 2000 network) that could not be addressed during the course of the project, but which proved to be important for the stability of meadows. In this sense, we propose to:

- Improve the management of the hydrological cycle (improvement of water purification systems, water reuse, etc.)
- Promote sustainable beach and banquette management, avoiding their increased erosion and therefore that of the marine meadows in front of them.

In relation to marine IAS, when the species is already present in the area (even if there is only few individuals or the species is scarcely represented) the results show that it is impossible to control its expansion.

The efforts should be directed to prevent new IAS in our area. Working with neighbouring countries and regions, sharing information, developing sectorial best practices protocols and investing in new technology in these sectors: mainly transport (ballast water) and aquaculture (pathogens associated).

In addition, we plan to explore and articulate funding mechanisms for the conservation of *Posidonia* meadows and the Natura 2000 network, based on a payment scheme in return for environmental services. To do this, the CMAOT Life has a new LIFE project (Life Blue Natura, www.life-bluenatura.eu) under the program of climate action mitigation.

4.3. LIFE Puffinus Tavolara - Protection of the largest population of *Puffinus yelkouan* on Earth and containment and eradication of invasive alien species

LIFE12 NAT/IT/000416

The main goal of the project is the protection of the breeding population of **Yelkouan Shearwater** (*Puffinus yelkouan*), one of the few species of seabird that occurs in the Mediterranean, and whose breeding population on Tavolara is estimated to comprise between 10,000 and 13,500 pairs; the Tavolara colony is by far the largest in the world, considering that the global population of Yelkouan Shearwater is estimated at 15,000 – 30,500 pairs. The protection of the **Yelkouan Shearwater** colony on Tavolara, which accounts for 1/3 to 2/3 of the global population, is thus of crucial importance for the survival of the species. As in nearly all known colonies, the nest predation rate on the part of Black Rats (*Rattus rattus*) on Tavolara is currently unsustainable, and is likely to be the cause of the decline in the Yelkouan Shearwater population over the last several decades.

In order to protect the Yelkouan Shearwater, the project aims to eradicate Black Rats from Tavolara. This should increase the number of fledged juveniles by 5,000-8,000 each year, which number is likely to be much higher than the total number of juveniles fledged each year by the entire global population. The eradication of rats will also benefit other tubenoses that are potentially (Mediterranean Storm Petrel *Hydrobates pelagicus melitensis*) or certainly (Scopoli's Shearwater *Calonectris diomedea*) breeding on Tavolara in small numbers; without rat predation, their populations could increase substantially. Other species that will presumably benefit from rat eradication include the European Leaf-toed Gecko (*Euleptes europaea*), a species endemic to a small part of the Mediterranean and which seems to suffer significantly from rat predation.

Additionally, in order to improve the quality of Tavolara's natural habitats, the project aims to contain the local population of feral goats, which currently has an extremely high impact on the island's vegetation and threatens the very survival of several rare plants. The project also aims to eradicate several alien invasive plant species, which are currently only present in limited numbers in the sector of the island most affected by human activities, but which could spread quickly causing the loss of habitats of great conservation value. These two activities aim to protect several habitats (4 direct targets of the project) and 4 plant species of Community interest, of which one (*Centaurea horrida*) is listed as a conservation priority and is known from only a handful of sites, two of which are on Tavolara.

Lessons learnt

To declare with certainty the eradication of rats from the island of Tavolara it is usually necessary to wait 2 years since the removal operations, as standard protocols. However, from the data collected to date with monitoring activities, we can say that the eradication operations were well conducted. Furthermore, by carrying out a monitoring of fish and non-target species at the same time as the distribution of baits, we highlighted an absence of negative effects from these operations and no detectable impact on fish and the marine environment, with a very low loss of non-target species.

The action concerning the removal of the Carpobrotus, which occupied a modest surface on the island, was successfully completed. Surely it was fundamental to have implemented actions to involve and inform citizens, carrying out some demonstration activities for the removal of the Carpobrotus with schools, on some stretches of coast of the marine area.

The action on which we have encountered the greatest difficulties, was that concerning the reduction of the number of goats from the island. The difficulties have emerged both in being able to capture a large number of specimens, both in the performance of the procedural and authorization aspects. It is therefore recommended, in cases such as these concerning the removal of populations of domestic animals reverted to a wild state, to define and ascertain in advance the timing and the authorization process (as uncertain and indefinite aspects).

5. The experiences gained in RES MARIS

5.1 Management of Posidonia meadows (habitat 1120*)

Mapping of seabeds

To manage any type of habitat, the first thing to be known is its distribution as well as its state of conservation.

As regards the marine habitat 1120* “Posidonia Meadows (*Posidonia oceanica*)”, a mapping was carried out by using non-impacting detection techniques (Side Scan Sonar and Multibeam). Afterwards, with an underwater wire camera pulled by nautical means (indirect method) and by scuba diving (indirect method), the upper and lower boundaries of Posidonia meadow extension were investigated and confirmed, while the following were observed: *P. oceanica* coverage and extension, type of substrate, percentage of alien algae (*Caulerpa cylindracea*) and percentage of marine plants (*Cymodocea nodosa*).

Thanks to this action, it was possible to reach a detailed and updated basis of knowledge of the distribution and state of conservation of the priority habitat 1120* necessary to proceed with the subsequent conservation interventions, such as the placement of mooring buoys and the interventions aimed at the recovery and repopulation of the sensitive (degraded) areas of habitat 1120*.

*Installation of mooring facilities at sea to protect habitat 1120**



Photo 11 - Boats moored in the buoys installed by the RES MARIS project in Località Imbarcadere - Isola dei Cavoli.

One of the main aggressions (pressures) that affect the *Posidonia oceanica* meadows is the free and irregular mooring of recreational craft; even though, in fact, the current legislation prohibits mooring on the Posidonia meadows, it is in actual fact not complied with. Bearing in mind the recreational use of the area, the distribution and the state of conservation of the meadow in the Marine Protected Area, the installation of mooring facilities represents a good measure for its protection (Photo 11).

The most sensitive areas have been identified, areas with a meadow-like seabed of relevance to yachtsmen, which is why the positioning of mooring facilities was planned: 31 mooring facilities for recreational craft (up to 15 and 24 m) were purchased and installed.

Each mooring facility consists of a concrete body, made to lie on the seabed, a top, a chain and an intermediate submersed buoy to avoid the damage to sea floors caused by chain rubbing and motions. This mooring system is applicable to the sandy intra-meadow seabeds or to those adjacent thereto more than 6 m deep.

The installation of mooring buoys, besides making available easy and safe anchoring points for operators and yachtsmen, reduces the impact of anchors on the meadow and mitigates its erosion. By avoiding mooring on the *P. oceanica* meadows, the sediment and water turbidity suspension effects, among the main causes of regression of the meadow, are effectively reduced (Cinelli, 2009).

Recovery and repopulation interventions in the sensitive areas of habitat 1120*

Repopulation is one of the interventions carried out to retrieve the integrity of the priority habitat 1120* in the degraded areas. Thanks to the investigations conducted, a detailed cartography was elaborated, thereby enabling the identification of the partially degraded areas (dead *matte* areas) on which to perform the repopulation action with a view to “stitching back” the fragmented areas of the habitat and facilitating the reinstatement of the natural conditions.

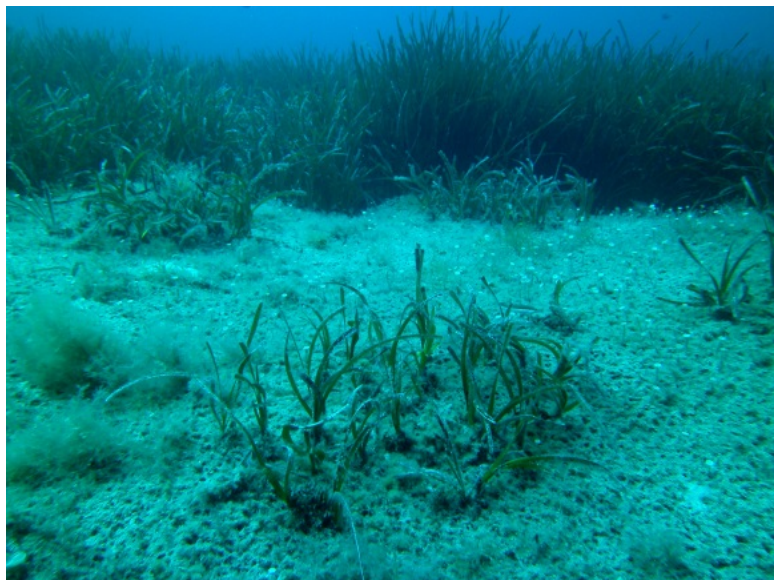


Photo 12 - Nuclei of *Posidonia oceanica* cuttings on MAC MAT® substrate

Repopulation of the native species

Posidonia oceanica was implemented by applying techniques already tested and consolidated, but with a further improvement consisting in the use of *Posidonia oceanica* plants locally dug out by the surge storms or by the erosion of the *matte*, without taking them, therefore, from the existing *posidonia* meadow. They have been harvested, selected and processed as cuttings, i.e. as parts capable of issuing forth roots and accordingly used to regenerate new plants, eventually planted on suitable wickers anchored onto the substrate (Photo 12).

Repopulation is an action that demands maintenance actions on growth substrates and monitoring of the plants-cuttings after the intervention, as it is known that the growth of *Posidonia oceanica* is quite slow.

To recover habitat 1120*, techniques for uprooting alien species were likewise deployed over limited-extension areas.

An invasive alien species is a species that is not indigenous to the place, that grows and expands invasively and aggressively, replacing the native species and/or altering the pre-existing communities.

The invasive behaviour of the alien algae *Caulerpa cylindracea* and its like influences also other habitats found in the Mediterranean region, apart from that of *Posidonia oceanica*, such as the rocky seabeds of photophilous algae or the coralligenous seabeds consisting of one or more varyingly combined red algae (maërl).

In a healthy meadow, the impact of *C. cylindracea* is imperceptible, thanks to the high density of leaves that creates a thick covering, precluding the algae from spreading around. Instead, in the case of a damaged meadow with eroded areas where *Posidonia* is found, the algae quickly colonises the substrate, thereby preventing the plant from growing as it should and occupying the areas colonised by the caulerpa, with its considerably fast growth times.

The attempts to rein in the spread of invasive alien species through removal techniques have proved ineffective and purely short term over the long run. Since the threat cannot be extirpated, the only effective measure is to try to preserve the integrity of habitat 1120*: that is the line adopted, by increasing the number of cuttings in the planted nuclei and by increasing the number of mooring buoys.

5.2 Management of dunal habitats

In order to be able to properly undertake management interventions in such an important and, at the same time, such as sensitive environment as the dunal one, it is necessary to conduct an in-depth fact-finding analysis, preliminary to the design of interventions, which was attended to by the Biodiversity Conservation Centre [Centro Conservazione Biodiversità (CCB)] of the University of Cagliari.

As envisaged by the structure of the LIFE projects as well, RES MARIS included the performance of fact-finding investigations through periodic field excursions on a monthly basis, aimed at the floral and vegetational analysis of the priority habitats and those linked thereto in the chain-like succession.

The purpose of such investigations was to acquire greater and more detailed information (characterisation) on the dunal coastal habitats and the structural species found in the intervention areas, to be able to equip oneself with planning tools enabling the detailed definition of the reinstatement and renaturation interventions that were then targeted by the concrete conservation actions.

Detection of natural and alien flora and vegetation

The floral and vegetational analysis of the habitats in the different localities of the Site of Community Importance was undertaken (Photo 13); the natural vegetation under study is the psammophilous one typical of sandy environments, described in chapter 2 of this Handbook. We are referring in particular



Photo 13 - Detection of natural and alien flora in dunal habitats

to the vegetation that is established on the consolidated dunes and falls within the priority habitat 2250* “Coastal dunes with *Juniperus* spp. (multiple species)” pursuant to Habitat Directive 92/43/EEC. The habitat is well represented on the Porto Giunco and Simius beaches; it is also found on the Is Traias locality, even though previously unreported.

Apart from juniper thickets, we have the planted and largely naturalised pine groves, characterised by

Mediterranean pine species (*Pinus halepensis*, *P. pinea*, *P. pinaster* subspecies *pinaster*). These formations have been detected in the most internal parts of fixed dunes. Produced by the reforestation activity, they nevertheless display a considerable biodiversity and naturalness. In Villasimius, they are well represented only on the Campulongu locality dunes and fall within the priority habitat 2270* “Dunes with forests of *Pinus pinea* and/or *Pinus pinaster*”.

The detected flora proved to consist of 127 different plants, 16% of which belonging to the Asteraceae (daisy) family. Of significance is the endemic component made up of as many as 8 species, half of which endemisms of the Sardinian-Corsican biogeographical province.

In order to properly undertake the control and/or eradication interventions targeting the invasive species that threaten the habitats, it was necessary to take a detailed census of the invasive alien species present in the priority habitats of the Site of Community Importance, in addition to the implementation of a cartographic tool that represents the impact area of the invasive species. The data collected during these activities led to the draft of a checklist of alien species consisting of 91 species, 16 of which invasive, 42 naturalized and 33 casual. The genera that proved to be most invasive were *Agave*, *Acacia* and *Carpobrotus*.

Selection of the species, collection and testing of the germplasm

In order to select the plants to multiply and subsequently introduce into the habitats, it was essential to identify the species of structural and functional importance: the selected species were the following:

1. *Juniperus macrocarpa* Sibth. & Sm.
2. *Juniperus phoenicea* L. subsp. *turbinata* (Guss.) Nyman
3. *Pistacia lentiscus* L.
4. *Pancreatum maritimum* L.
5. *Eryngium maritimum* L.
6. *Elytrigia juncea* (L.) Nevski
7. *Cistus salviiifolius* L.
8. *Achillea maritima* (L.) Ehrend. & Y.P.Guo subsp. *maritima*
9. *Pycnocomon rutifolium* (Vahl) Hoffmanns. & Link.
10. *Glaucium flavum* Crantz
11. *Rhamnus alaternus* L.
12. *Helicrysum microphyllum* (Willd.) Camb. subsp. *tyrrhenicum* Bacch., Brullo & Giusso
13. *Crucianella maritima* L.
14. *Ammophila arenaria* subsp. *arundinacea* H. Lindb.



Photo 14 - Collection of germplasm



Photo 15 - Cleaning of germplasm at the Germplasm Bank of Sardinia



Photo 16 - Germination test

Based on the calendar of fructification and production of seeds of the selected species, and bearing in mind the distribution of the different populations the Site of Community Importance, a harvesting plan was drawn up. The harvests were done in order to obtain a quantity of seeds sufficiently representative, genetically speaking, of the entire diversity found on the Site of Community Importance, while simultaneously avoiding an excessive harvest that was such as to potentially damage the populations (Photo 14).

All the material harvested was stored in the facilities of the Germplasm Bank of Sardinia (BG-SAR), which is affiliated to the University of Cagliari, where the germplasm (in this case seeds) was made to undergo a post-ripening phase (at a 20°C environment and 40% of relative humidity) to facilitate the homogeneous degree of ripening of the harvested lots. Thereafter, the seeds were subjected to manual (Photo 15) or mechanical cleaning, as well as a qualitative check of the harvested material.



Photo 17 - Germplasm analysis



Photo 18 - Sowing of the germplasm

At the Germplasm Bank of Sardinia (BG-SAR), germination tests (Photo 16) were performed for each of these species at different temperatures, ranging between 5 and 30°C under different lighting conditions (12 hours of light and 12 hours of darkness or 24 hours of darkness). The seeds were sown on a gelatinous substrate made up of agar 1% that ensures a constant supply of water, inside Petri dishes placed in the growth chambers. It was possible to obtain optimal germination protocols for all the tested species (Photo 17).

Multiplication of the plants

This action has been entrusted to the Regional Agency Forestas, pursuant to a collaboration agreement concluded between the Metropolitan City of Cagliari (coordinating beneficiary of the project), the Forestas Agency and the Biodiversity Concentration Centre (CCB).

Forestas is in fact endowed with suitable facilities for accomplishing the stated objective; more specifically, the Campulongu (Massama, OR) nursery was identified as it was equipped with infrastructures suited to the vegetable multiplication in a controlled environment run by staff highly specialised for such activities (Photo 18). The Biodiversity Concentration Centre (CCB), as envisaged by the project, lent its scientific assistance for that activity, in order to adapt the protocols ensuring full compliance with the ecophysiological needs of the selected species.

Once the germplasm was received, the nursery staff immediately set up a camp devoted to the RES MARIS project. After the camp was positioned with an anti-algae sheet preventing the penetration of roots into the ground, and the topsoil was readied for the sowing (mixture of earth, peat and sand), the nursery staff prepared and placed around 40.000 phytocells with a 1-litre capacity, arranged on boxes of 18 phytocells each.



Photo 19 - Sowing of *Pancretium maritimum*

Thereafter, the manual sowing (Photo 19) was done with a hole about thrice the diameter of the seeds, preceded, wherever necessary, by the pre-treatments set out in the germination protocols. The phytocells were covered with 75% shading sheets until the emergence of the seedlings. The manual weeding was seen to weekly (Photo 20); the cultivation took place without use of fertilisers, plant protection products or pesticides.



Photo 20 - Plants produced in the nursery

During the actions in the field and at the nursery, jointly between Metropolitan City, Forestas and the Biodiversity Concentration Centre (CCB), the inclusion of a fifteenth species, *Olea europaea* L. var. *sylvestris* Brot, was deemed appropriate. Based on Forestas Agency's protocol of traceability of the germplasm from harvest to plant production, it was ascertained that the plants already in possession of the nursery had been produced from germplasm compatible with the reintroduction site.

The plants produced and delivered totalled **31.070**.

Restoration of the dunal habitats through reintroduction of the plants produced and naturalistic engineering intervention

Prior to this action, attended to by the Metropolitan City of Cagliari, the planning that revolved around 3 sub-phases took place: (1) designing (draft of the preliminary, final and executive project), (2) authorising (acquisition of clearances and concessions), (3) procedural (definition, invitation to tender for works and subsequent awarding of the contract, delivery and commencement of the works). It was then possible to begin the field activities, firstly through the (manual or mechanical) (Photo 21) eradication and, at a same or a subsequent time, through the placement of primer nuclei, barriers and bionets, the sowing and the planting of the multiplied plants.



Photo 21 - Eradication of Agave

The latter action was performed in accordance with the natural distribution owed to the vegetation series, opting for a planting inside the shadow cone of the existing vegetation, which ensured that the new plants were sheltered from high temperatures and excessive insulation. To contain the development of the acacia, it was furthermore decided to perform a covering intervention with black sheets of the already cut stumps, to check its effectiveness both in terms of inhibiting offshoots and in terms of drying the plants themselves. It is an experimental

intervention, subject to monitoring actions, which is yielding substantial results on a preliminary basis.

As regards the sowing, it took place in the Autumnal period, through a manual scattering of germplasm of 4 structural species: seeds of *Pancratium maritimum* and *Eryngium maritimum* in the primer nuclei and in the windbreak barriers, mixture of cones of *Juniperus macrocarpa* and *Juniperus phoenicea* subspecies *turbinata* in the bionets.

Hereunder we describe the activities carried out in the different areas.

Campulongu

This area witnessed a substantial quantity, in terms of both surface and biomass, of *Carpobrotus*. The eradication was done manually, lest any damage be caused to the habitats (Photo 22). There were also, albeit in a smaller quantity in terms of occupied area, young and adult individuals of *Acacia* and *Agave*; they, too, were uprooted.



Photo 22 - Eradication of *Carpobrotus* in Campulongu

At the end of the eradication works, the naturalistic engineering works were performed (placement of primer nuclei, windbreak barriers and vegetable fibre bionets) (Photo 23) with a view to facilitating the accumulation of sand, protecting the root systems of the existing junipers, and avoiding that, especially through the removal of *Carpobrotus*, erosion processes affecting the dunal environments might occur; lastly, planting with native species was carried out (Photo 24).

Porto Giunco

In this macro area, already targeted by interventions carried out as part of a previous Life PROVIDUNE project, it was deemed sufficient to simply supplement what had already been done, limiting the action to the eradication of a small area where *Agave* was present. Thereafter, 13 primer nuclei were positioned and a tiny area of some 25 square metres planted.

TimiAma

In this macro area, *Carpobrotus*, *Acacia* and *Agave* were uprooted. Moreover, 17 primer nuclei were positioned, along with 40 windbreak barriers in mutual continuity with each other (Photo 25), the former to facilitate the accumulation of sand and the latter to block the sand and prevent its dispersion inside the condominium at the back, while simultaneously facilitating the reconstruction of the dune, thanks also to the planting performed inside the structures (Photo 26).



Photo 23 - Biomats



Photo 24 - Planting in dunal habitats

Simius – Su Stangioni



Photo 25 - Nuclei and barriers

In this area, there was an extensive zone with adult and young *Acacia* trees that posed a threat to the juniper, overlapping with it in spatial terms of surface and height. All the existing individuals were thus entirely uprooted.

Biomats were positioned and windbreak barriers set up behind the dunes as reinforcement of interventions already undertaken within the scope of the previous Life PROVIDUNE project, with the two-fold purpose of facilitating the reconstruction of the dunes and establishing a physical barrier to the access. Precisely in relation to the presence of

the said *Acacia* “grove”, in fact, this area was particularly frequented and used as rest area and “toilet” by beach users.

Is Traias

This macro area was characterised by a significant presence of *Agave* plants, large-sized as well, both on the backshore and on a sloping wall close to the beach.

Straight after they were uprooted, the biomats were positioned to ensure the reinforcement of the sloping wall.



Photo 26 - Sowing inside the primer nuclei

5.3 Communication and environmental education

The communication activities have represented one of the essential aspects of the LIFE RES MARIS project, since the protection and preservation of the habitats demand the broadest possible involvement from all the interested stakeholders, from local authorities to economic operators, from school-going children to the public in general.



Photo 27 - Brochure, flyer, role-playing game, boardgame.

For this reason, the communication strategy of the RES MARIS project envisaged the activation of various channels and tools, adapted on an ad hoc basis to the characteristics and needs of the different addressees: from the most “conventional ones”, public events, educational materials or website, to the latest generation ones, such as an increasingly greater recourse to social networks. All of that as part of an easily recognisable unified and identity-shaping image.

More specifically, the project saw the implementation of separate yet mutually integrated communication actions.

- E1 – Draft of the project communication plan, coordinated image and educational material
- E2 – Project website and social networking
- E3 – Creation of informational boards on the habitats
- E4 – Environmental education programme
- E5 – Territorial animation
- E6 – Publication of the final informational report (Layman's report)
- E7 – Campaign for the replacement of alien species with typical native species in private areas
- E8 – Video documentaries and Youtube channel
- E9- Handbook of good practices and guidelines for the correct enjoyment and management of natural habitats in the beach system
- E10 – Sensitisation of tourists

The consistency and homogeneity of the communication actions within the project have been ensured by the coordinating beneficiary, the Metropolitan City of Cagliari, that succeeded the Province of Cagliari, with the active support of all the partners.

The communication activities have encompassed the entire length of the project.

The first action to be implemented was the draft of the Communication Plan that in just one programme organised and monitored all the other actions. The plan proved to be a “live” tool that followed the project, adapting to it over time.

Within the scope of the first action, besides the communication plan the logo and the claim, RES MARIS – A SEA OF RESPECT, were also elaborated.

The logo intended to represent the vitality of nature and the balance of the parts, open to the eyes of the world halfway between land and sea: on the left the yellow of the beach and the green of vegetation on the dunes, and on the right, in a game of mirrors, the blue of sea waves and the green of the posidonia meadow. The claim transmits instead, in its pun of words, the key points of the project: SEA and RESPECT.

The educational materials produced have been:

- a project brochure (in Italian and in English, printed in 20.000 copies)
- a flyer on the habitats and on the sustainable use of the site (in Italian and in English, printed in 50.000 copies)
- a large-sized leaflet addressed to children showing on the back the board of a parlour game linked to the project objectives (only in Italian, printed in 10.000 copies)
- a role-playing game, elaborated in the form of a handbook, as an example of involving teaching methodology in the self-learning process (only in Italian, printed in 3.000 copies). The handbook was followed by two separate extensions that enlarged the proposed scenarios (Photo 27).

The website - www.resmaris.eu – set up in dual version, Italian and English, has been, and will still be in the subsequent post-LIFE phase, the large container of all the project papers, as well as the main source of information for stakeholders, especially those not connected to social networks. It has been structured in such a manner as to gather all the news, the appointments and the state of progress of the activities through a vast phot gallery as well. The site likewise envisages a “networking” section dedicated to other projects with similar objectives aimed at the establishment of a national and international collaboration network with subjects that support the same purposes as those of RES MARIS.

Next to the traditional website, social pages have been activated on the main platforms: Facebook, Twitter, Instagram and the Youtube channel that still hosts all the documentaries created in the project.

An especially significant role was played by the environmental education activity addressed to all the children and youngsters of the Villasimius schools, perhaps the most important target of the environmental communication actions.

The environmental education activities (Photo 28) proposed in three of the four years in which the project lasted (starting from the 2015/16 school year) aimed to inject into the young generations

interest, sense of responsibility and belonging vis-à-vis the habitats subject to intervention, communicating the importance and rarity of coastal habitats, informing about the damages that might be caused by an irresponsible use of these areas, about the reasons why these habitats are important and worth protecting, and about Europe's role to promote their preservation through Natura 2000.

The action involved about 600 students altogether. The educational programme offered in the three years did not consist in a mere repetition of the activities year after year, but revolved around a structured process that ensured the students' involvement and participation. The educational project was differentiated based on the school level and envisaged the implementation of a process in stages alternating moments of individual work and playful group moments. Each stage ended with a guided tour across the different beaches of Sites of Community Importance (Photo 30).



Photo 28 - environmental education in schools

The **summer sensitisation action** addressed at all users of the territory, citizens, tourists, and economic operators, began in the summer of 2015 and went on in the next two years. Informational islands have been annually set up in the beaches included among Sites of Community Importance, Simius, Porto Giunco and Campulongu, and in the Fortezza Vecchia beach, because, though not comprised inside a Sites of Community Importance area, it is nevertheless a site disclosing some crucial aspects for the RES MARIS project. In this beach we can in fact observe the banquette Posidonia formations consolidated on the beach, the presence in the water of the barrier reef (*récif-barrière*), a natural barrier erected by the Posidonia, a special aspect of this habitat of marked conservation concern, which contributes to protect the coast from storm surges.



Photo 29 - Gadgets

All the beach activities have been accompanied by recreational/educational activities addressed at children.

Apart from beaches, the informational islands have been set up in the inhabited centre in the evening, in the points of greater aggregation or at the time of events particularly felt by the citizens.

Guided tours were furthermore implemented along the Porto Giunco route.

To make it easy to attract the public at the informational points and to convey the image of the project, personalised gadgets of modest value bearing the project logo were distributed to users alongside the informational materials: shoppers, pens, caps, beach ashtrays, t-shirts and stickers (Photo 29).

Altogether, it is estimated that for the three years in question, between direct and indirect contacts, the sensitisation activities have reached approximately 12.000 people.

Another important communication action consists in the creation of 10 short-length videos that documented the implementation of the project: the territory, objectives and expected results, actual studies of the land and marine habitats, concrete actions of germplasm conservation, collection and multiplication and recovery of *Posidonia* meadows; concrete conservation actions on the ground, communication and Club RES MARIS actions, environmental education activities and monitoring.

The videos are available on the Youtube channel of the project and have been disseminated, as they were produced, through the website and the Facebook page.

The territorial animation action, too, was carried out throughout the length of the project via public events of presentation and refreshment and at the end of the project. Currently, specific technical round-tables targeting companies and other stakeholders have been set up.

The activities envisaged for the campaign to uproot alien species in private areas have been organised in close association with what is envisaged in respect of Club RES MARIS, which as per the project initially targeted only the local tourism companies (managers of tourism, hospitality and catering facilities, travel agencies and tour operators) to be involved in the project dissemination activities and the activities of virtuous conduct by customers-tourists.

The implementation of an eradication campaign at private facilities has been of essential importance for the success of the project, since precisely the concrete conservation actions, which represented the most significant part of RES MARIS, contemplated interventions in public areas only. The



Photo 31 - Distribution of native plants



Photo 30 - Environmental education – visit to the SCI

invasive alien species found however in a large number of private areas could have posed a potential threat to the habitat. An important contribution had to come, therefore, from the collaboration of citizens themselves and tourist sector operators.

The Club RES MARIS, therefore, was addressed both at private

subjects and at economic operators, involving all those who wished to commit themselves to the removal of invasive alien species present in the green areas or to back up the project by supporting its information and communication activities if there were no alien plants to remove in the facility.

Informational materials, project gadgets, a compost bin, and especially the native plants to be used in lieu of the uprooted alien counterparts, were distributed to participants in the CLUB. Altogether, over



Photo 32 - Informational board

4500 seedlings were distributed (Photo 31).

No less important was the action that envisaged the creation of informational boards, likewise bilingual (Photo 32). They are seven in total, positioned at the points of access to the sea and tasked with the educational-informational function vis-à-vis users of the territory. The boards set out the essential information for use of the site, such as presentation of the Site of Community Importance, its territory and the existing habitats, the general information relating to the Natura 2000 Network, and, especially, the rules of conduct to comply with in order to reduce damage to the habitats and disturbance to the species of EU concern.

Lastly, at the end of the project the final conference was held: it represented an important opportunity to present the results attained in the four years of activity and exchange good practices thanks to the participation of national and international experts. Besides our partners, in fact, institutional

representatives and spokespersons for different LIFE projects involved in topics sharing similar purposes took part in the event.

The programme, structured across two days, saw an alternation between moments of activity in the hall and on the ground: the concrete interventions carried out were illustrated, not just in the hall, but also through field visits, on the land, with a short inspection in the intervention areas, and at sea, with an excursion in the marine area.

In this phase, it is seemingly still premature to objectively assess the results achieved by the communication actions, especially in terms of real repercussion on the territory. Only with the passage of time, we might be able to appreciate their impact. The hope is that the local community, by increasing its awareness of the inestimable potential of its own territory to protect and enhance might adopt an increasingly more environmentally sustainable and respectful approach. All this will undoubtedly have positive effects even on the tourism sector, which might generate an economic spin-off with a concrete return on the local population as well.

6. Practical advices on managing invasive species

6.1 Acacia



Photo 33 - Flowering of *Acacia saligna*

Acacias are a group of woody plants, with shrub-like or tree-like posture belonging to the Fabaceae family (also called Leguminosae from legume, the most typical fruit). Most of these plants are originally from Australia and southern Africa: they have been introduced both for ornamental and for forestry and dunal consolidation purposes. Quite widespread in Sardinia is the willow acacia (also termed narrow-leaved mimosa) (*Acacia saligna*), with beautiful bright yellow flowers, which is often confused with the common mimosa (*Acacia dealbata*) it is easily distinguished

from by the leaves (consisting of and divided into several small segments). The former is more common in the coastal areas, where it often poses a threat to the natural habitat, becoming invasive in the dunal areas, whereas the latter prefers the cooler areas and can turn invasive in the humid and riparian habitats (riverbanks) (Photo 33).

In recent years, the coastal habitats are witnessing the spread of mimosa horrida (*Vachellia karoo*, synonymous: *Acacia horrida*), originally from South Africa, thus called because of the presence of huge and robust thorns. Although not so common as the willow acacia, it might in future become an invasive species given its frequent use as ornamental plant. All acacias are invasive, except that some are more widespread for being used more often by man. Their invasiveness is mainly due to the high capacity to produce seeds and suckers (shoots that mainly originate at the base of the trunk), especially in the event of a cutting (Photo 34).



Photo 34 - Flowering of *Vachellia karoo*

How does it behave? It forms communities of plants with an average height of 2-5 m that might grow to a height of as much as 8 m with a trunk diameter of up to 30 cm. It is a plant highly resistant to dryness, to different types of soil, to strong winds and to salinity, as well as to the transit of fire (especially the seeds). It prefers sandy grounds such as those of coastal dunes, but it can colonise a wide range of lands and habitats, including the poorest ones in nutrients. It does not tolerate freezing cold, as it in fact grows better where temperatures average 13°C in winter and 30°C in summer, typical of the Mediterranean climate (Photo 35).



Photo 35 - Flowering of *Vachellia karroo*



Photo 36 - Seedlings of *Acacia saligna*.

Its reproductive capacity is highly precocious (it can bloom already after a few years of age). Measured on the ground, the annually produced quantity of seeds is around 5.440 seeds per square metre of tree coverage, giving rise over time to an average accumulation in the soil of some 46.000 seeds per square metre! The greater invasiveness of the plant is caused by the permanence of these seeds, which might remain vital for over 50 years as well (permanent bank of soil seeds), until the environmental conditions favouring their germination arise (Photo 37).

Why is it a threat? It has been introduced into the Sardinian coasts beginning with the 50s for coastal reforestation purposes, and there it was naturalised, becoming invasive and in competition with the typical plants of dunal forest communities, such as the juniper groves. The competition, for junipers, is lopsided: whereas the juniper is a slow-growth plant with an extremely high mortality rate for seedlings, acacia multiplies in abundance both vegetatively and by seed (Photo 36).



Photo 37 - The priority habitat dunes with juniper is a favorable environment for the growth of *Acacia saligna*.

What can we do? As with all invasive species, it is important to release the plant in a natural environment. Especially the seeds, which might fall on the ground and be carried by ants, must not arrive near natural coastal areas (Photo 38).



Photo 38 - Acacia seeds in the sand.

Successful eradication is quite difficult, since after a few months from its removal we might witness the regrowth of new shoots (discards, suckers) in case of cutting or of new seedlings born out of seeds. The seedlings and the young individuals can be uprooted by hand, grasping the plant and pulling it delicately from the soil;

this operation should be preferably performed during the autumnal period after the rains, which facilitate the birth of new seedlings and soften the soil (Photo 39 and 40).

As regards the adult individuals, wherever possible the trunk is cut from the base and the plant is then fully uprooted from the ground. Should that not be possible, only the cutting at the base of the stem is carried out. In the following years, the plants subjected to intervention must be monitored, repeatedly cutting any suckers until the plant is completely dead. It is important to clear the ground well by removing the seeds.



Photo 39 and 40 - *Acacia saligna* regrowths after cutting.

Better to purchase a native plant.

There are many plants, which produce lovely blooms, that can be cultivated instead of the mimosa: tamarisks, junipers, agnocasts and brooms.

6.2 Agave



Photo 41- Flowering of agave.

Agaves are succulent plants originally from Central America and used in Sardinia especially for ornamental purposes in parks and in public and private gardens. They are also cultivated for nutritional purposes due to the high sugary content (to produce beverages and liquors), for medicinal purposes on account of their phytotherapeutic properties (to treat spleen disorders), and for textile purposes to produce various fibres (mats, bags and ropes) (Photo 41).

Among the plants imported after the discovery of America, they are the oldest ones to be introduced into the Mediterranean region, so much so that the best known one, the American agave (*Agave americana*) was probably already present in 1561. In Sardinia, it was already recorded in the 1842 catalogue of the Villa d'Orri nursery and in the first guide to the Botanical Garden of Cagliari dating from 1874 (Photo 42).

The agaves, just as much as the acacias and the Hottentot-fig, are such common plants in the Mediterranean landscapes as to be normally deemed part of our natural flora (Photo 43).



Photo 42 - *Agave americana* in the habitat dunes with juniper.



Photo 43 - *Agave fourcroydes* in the sandy dunes.

Due to their reproductive capacity and the winning competition strategies, it is considered an invasive species, especially in coastal environments, both dunal and rocky, throughout the Mediterranean area (Photo 44).

How does it behave? They are plants that come from desert areas, and are thus capable of enduring long periods without water, but do not tolerate low temperatures or winter frosts. They live quite long, up to 20 years, after which they bloom and bear fruit once (monocarpic) and then die, leaving many shoots at the base of the trunk that develop into separate plants (Photo 45).



Photo 44 - *Agave fourcroydes* in rocky coastal environment.



Photo 45 - The death of the plant after its flowering.

The shoots can also originate from the underground rhizomes, which is why a single plant might produce dozens of individuals and form dense populations over the years.

They grow very quickly, and when they bloom they can reach with the inflorescence a height of up to 10 m (Photo 46).



Photo 46 - Inflorescence of agave.



Photo 47 - Seedlings in the stalk of the inflorescence.

The inflorescence can produce hundreds of fruits (*Agave americana*), or in the stalk of the inflorescence (*Agave fourcroydes*) hundreds of seedlings might be formed, giving rise as they fall onto the soil to new individuals (we speak of the plant as being viviparous like we do for animals) (Photo 47).

Why is it a threat? Having escaped cultivation, they were naturalised in the natural environment, spreading for the main part vegetatively. Vegetative reproduction is in fact the best strategy they deploy in different guises.

Some species were caused to spread more widely in the territory, such as *Agave americana*, *Agave fourcroydes* and *Agave ferox* (synonymous: *Agave salmiana* var. *ferox*). The latter can prove quite dangerous due to the many robust thorns found both on the edges and at the summit of the leaves. Species in which the thorns are absent (*Agave attenuata*) (Photo 48) have also been introduced, yet



Photo 48- *Agave attenuata* and *A. americana*



Photo 49 - Agave seedling.

all agaves are deemed potentially invasive. Most threatened are the coastal habitats, given the environmental conditions favouring the growth of these plants.

What can we do? It is important to prevent the release of the plants in a natural environment, without abandoning any pruning remains on the ground and taking care that they do not trespass the place of cultivation or, even better, we should not cultivate this species in our gardens, parks or urban green, especially if they are close to coastal areas. If the plant is still young (in the seedling phase or up to approximately three years of age) (Photo 49) and has occupied a limited area, it can be uprooted by hand, with special care if we are in a natural environment, since this practice might cause damages to the habitats and to the other plants.

We must carefully grasp the plant, pulling it delicately from the soil (Photo 50) and trying in the process not to extirpate the other plants as well (both the native ones if we are dealing with a natural environment and those cultivated in one's garden). It is likely that the underground parts, consisting of long and thin roots and of rhizomes, might escape, and unless they are fully removed they might give birth to new specimens.



Photo 50 - Manual eradication of Agave

Harder is the manual eradication if we are dealing with individuals over three years of age, still less with adult individuals in a reproductive period. The best thing is to cut the plant at the base of the stem and remove all the nearby seedlings and shoots. If it is an adult individual with inflorescence, it is better to wait for the death of the plant that will naturally occur after the blossoming. Even in this instance, remove all the nearby plants and shoots the plant will inevitably have disseminated before dying. The ideal period for removing the plant is straight

after the summer period; the plant blossoms in fact in summer and after this period, having spent all its energies for the single blossoming, will prove weaker and eventually die after a few months. Merely removing the inflorescence is not enough, as in this case the plant might not die and resume blossoming the next year. It is important not to leave the uprooted seedlings on the soil, for they might recover and multiply even after lengthy periods without water.

We must especially remove all the fruits (Photo 51), since the seeds of this plant might easily germinate when just a few requirements are met.



Photo 51- Fruits of Agave

Better to purchase a native plant.

Instead of the agave, you can cultivate succulent plants suited to dry conditions, such as our glassworts, sedum or sempervivum species.

6.3 Hottentot-fig

The Hottentot-fig is a succulent plant extremely common on our coasts, which in spring colours in pink or yellow the dunes of almost the entire Sardinian coast. Few are aware of the fact that it is a plant originally from South Africa, among the most invasive ones in the coastal ecosystems of the Mediterranean Sea and Sardinia. Introduced both as ornamental plant and for the consolidation of dunes and escarpments, it can start competing with our plants and prevent their germination owing to its capacity to modify the pH of the soil (Photo 52).

Both the pink-flowered species (*Carpobrotus acinaciformis*) and the yellow-flowered one (*Carpobrotus edulis*), together with their hybrids, represent a serious threat to the biodiversity of coastal ecosystems (Photo 53).



Photo 52, 53 - Flowering of carpobrotus.

How does it behave? It is a heliophilous plant (thus fond of sunlight), quite resistant to lack of water, strong winds and the various soil salinity conditions. It grows quickly (around 40 cm a year), creating carpets stretching up to 20 square metres and 30-50 cm high. For this reason, it is a plant suited to life under difficult conditions, such as coastal dunes, but with the passage of time the nice initial appearance disappears, leaving in the soil many areas made up purely of dry branches (Photo 54). These dead remains show a high toxicity, and by modifying the pH of the soil, they prevent the germination of other plants.

Why is it a threat? Having escaped cultivation, it was naturalised in the natural environment (i.e. it forms stable populations for at least 10 years, without direct intervention from men, reproducing independently) in the natural environment, becoming invasive: it is in fact capable of reproducing abundantly, spreading very quickly across vast areas. It has been observed that wherever it is found it occasions a loss of biodiversity, in other words, a decrease in the number of native species in the habitat, due to the aggressive competition it mounts against the typical plants of dunal communities (Photo 55).



Photo 54 - Dead remains of carpobrotus.



Photo 55 - Invasion by carpobrotus of dunal communities.

What can we do? It is important to prevent releasing the plant in a natural environment, taking care not to abandon any pruning remains on the ground and carefully ensuring that the plant does not trespass the place of cultivation or, better still, we should not cultivate this species in our gardens, parks or urban green, especially if they are close to coastal areas. If the plant has occupied a limited area, it can be uprooted manually, being extra cautious if we are in a natural environment, inasmuch as this practice might cause damages to the habitats and to the other plants. We must carefully grasp the plant, pulling it delicately from the soil and trying in the process not to extirpate the other plants as well (both the native ones if we are dealing with a natural environment and those cultivated in one's garden) (Photo 56). It is likely that the underground parts, consisting of long and thin roots, might escape, and unless they are fully removed they might give birth to new specimens. The ideal period for removing the plant is before the summer period.

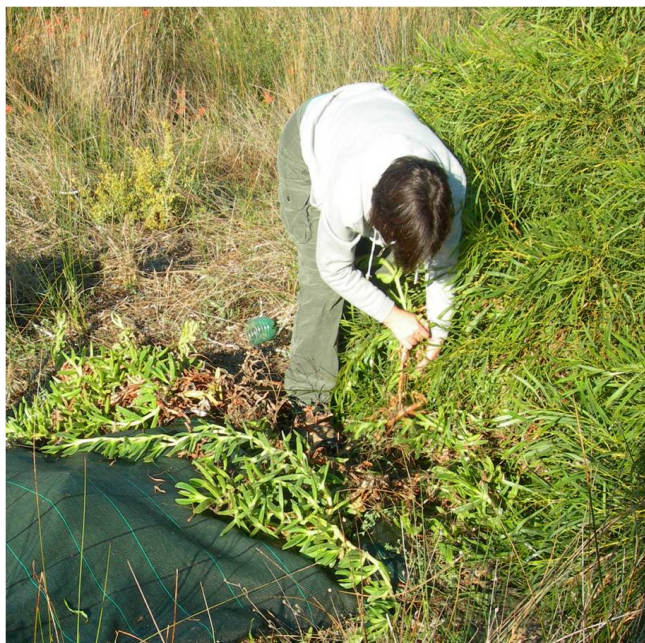


Photo 56 - Carpobrotus hand eradication.

The plant blooms from March to May and bears fruit from June to August: the fruits are edible and different animal organisms (ants, birds, mice and other mammals) feed on them, contributing to the

dispersion of the seeds and the spread of the plant. It is important not to leave any vegetable residue on the soil, since any part of the plant can revegetate and multiply under the hardest circumstances as well. It is especially important to eliminate all the fruits, given that the seeds of this plant are able to tolerate high salt concentrations in the soil, subsequently bearing fruit under the first favourable conditions, such as autumnal rains.

Better to purchase a native plant.

Many are the native plants that might be cultivated in lieu of the Hottentot-figs: cistus, santolina, helichrysum, broom, which produce beautiful blooms.

You can act consciously and responsibly in this way:

- 1) If you have an alien plant in your garden, lavish great care on the pruning remains. Do not release them in the natural environment.
- 2) Before you purchase any plant, find out whether it is an invasive species. Better to buy a native species: the environment will thank you by letting you save water and time.
- 3) If you detect in the natural environment the presence of an invasive species, report that to the authorities with jurisdiction over the territory (e.g. Park or protected area authority, Environmental Protection Department of your Municipality, Province, Region, Forest and Environmental Supervision Authority, Regional Agency Fo.Re.S.T.A.S., Botanical Gardens and Germplasm Banks, environmentalist associations)..

Appendix

Draft ordinance of the Municipal Council

THE MUNICIPAL COUNCIL

Given the richness of the vegetable diversity found in the municipal territory and considering that these peculiarities represent an asset of the local population that undertakes to preserve it and protect it in the interest of the whole humanity;

Considering that the preservation of vegetable biodiversity is an ethical imperative as it represents not only an asset to defend and to transmit to the future generations for improving the quality of life, but is itself an asset entitled to its own existence;

Given the international conventions:

- 1. International Plant Protection Convention (IPPC)** (Rome, 1951, Reviewed in 1997 by the FAO Conference), which creates an international regime to prevent the spread and introduction of insect pests affecting plants and plant products through the deployment of sanitary and phytosanitary measures;
- 2. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)** (Washington, 1973), which regulates the invasive species not yet covered by the IPPC or by other agreements;
- 3. Bonn Convention**, (Bonn, 1979) in Article 3(4) (c), which requires the signatory States to strive to their utmost to prevent, reduce or control the factors that threaten or might increase the level of threat to the native species, through measures that include the block of introductions, as well as the control or elimination of the exotic species introduced;
- 4. Berne Convention** (19 September 1979), which stipulates in Article 11(25) that the contracting parties should undertake to strictly control the introduction of non-native species;
- 5. Resolution No. 57 of the Permanent Committee for the Berne Convention** on the introduction of organisms belonging to non-native species in the environment, approved on 5 December 1997, which recommends to the signatory States to: a) prohibit the deliberate introduction within their borders or part of their territory of allochthonous organisms in order to establish naturalised populations; b) prevent the accidental introduction of allochthonous species; c) produce a list of the invasive of allochthonous species already present in nature,
- 6. Rio de Janeiro Convention on biodiversity** (93/626/EEC: Decision of the European Council of 25 October 1993 ratified by the Italian State through Law No. 124 of 14 February 1994, headed “Ratification and execution of the convention on biodiversity, together with its

annexes, stipulated in Rio de Janeiro on 5 June 1992”), which stipulates in Article 8, relating to “Conservation on site”, under the letter h, that, as far as possible and appropriate, each contracting party should ban the introduction of exotic species or control and remove them, where they threaten the ecosystems, the habitats or the species;

Given Directives 92/43/EEC and 79/409/EEC by which the Council of Ministers of the European Union has intended pursuing the creation of a coordinated and consistent system of areas set aside for maintenance of biodiversity within the EU territory called Natura 2000, the latter consisting in the totality of sites termed Special Protection Areas (SPAs) and Sites of Community Importance (SCIs), including.... *(mention any protected areas within the reference territory)*.....; in particular, in Article 22(b) the Habitat Directive (92/43/EEC) enjoins on EU countries the control and if need be the prohibition to introduce allochthonous elements that cause damage to the natural biodiversity;

Considering that the EU biodiversity Strategy until 2020 (COM/2011/244 of 03/05/2011), stipulates, in Objective 5, that by 2020 the Member Countries should identify and classify pursuant to an order of priority the invasive exotic species and their vectors, should contain or eradicate the priority species, and manage the vectors to prevent the introduction and settlement of new species;

Given *cite any applicable local rules*

Considering that the Municipality of ... *(insert the name)*.... has as its goal the preservation and recovery of the ecosystems *(insert the habitats to be protected)*.....;

Having deemed it necessary to equip itself with a tool for protecting the vegetable assets of the territory of *(insert the name of the municipality)*.....;

This ordinance lays down rules to ensure the protection of vegetable diversity with a view to preserving the balance essential to the different entities and ecosystems present, consistently with the Constitution, national and international obligations, giving effect to the EU System and the specific Regulations.

It aims to integrate the various specific protection measures currently in force with their extension to other species that represent an asset of the Municipality and for which on-site preservation is sought to be ensured, by controlling the spread of invasive exotic species.

HEREBY DECREES:

- 1) the prohibition to introduce new allochthonous floral species of invasive character, as included and described in attachment X;
- 2) the obligation to notify the Municipality of the presence of floral species included in attachment X

using the specific form in order to take a census of invasive species.

It should be noted that the foregoing will neither amount to any obligation on the owners of the lands where the said species are present to uproot them nor entail any penalty;

3) the commitment to contain what is in existence; the eradication and/or control of what is in existence: all the residents, owners and/or managers of lands belonging to any category of use of the soil, if they happen to have such plants inside the areas owned by them, must fully uproot them or control them or circumscribe their development solely with regard to their lands, avoiding the spread and/or propagation in the surrounding areas, as stipulated in the attachment for each species. It is furthermore prohibited to disperse in the natural environment the pruning remains of such species.

In the event of breach, the transgressors will be dealt with in accordance with the stipulated penalty.



www.resmaris.it - info@resmaris.it

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CITTA' METROPOLITANA DI CAGLIARI



Comune di Villasimius



COORDINATOR BENEFICIARY

Città Metropolitana di Cagliari

Settore Pianificazione territoriale, strategica e progetti comunitari
via Diego Cadello, 9/B – 09121 Cagliari
Tel. +39 070 4092726
www.cittametropolitanacagliari.it
e-mail: resmaris@cittametropolitanacagliari.it

ASSOCIATED BENEFICIARIES

TECLA - Associazione per la cooperazione trans regionale, locale ed europea

via Palestro 30
00185 Roma
Tel. +39 06 4468217
Fax +39 06 42010906
www.tecla.org
e-mail: l.lentini@tecla.org

Università di Cagliari

Dipartimento di Scienze della Vita e dell'Ambiente
Centro Conservazione Biodiversità (CCB)
v.le Sant'Ignazio da Laconi, 13
09123 Cagliari (ITALIA)
Tel. +39 070 6753508 (Direzione)
Tel. +39 070 6753509 (Laboratori)
Fax +39 070 6753509 – 35
www.ccb-sardegna.it
e-mail: ccb@unica.it

Comune di Villasimius

Piazza Gramsci, 9 – 09049 Villasimius (CA)
Tel. 070 79301 – Fax 070 792004

Area Marina Protetta Capo Carbonara

Via Roma, 60 – 09049 Villasimius (CA)
Tel. 070 790234 – Fax. 070 790314
e-mail: resmaris@ampcapocarbonara.it