Technical update report

Subject:	TECHNICAL UPDATE ON *DELIVERABLE* N. 2– MONITORING AND ACTION PLAN FOR *CARPOBROTUS EDULIS* (L.) N.E. BR. / *C. ACINACIFORMIS* (L.) L. BOLUS
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Realized by:	ERSE *Ecological Research and Services for the Environment* soc. coop. s.t.p. Via Aurelia sud 291, 55 049 Viareggio (LU) – www.erseambiente.it
activities:	Technical report: specific monitoring protocol and relative action plan towards the IAS *Carpobrotus edulis* and *C. acinaciformis,* aimed at the "evaluation of the threats to biodiversity caused by the IAS and relative action plan for the protection of biodiversity", inside BEST project- *Addressing joint Agro-and Aqua-Biodiversity pressures Enhancing SuSTainable Rural Development*").

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Premise

The present report aims at realizing a management plan concerning the Invasive Alien Species *Carpobrotus edulis* and *C. acinaciformis*, also known as hottentot figs, for which the same prescriptions are valid. This plan is composed by two sections: a monitoring plan, whose goal is to characterize the spatial and quantitative patterns of the distribution of the species on the territory, and a relative action plan. The latter will be strictly related to the monitoring plan, proposing different management strategies depending on the different outcomes.

Chapter 1. Introduction

Protecting biodiversity is one of the main and most ambitious goals of our times, requiring a strong cooperation among institutions and local managers. Many anthropic factors represent a great menace in this regard, including the introduction of Invasive Alien Species (IAS), which is considered one of the main threats to biodiversity around the world.

1.1 The Invasive Alien Species

According to Kolar & Lodge (2001), ecologically speaking a species is defined as invasive when able to quickly spread from the introduction point throughout the territory, becoming abundant and eventually dominant in this new area. This is possible thanks to the following characteristics (Life ASAP Project):

1. Resistance to parasites and diseases
2. Adaptation to different environmental conditions, including highly anthropized ones
3. Higher competitiveness in exploiting the resources, compared to the native species (sometimes producing allelopathic substances)
4. Quick growth
5. Short life cycle
6. High reproductive potential
7. High diffusion capabilities, eventual asexual reproduction
8. Adaptation of the life cycle depending on the invaded environments
9. Consociation with human activities
10. Resistance to predators/competitors in the new area

From a regulatory point of view, IAS are defined as those species threating biodiversity and related ecosystem services (CDB 2000, 2002), with negative impacts on economic activities and human health. It is thus important to distinguish between alien species and invasive species, as a new introduced species may not necessarily be related to a menace for local biodiversity.

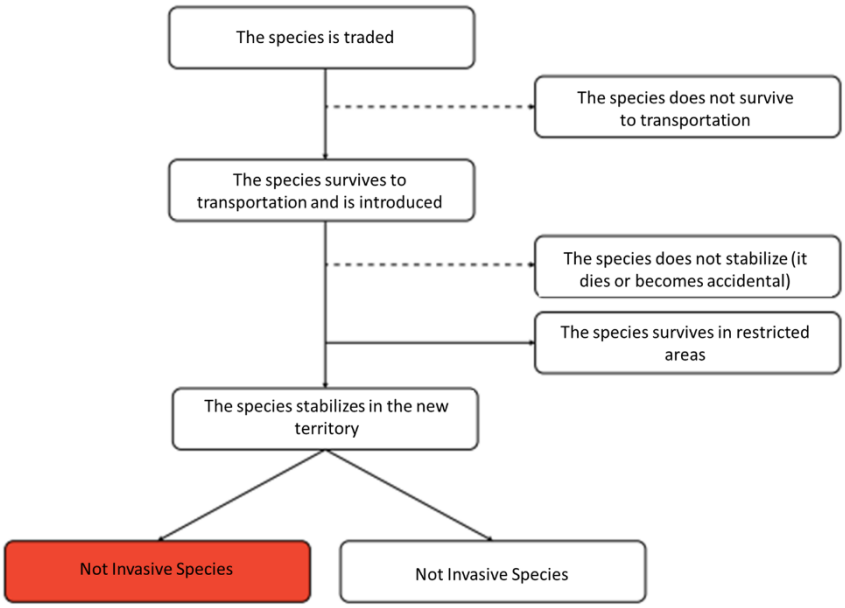


Figure 1: introduction and potential invasion process of an alien species (from lifeasap.eu).

According to the tens rule (Williamson, 1996), around 10% of introduced species survive to the transportation, and 10% of these species stabilize in the new environment. Again, a 10% of these stabilized species may become invasive, giving an overall 0,001% probability of invasion of a new introduced species. Obviously, this "rule" represents an estimation, but still remains a reference point in the study of biological invasions.

1.2 The species *Carpobrotus edulis* as an invasive species inside The Regional Natural Park "Dune Costiere da Torre Canne a Torre San Leonardo"

Carpobrotus edulis is commonly known as hottentot fig, ice plant or clawberry. It is a perennial, succulent plant not taller than 20 cm. The leaves are triangularly shaped, tapered towards the apex, with a greenish/reddish colour. The flower is considerable in dimensions, yellow or magenta, developing into an indehiscent yellow fruit. Fruits are edible, as the scientific name suggests. The species is native of South Africa, growing on the coasts and internal regions of the Cape of Good Hope province. The hottentot fig has been introduced in Europe, USA, Australia, South America, North Africa, and some islands of Pacific and Atlantic Ocean, where it has settled in the wild. *C. edulis* produces a great number of seeds, it has many different pollinators and it is able to self-pollinate. Seed dispersion is carried out mostly by mammals. Concerning the liming factors, the species does not tolerate high levels of nitrogen and freezing. In Italy the species grows on coastal dunes and close-by habitats, swamps and rocky environments. It is nevertheless capable of growing along roadsides and railways, requiring well-drained soils and much light.

Given its high adaptation capabilities, in the introduced areas the species may create dense mats covering up to 100% of the available soil, representing a serious threat to local biodiversity. It has also been demonstrated that it can

produce tannic acids, creating an allelopathic effect on the other plant species. *C. edulis* is listed as an alien species menacing Habitats of Community Interest such as the 2110 "Embryonic shifting dunes", 2120 "Shifting dunes along the shoreline with *Ammophila arenaria* ('white dunes')", 2250* "Coastal dunes with *Juniperus* spp" and 5320 "Low formations of *Euphorbia* close to cliffs". The congeneric *Carpobrotus acinaciformis,* which shows many similarities in terms of ecology and morphology, is listed as a menace for Habitats like 1240 "Vegetated sea cliffs of the Mediterranean coasts with endemic *Limonium* spp", 2210 "*Crucianellion maritimae* fixed beach dunes", 2230 "*Malcolmietalia* dune grasslands", 2240 "*Brachypodietalia* dune grasslands with annuals" and 2260 "*Cisto-Lavenduletalia* dune sclerophyllous scrubs".

The main purposes of this Plan are the production of an eradication/containment protocol for *Carpobrotus edulis* on the Regional Natural Park "Dune Costiere da Torre Canne a Torre San Leonardo". This plan focuses on the realization of a first monitoring plan, to locate the individuals of the species on the Park and a management plan dedicated to the eradication/containment of these individuals in the area. The coastal area of the Park stretches for 8 km, with mobile dunes of a maximum extension of 100 m. The plan includes a punctual visual monitoring section, including georeferentiation, and an eradication/containment section consisting in the mechanical removal of the individuals and the litter underneath. A proper communication strategy will be set up to involve the local population in the whole process.

The Regional Natural Park "Dune Costiere da Torre Canne a Torre San Leonardo" extends for about 100 hectares, and it is characterized by a high environmental differentiation, with a well preserved dunal ecosystem, interdunal depressions, fossil dunes and humid areas. The Park partially overlaps with the Special Area of Conservation (SAC) IT9140002 "Litorale Brindisino", according to Directive 92/43 CEE "Habitat". The coastal plant community is particularly vulnerable to the ingression of alien species, as it is composed by many endemic species or subspecies, which menace the resistance of the environment to the coastal erosion, with the risk of the ingression of the salt wedge intrusion. The Park also represents a very important breeding and stop-over site for the bird community, thanks to its humid areas.

Relatively to *Carpobrotus acinaciformis,* the species has not been reported yet inside the protected area but considering the similarity of the species with *C. edulis,* the present plan may be applied for both species, whereas the first species would be reported in the area.

Table 1: Characterization of invasiveness of *Carpobrotus edulis* (and *C. acinaciformis*.

Invasiveness characteristics	Evaluation
Velocity of dispersal	Dispersive
Tendency of prevalence	Dominant
Level of threat to biodiversity	Highly competitive
Regional distribution	Distributed at a regional level

Chapter 2. Characteristics of the species

2.1 Morphological description

TAXONOMY

Division: Magnoliophyta
Class: Magnoliopsida
Order: Cariophyllales
Family: Aizoaceae
Genus: *Carpobrotus*
Species: *Carpobrotus edulis*

Photo: www.actaplantarum.org

Figure 2: taxonomical framework of *Carpobrotus edulis,* with pictures.

Carpobrotus genus includes 20-25 species native to South Africa, of which *C. edulis* (L.) N.E. Br. and *C. acinaciformis* (L.) L. Holub are present in the Italian territory. These are perennial succulent plants, with a prostrated stem, triangularly shaped leaves up to 10 cm long, with no hair. The leaves colour goes from green to light blue. The flower is hermaphrodite, 5 to 12 cm in diameter, with many petals and stamens, from yellow to purple. The fruit is oval shaped, fleshy and indehiscent, from green to yellow-reddish when mature. The plant produces a greatnumber of small seeds.

Figure 3: individuals of *Carpobrotus acinaciformis*.

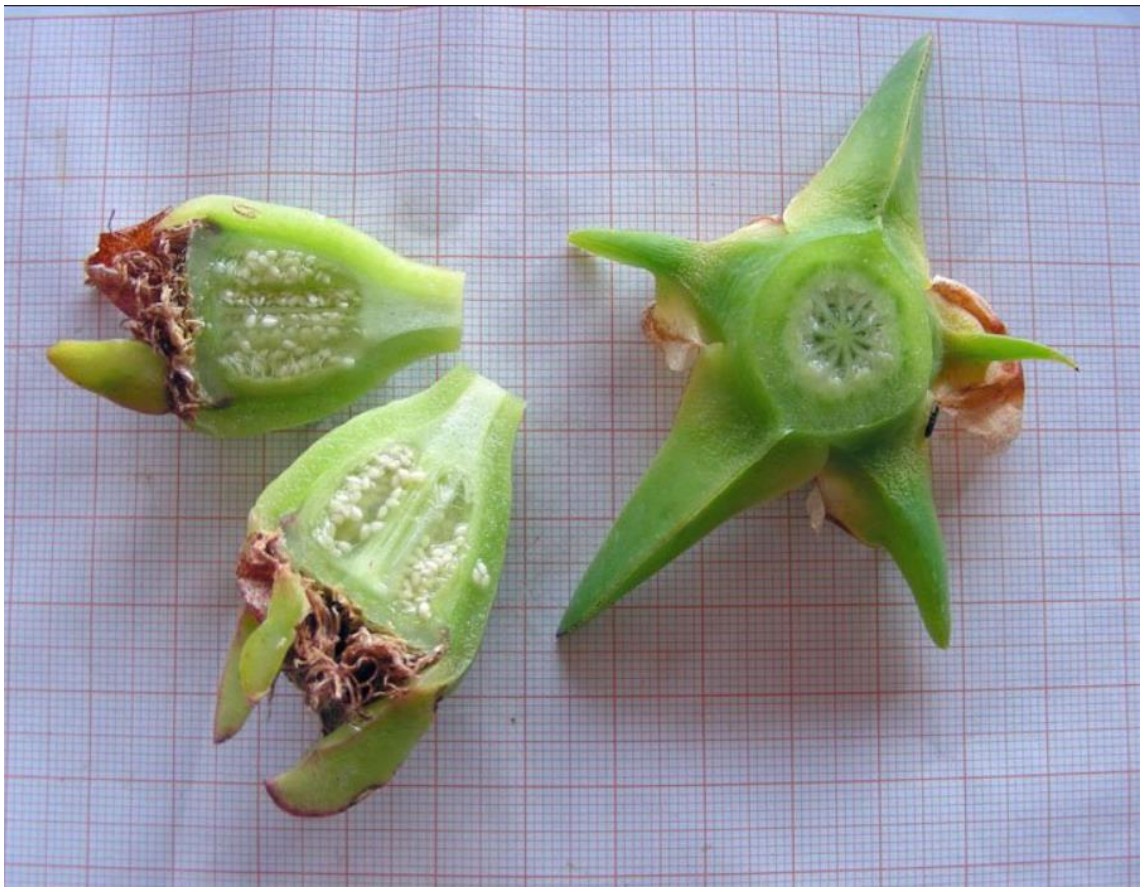


Figure 4: immature fruits of *Carpobrotus edulis*.

Even if *Carpobrotus edulis* flowers are mainly yellow, they can also be purple in colour, the same of *C. acinaciformis.* For this reason, purple flowers may belong to both species, and the identification must rely on different characters:

- *C. edulis* has more straight leaves, while they are more curved in *C. acinaciformis.*
- *C. edulis* has leaves with an isosceles triangle section and a more vivid green colour, while in *C. acinaciformis* they have the section like an equilateral triangle and a more whitish green colour.
- The flower calyx has unequal lobes in *C. edulis,* and subequal lobes in *C. acinaciformis*
- The ovary has 9-11 locules in *C. edulis,* 12-16 locules in *C. acinaciformis*

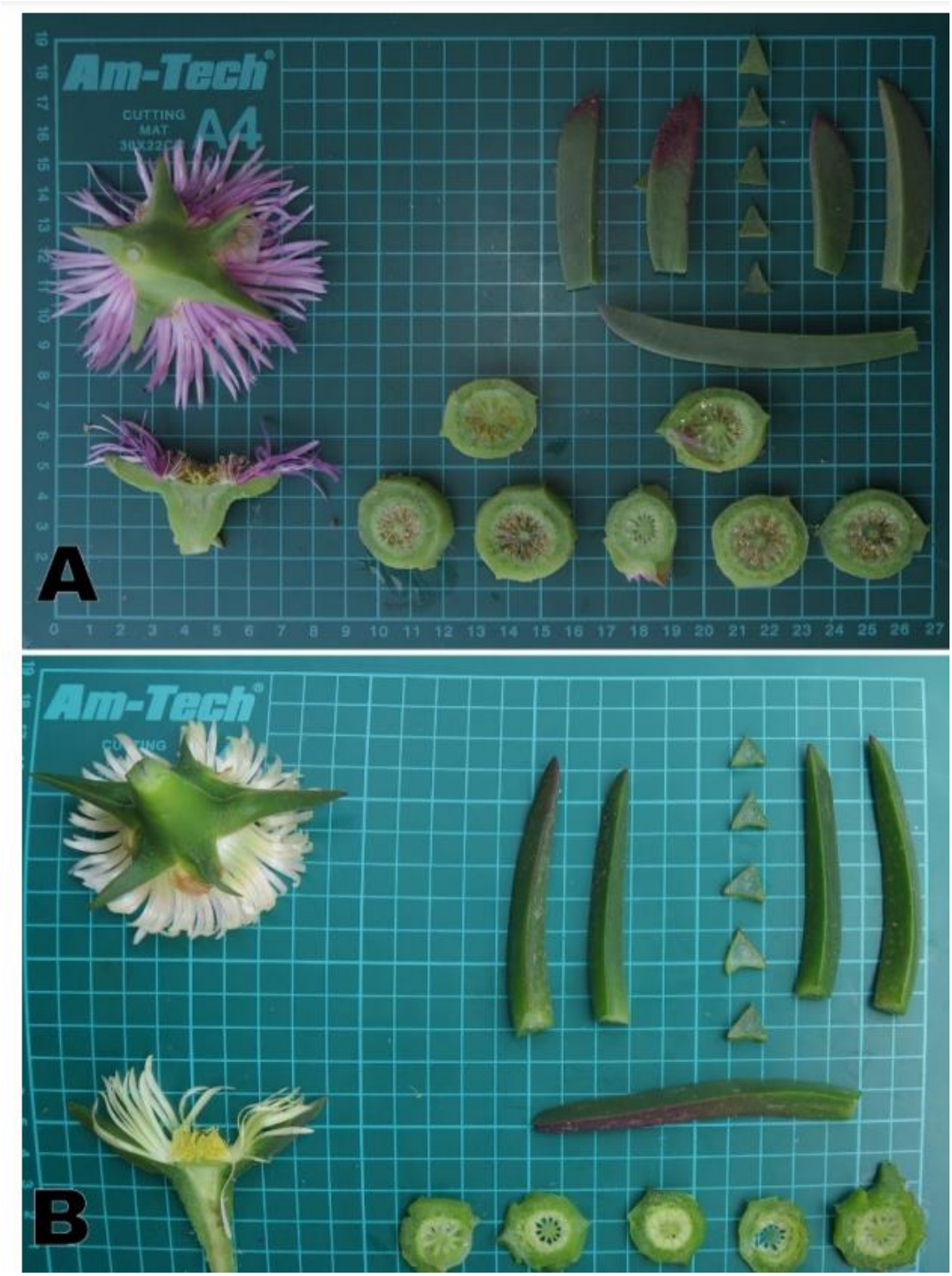


Figure 5: diagnostic characters of both species. (A: *Carpobrotus acinaciformis*, B: *Carpobrotus edulis*).

The capability of hybridization, the artificial selection carried out by the horticultural environment and an incomplete taxonomical definition require nevertheless the identification of new diagnostic features for the identification of the species.

We hereby provide a dichotomous key to easily distinguish the species inside the Aizoaceae family, from non-technical staff.

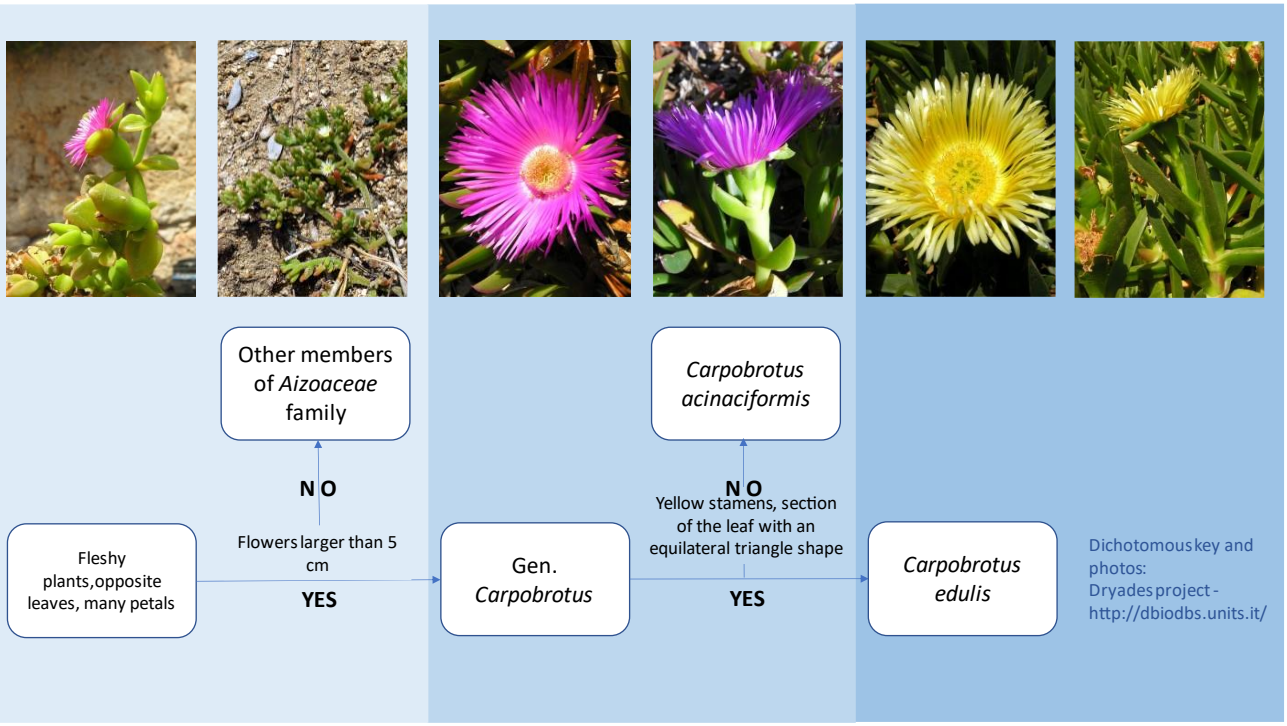


Figure 6: streamlined dichotomous key to the identification of *Carpobrotus edulis*.

2.2 Ecological features

The hottentot figs grows on sandy and rocky coasts of South Africa, with a temperate or semi-arid climate, tolerating droughts and a variable amount of rain. The species hardly tolerates freezing, not surviving with temperatures below -2/ -3° C. Its native soil is mostly acid, sandy and poor in nutrients, and in its introduced range it can grow on acid, neutral or even poorly basic soils. It also tolerates relatively salty environments and poor soils.

Except for Sardinia, the species grows only in coastal habitats, both in sandy and rocky environments, and may also spread among Mediterranean shrublands. Thanks to its well-developed root system, the species can settle in different environments, both natural or anthropized, tolerating different types of stress like droughts, salt and fire.

2.3 Reproduction and development

Carpobrotus edulis can reproduce both sexually and asexually, the last one usually leading to a quick spread and a higher degree of invasiveness. Pollination is mediated by insects, mainly hymenoptera, flies, beetles and butterflies, but some cases of apomixis are reported, where seed production can occur without fecundation.

The fruit is big, and seed dispersion is mediated by the animals feeding on them, mainly rodents, rabbits, birds and sometimes cats. Animals can also induce the fragmentation of leaves by trampling, together with weather or human activities, and sea can disperse these fragments in very distant areas.

Figure 7: internal view of a fruit of *Carpobrotus edulis*.

Chapter 3. Distribution and pathways of introduction

3.1 Distribution

The hottentot fig is native to the provinces of Cape of Good Hope, in South Africa, where it grows along the coastal and internal areas up to 800 m of altitude. Nowadays, *Carpobrotus edulis* is widespread around the world, in all five continents, including other parts of Africa like Morocco.

Starting from the XVII century, *C. edulis* has been traded as an ornamental plant in the European gardens, and the first reporting of the species in the wild date back to the end of XVIII century, in England. During the following decades, the plant has been reported in Spain, France, Portugal and Italy (1923), where the species has found the best climatic conditions. From the 1980s the species has undergone another geographic expansion.

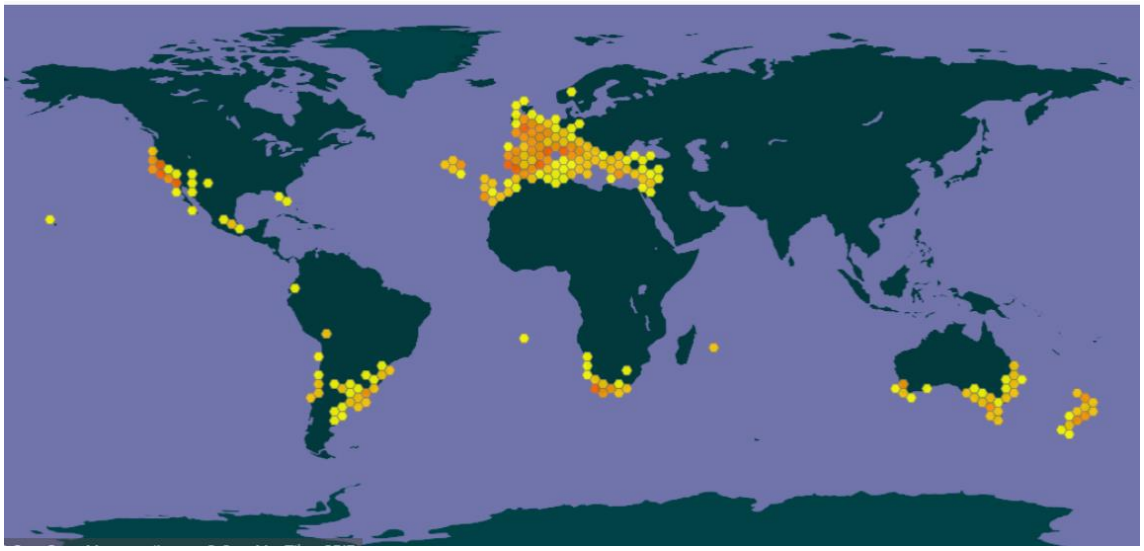


Figure 8: native and introduced range of *Carpobrotus edulis* (www.gbif.org).

In Italy the hottentot fig is located in all the coastal regions (except for Emilia-Romagna and Friuli-Venezia Giulia). It is considered as invasive in Tuscany, Sardinia, Campania and Sicily; casual exotic in Veneto, Molise and Basilicata and exotic and naturalized in the other regions.

In Apulia the species is present in all the provinces, often together with *C. acinaciformis*, and it has been reported in the following protected areas: Regional Natural Park “Bosco e Paludi di Rauccio”, Regional Natural Reserve “Litorale Tarantino Orientale”, Natural Reserve “Stornara”, Natural Reserve “San Cataldo”, Regional Natural Park “Dune Costiere da Torre Canne a Torre San Leonardo”, Regional Natural Park “Fiume Ofanto”.

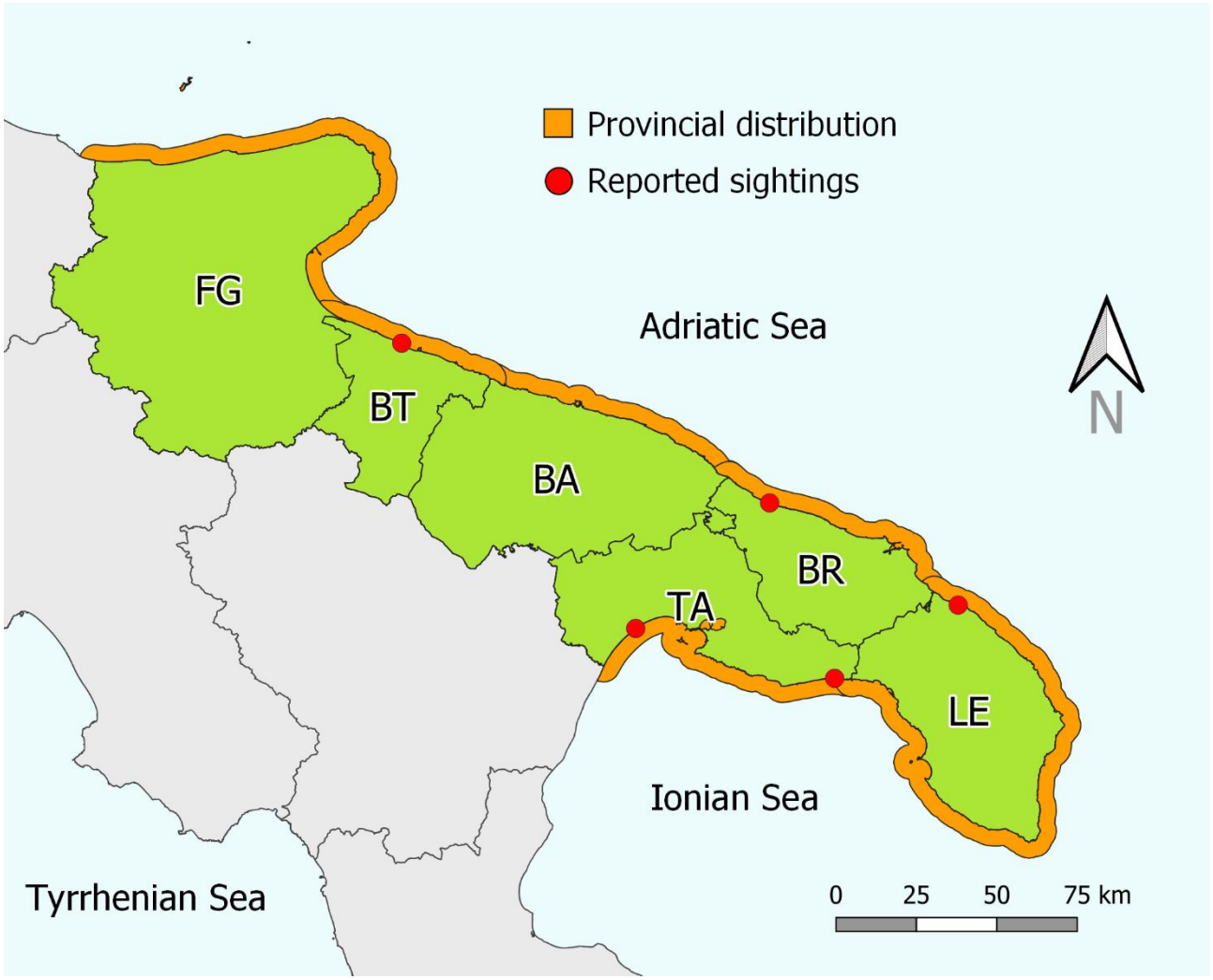


Figure 9: distribution of *Carpobrotus edulis* in Apulia; the species is often found together with congeneric *C. acinaciformis*.

3.2 Pathways of introduction

The human being is the most important vector for this species, as the hottentot fig has been traded as an ornamental plant since the XVII century. In other regions, like California, the species has also been introduced as a soil stabilizing agent, like for example in railways constructions.

With the development of the coastal tourism, the cultivation of this species in private gardens has deeply contributed to the spread of the species.

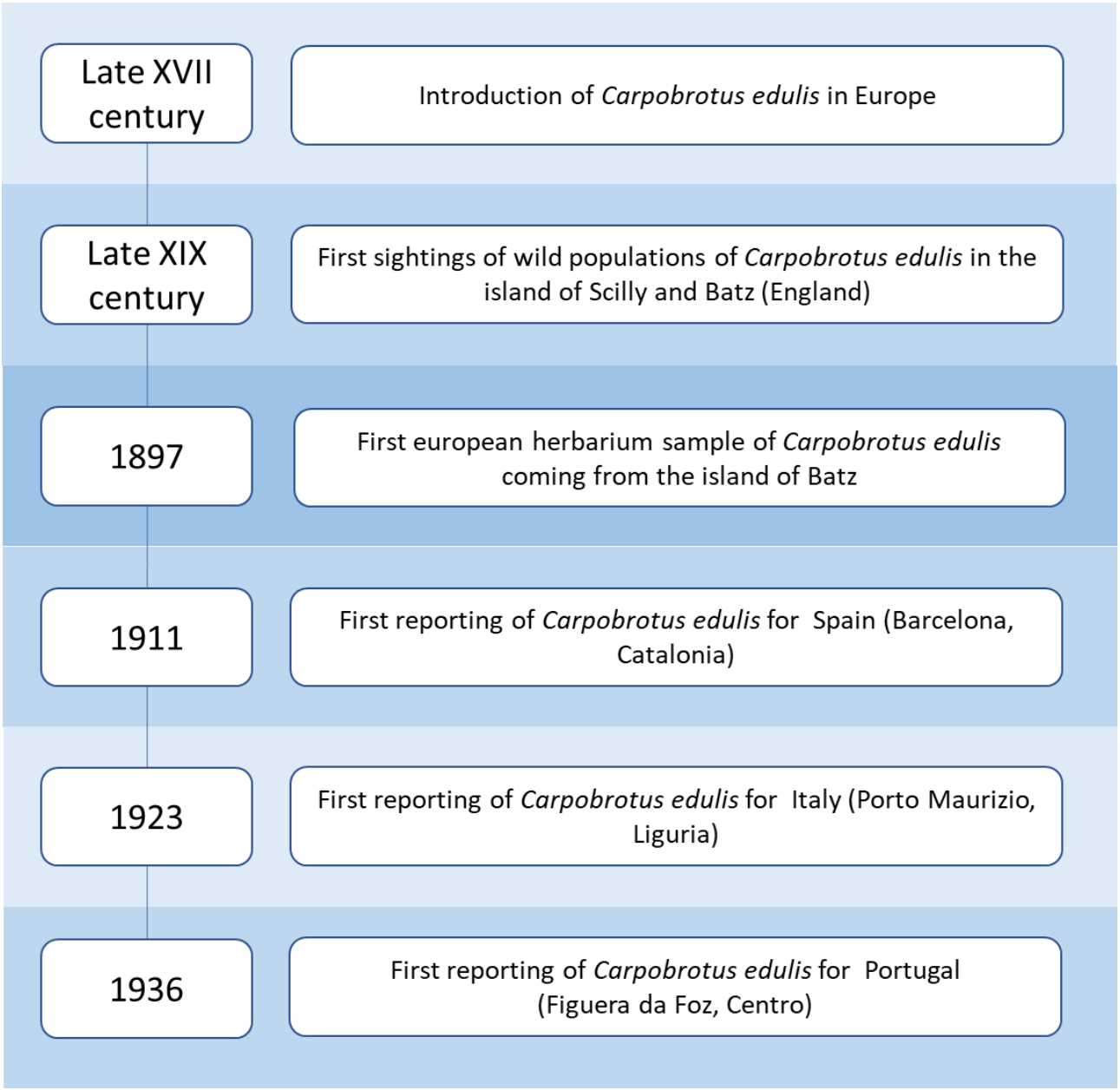


Figure 10: steps of the introduction of *Carpobrotus edulis* in Europe.

Chapter 4. Impacts

4.1 Ecological impacts

In its native range the hottentot fig lives in habitats characterized by a strong dryness, where the other plants compete and prevent *Carpobrotus edulis* from expanding. In the introduced areas, especially in dry and poor soils, the species show a high degree of competition, overwhelming the native flora and forming dense monospecific mats which threats local biodiversity. In addition, together with competing for nutrients and water, the hottentot fig can increase the acidity of the soil through the decomposition of its leaves, acting as an "ecosystem engineer" organism and producing an allelopathic effect on the local flora.

It is fundamental to stress out that the main habitats where *C. edulis* acts as an invasive species, located in the dunal and rocky ecosystems, are one of the most vulnerable and of the most valuable in terms of conservation. Endemic species with restricted ranges like *Limonium* ssp. and *Centaurea horrida* may be led towards extinction.

The same considerations may apply to the congeneric *C. acinaciformis,* which may produce the same impacts as *C. edulis.* The present report is therefore structured for the definition of a monitoring and action plan for both species.

Figure 11: individuals of *Carpobrotus* sp. competing with other species of rocky environments. (www.ponderat.eu)

Figure 12: individuals of *Carpobrotus edulis* competing with other species of sandy environments. (www.actaplantarum.org)

4.2 Economic impact

The hottentot fig produce both direct and indirect economic impacts. In rocky environments, *Carpobrotus* sp.pl. mats may weigh down the cliffs, producing landslides. These effects have a heavier impact in case of presence of streets or buildings underneath the cliffs, including being harmful for people.

In sandy environments the impacts are mainly indirect, as all the ecological services provided by the dunal ecosystems are compromised. Many investments are dedicated to the construction of barriers or plantings, mostly to stop coastal erosion, and the colonies of *Carpobrotus* sp.pl. are not deeply tolerant to the swells, showing a lower resistance to the erosion compared to the native flora and thus producing indirect economic damages.

Chapter 5. Regulatory aspects

The cornerstone of European legislation, and subsequently the Italian and Regional legislation, is Regulation (EU) n. 1143/2014 of the European Parliament and the Council, of 22 October 2014, laying down provisions to prevent and manage the introduction and spread of invasive alien species. It requires, inter alia, the rapid eradication or control of those species by the Member States.

This decree introduces the prohibition of "introduction, transport, detention (even in confinement), exchange, breeding, reproduction, trade and release into the environment" of the species, for public and private subjects (including individual citizens), and requires eradication, where possible, and control or containment of populations of naturally occurring invasive alien species to prevent further dissemination and mitigate adverse impacts on biodiversity. MiTE (Ministero della Transizione Ecologica) may grant derogations from the prohibitions, subject to authorisation, to botanical and zoological gardens, research institutes and other entities carrying out research or conservation activities ex situ. In exceptional cases, derogation shall be granted on grounds of overriding public interest, including those of an economic or social nature. No derogation shall be granted for trade and release into the environment of species listed in the relative Annexes.

The allochthonous species to which the aforementioned regulations apply were subsequently identified through the establishment of lists of invasive alien species of Union relevance or IAS (Invasive Alien Species), through the Implementing Regulation (EU) of 13 July 2016, Commission Implementing Regulation (EU) 2017/1263 of 12 July 2016, Commission Implementing Regulation (EU) 2019/1262 of 25 July 2016.

Italian legislation transposes Regulation (EU) No. 1143/2014 of the European Parliament and of the Council by means of Legislative Decree 230/2017 of 15 December 2017. The measure establishes rules to prevent, minimize and mitigate the adverse effects on biodiversity caused by the introduction and spread, both deliberate and accidental, of invasive alien species within the European Union, and to minimise and mitigate the impact that these species may have on human health or the economy in Italy. The Ministry of the Environment and the Protection of the Territory and the Sea has moreover published two decrees directly connected to the D.Lgs. 230/2017, that is the Ministerial Decree of 6 March 2020, that regulates the institution and the compilation of the register of the exotic species, and the Ministerial Decree of 29 April 2021, which regulates tariffs for activities provided for by Legislative Decree no. 230/2017.

The Apulia Region, in addition to the provisions of Community and Italian legislation on the problem of alien species, establishes a regional coordination table for the control of invasive alien species, through the Decree 815/2019, of 2 May 2019.

None of the species of the genus *Carpobrotus* has been defined as an invasive alien species of Union concern, and in Italy there is no specific legislation for the hottentot fig. In France, with the “Arrêté” of 13/07/2010, the utilization of *Carpobrotus edulis* and *C. acinaciformis* as species for plantings around the cultivated lands has been forbidden, followed by Portugal and Scotland.

Chapter 6. Monitoring plan

Considering the regulatory aspects of the European Union, monitoring appears to be a key tool to determine the status of the species, by individuating the essential parameters to determine its presence, distribution, abundance, habitats and future trends.

Data must be collected through standardized methodologies, and these must be combined with information collected through previous monitoring campaigns, scientific literature, sightings, and so on. This chapter will then focus on the monitoring techniques required to reach the aforementioned goals

6.1 Data collection

Collecting the data through bibliography represents a crucial step, as a high-quality information allows to correctly set up the monitoring protocol, together with regards to the techniques and the time scale. This information itself cannot substitute the direct data collection on the field, but it can optimize the sampling effort, with a positive impact on the economy of the project.

The information is collected from three sources:

- Scientific papers
- *on-line databases*
- Protected area manager survey.

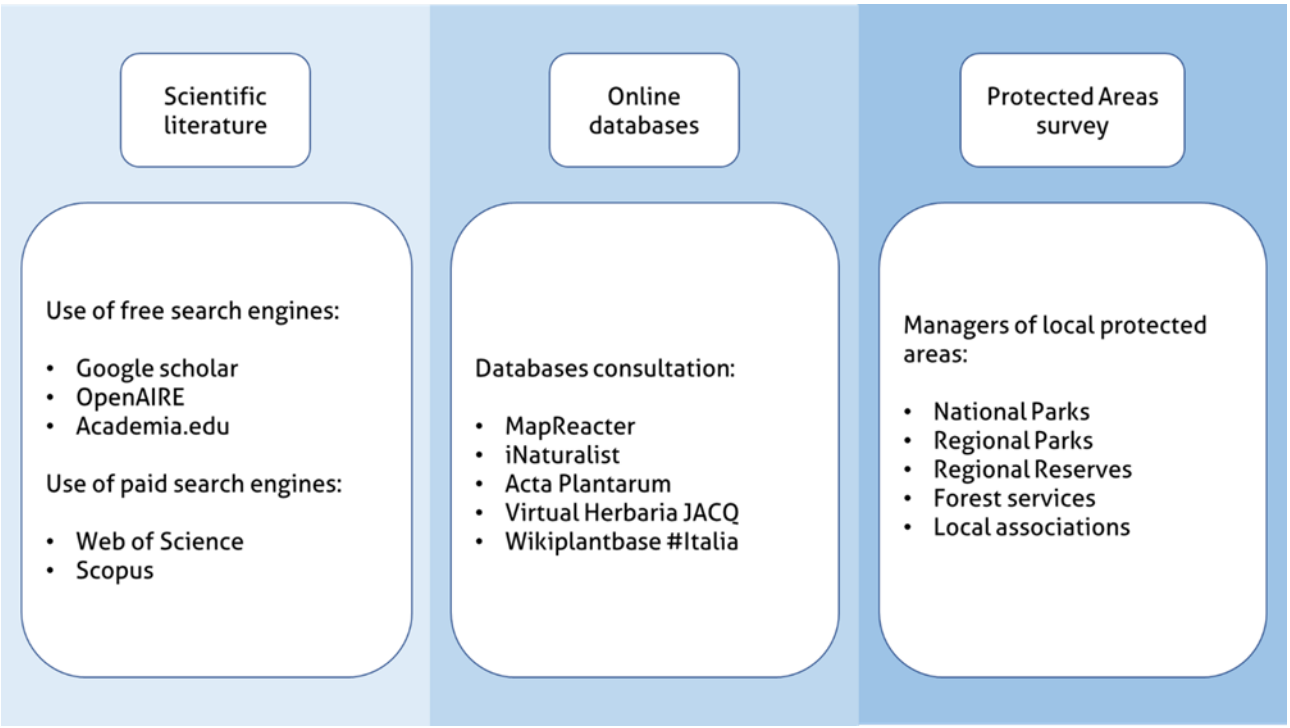


Figure 13: diagram of the sources of the data.

6.1.1 Scientific literature

This source is represented by highly specific scientific journals or technical/informative material, with a major attention to the most authoritative papers (high-impact periodicals, subjected to peer-review; local journals, with high attention to the small-scale patterns). This source may give us information about distribution and abundance of the species. For the present project dedicated search engines have been consulted, as for example *Google Scholar, OpenAIRE, Academia.edu, Web of Science, Scopus*.

6.1.2 Consultation of online databases

This source is represented by online data collectors, like for geographical information (from which we can determine part of the spatial distribution of a species). There may be some biases due to the upload of incomplete/wrong data, especially by people participating to citizen science projects; specific databases periodically review by experts or technical staff. This tool has the advantage of being continuously updated, avoiding the usual gap between the writing of scientific papers and their publication.

For the present project two main databases have been used: *Mapreacter* from ISPRA and *iNaturalist.*

6.1.3 Surveys

Many projects rely on the contribution of citizen science protocols, by gathering information from citizens or stakeholders. For the present project, a specific survey has been proposed to the managers of the local protected areas concerning the presence and distribution of IAS (available at the end of the document, annex A, produced by Puglia Region and ERSE soc. coop. s.t.p.). This tool aimed at evaluating the critical points about the impacts of these species on the habitats and on the other species, together with gathering information on existing projects for this issue.

6.2 Description of the monitoring plan

This chapter will define the specific modalities to carry out the Monitoring Plan of the species *Carpobrotus edulis* within the territory of the Regional Natural Park “Dune Costiere da Torre Canne a Torre San Leonardo”. Currently, the species has been reported inside the protected area, and it has been indicated as a problematic exotic species for conservation by the Park administration within the questionnaire carried out during the BEST project. Given the ecology of *Carpobrotus edulis*, monitoring actions will focus on the coastline inside the protected area. However, censuses will also be provided within the natural areas behind the dunes, composed mainly of meadows and interdune ponds, because the ecological plasticity of this species allows it to colonize these types of environments, especially with particularly sandy soils. Urbanised areas, public parks and agricultural areas are excluded from this monitoring actions, given the necessity of specific permissions by the local authorities or by the private sector to which they belong.

In case of finding new colonies of *Carpobrotus acinaciformis* (at the moment not reported for the protected area under investigation) or of hybrids between the two species, the protocol must apply the same treatment reserved to the congeneric species. Therefore, the information and considerations expressed in the following paragraphs must also refer to the latter species.

The Monitoring Plan is divided into two phases:

- Mapping of areas with the presence of *Carpobrotus edulis*.
- Floristic surveys for surveillance monitoring.

6.2.1 Mapping of areas with the presence of *Carpobrotus edulis*

This phase is necessary for the identification and evaluation of the presence of *Carpobrotus edulis* in the coastal territory of the Park. Staff must be trained in the recognition of species belonging to this genus, possibly with the help of the taxonomic key presented in Chapter 2 (Figure 6). Technical staff must also have the ability to use a GPS device that can map the affected area. A preferential period for monitoring activities is not indicated, as the species of the genus *Carpobrotus* are all perennial and can be identified in every season. However, as described in paragraph 6.5, it is advisable to follow the timing of the work to facilitate the performance of the activities. The operator shall use the following protocol:

- ***Identification of Carpobrotus edulis***: the operator must detect the presence of *Carpobrotus edulis* at sight. Monitoring must be carried out on sight, strictly without the use of vehicles in order not to cause damage to the coastal dunes. This monitoring must mainly focus on the coastal areas; secondly, the natural territories behind the dunes must be recorded with particular attention to those with soil with high percentages of sand and presence of sclerophylls (Habitat 2260). Finally, agricultural areas or areas used as tourist facilities must be carefully controlled after authorization. These protocol must be carried out in an effort to maximise the sampling effectiveness, taking into account the above recommendations:
  - while monitoring the dune environment keep as close as possible to the ridge or the highest point of the dune: this area, in addition to being more suitable than the front of the dune in the presence of the hottentot fig, allows a better view;
  - pay special attention to the areas below the most structured vegetation: if properly sunny the areas below individuals of large-fruited juniper, cade juniper or sclerophylls can be the optimal soil for the presence of *Carpobrotus edulis*, therefore it is necessary to adequately control below the individuals of these species;
  - always take into account the extent of the view; this can be prevented by obstacles or vegetation and can vary depending on the light and the weather.

The following map identifies the main botanical aspects present in the territory of intervention. The identification phase should include the following minimum actions:

- n. 1 linear coastal transept along the whole stretch of the Regional Park, for a total of about 8.6 km.
- n.1 linear transept parallel to the shoreline every 50 m within the interdune natural areas. These areas have been identified by crossing data from “Carta Natura”, Corine Land Cover cartography and GIS cartography of the Regional Territorial Landscape Plan. Dividing the intervention area of the coastal area of the Park will produce n.26 linear transepts of varying length for a total of about 9.9 km;
- n.1 linear transepts parallel to the shoreline every 100 m within the semi-natural interdune areas (mostly cultivated or uncultivated). These areas have been identified by crossing the Corine Land Cover cartography with the GIS cartography of the Regional Territorial Landscape Plan. Dividing the intervention area of the coastal area of the Park will produce n.8 linear transepts of varying length for a total of about 5.3 km;

- n.1 linear transepts for each section of the existing path. These paths have been identified by photodetection, and the coordinates of the access points have been catalogued in Table 2. Overall, 23 paths have been identified, for 23 transepts whose total length turns out to be about 6.4 km

Table 2: coordinates of entrance of the pre-existing pathways.

Paths	Coordinates (Lat., Long.)
1	40.82781 N 17.47752 E
2	40.82781 N 17.47752 E
3	40.81911 N 17.49738 E
4	40.81603 N 17.50524 E
5	40.81358 N 17.51146 E
6	40.81259 N 17.51386 E
7	40.80952 N 17.52168 E
8	40.80890 N 17.52309 E
9	40.80856 N 17.52409 E
10	40.80759 N 17.52714 E
11	40.80679 N 17.53587 E
12	40.80446 N 17.53899 E
13	40.80454 N 17.53954 E
14	40.80414 N 17.54022 E
15	40.80398 N 17.54038 E
16	40.80390 N 17.54045 E
17	40.80340 N 17.54161 E
18	40.80350 N 17.54293 E
19	40.80301 N 17.54493 E
20	40.80262 N 17.54659 E
21	40.80185 N 17.54778 E
22	40.80176 N 17.54822 E
23	40.80167 N 17.54874 E

The total number of transepts is 57, for a total length of about 30.2 km. The transepts must be built using the parameters of the map described in figure 14, paying special attention for the habitats listed in Directive 92/43/EEC for which the *Carpobrotus edulis* represent a serious threat, or 2120 "Mobile coastal cordon dunes with presence of *Ammophila arenaria* (white dunes)", 2250* "Dunes with *Juniperus* spp." and 2260 "Dunes with sclerophyll vegetation of the *Cisto-Lavanduletalia*".

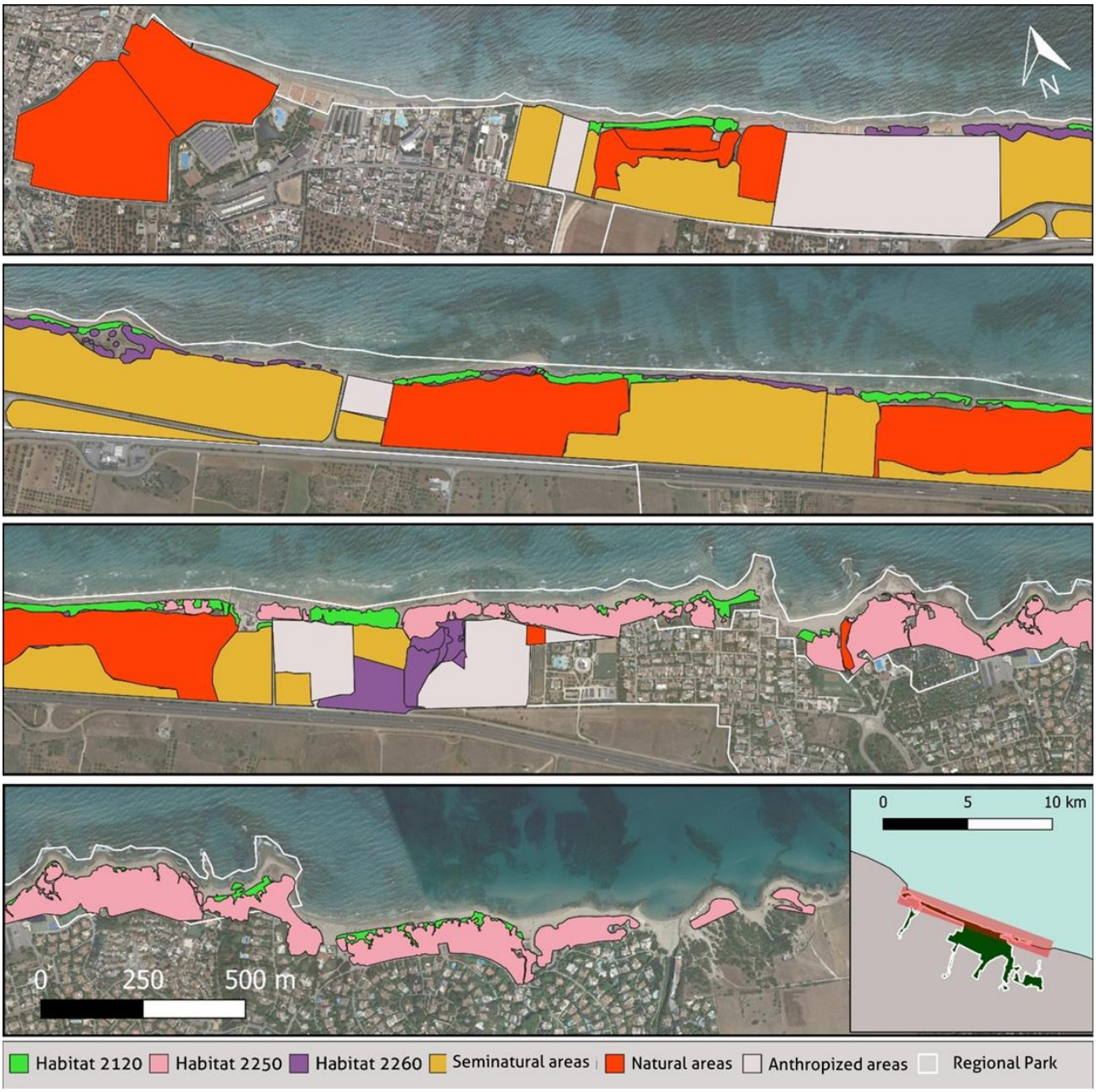


Figure 14: Mapping of the coastal area of the Regional Natural Park "Dune Costiere da Torre Canne to Torre San Leonardo".

An example of the structure of the transepts is given on the basis of the map information, where it is possible to observe how transepts of different types can map effectively the territory affected by the monitoring, with particular attention to the environments most affected by the present of the hottentot fig.

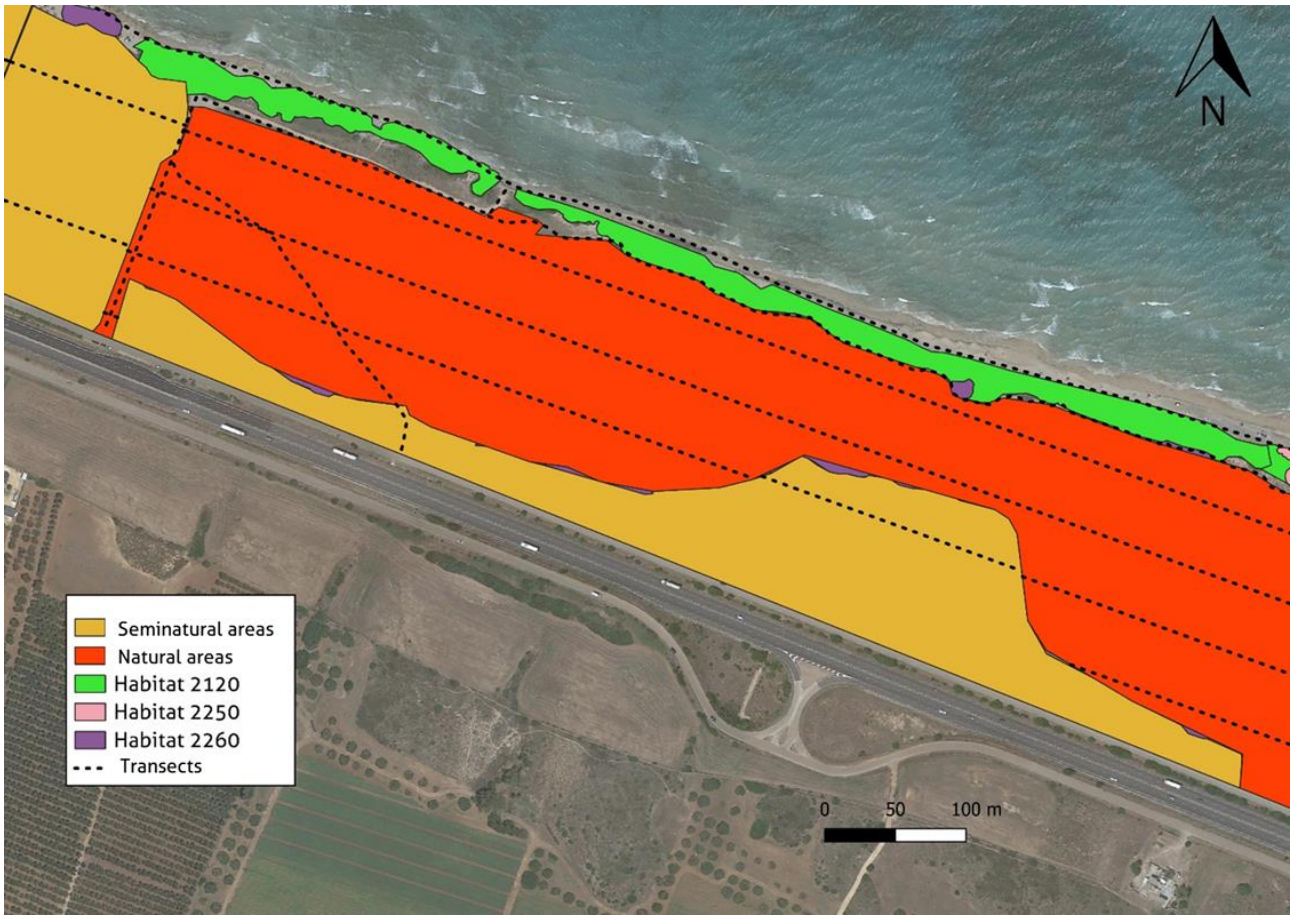


Figure 15: example of transept structure according to the described protocol. In the enlargement, we can see the coastal transept, the transepts in natural areas, those in semi-natural areas and those belonging to the existing path.

- ***Carpobrotus edulis*** **mapping:** using a GPS device, the operator must map the perimeter of the area containing *Carpobrotus edulis*, creating a perimeter track. This area may present a coverage of the cluster-like exotic species, in those cases is however advisable to make large polygons (greater than 10 m^2) in order to facilitate the perimeter with GPS instruments even of limited sensitivity. The identification of the perimeter must take into account all the individuals, including the small seedlings; therefore, it is recommended an accurate investigation of the area before realizing the GPS track.

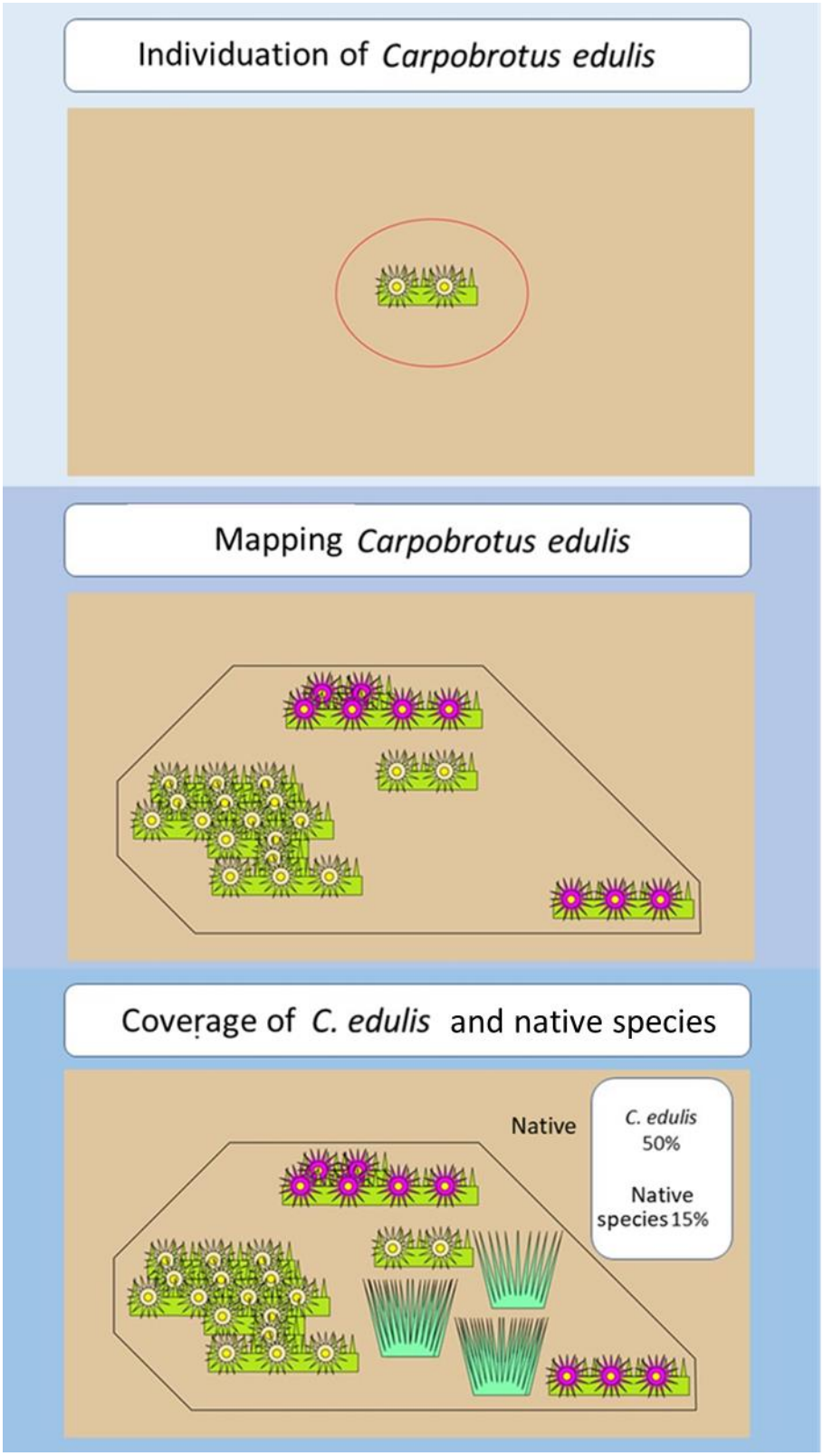


Figure 16: diagram of the steps of mapping areas with the presence of *Carpobrotus edulis*.

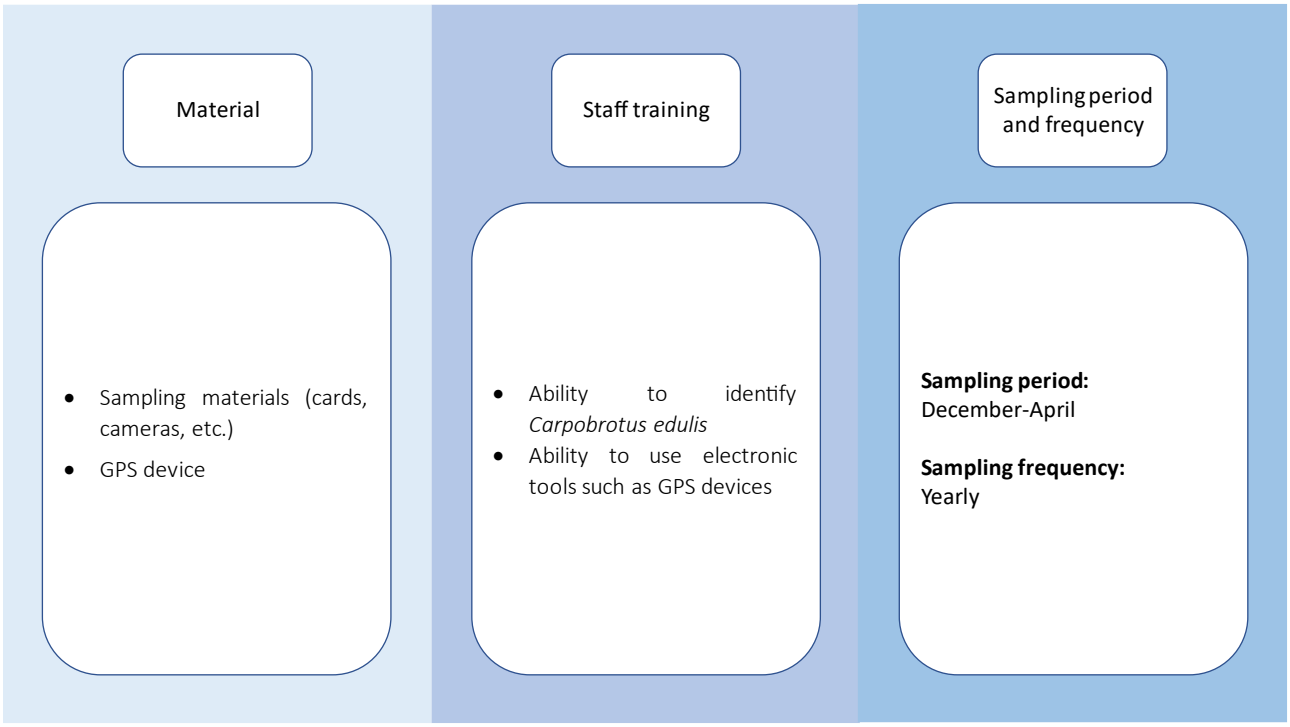


Figure 17: key information for mapping areas with the presence of *Carpobrotus edulis*.

6.2.2 *Carpobrotus edulis* mapping via GIS

Spatial mapping is an important step of data collection, in which the collected information must be standardized in order to be able to analyse it through GIS spatial processing software. Therefore we provide the data to be collected during the mapping step, necessary for the production and processing of spatial geometries:

- **Point sites with the presence of *Carpobrotus edulis*:** collection of GPS points representing the isolated individuals of *Carpobrotus edulis* and/or the best representative centroid of the populations, in order to produce point geometries of the sites where both individuals and colonies are located.
- **Extension of the colonies of *Carpobrotus edulis*:** collection of the GPS points representing the vertices of the area affected by the colonies/mats of *Carpobrotus edulis* in order to produce polygonal geometries and subsequently calculate the area through software.
- **Extension of the monitoring linear transepts:** GPS tracks of the linear transepts, in order to produce linear geometries that will serve to identify in the following years the exact location of the same transepts.

Concerning the information to be included in the table of attributes of the geometries described above, it will be necessary to record the following data:

- **Scientific name of the identified species** (*Carpobrotus edulis*, or in case of finding *Carpobrotus acinaciformis*, or hybrid taxa).
- **Environmental type/habitat affected/or the presence of *Carpobrotus edulis*** (e.g., dune crest or habitat 2260).
- **Extension of populations of *Carpobrotus edulis*** (area).

Table 3: example of attribute table for point geometries referring to individuals/colonies of *Carpobrotus edulis*

ID	Species	Type of environment	Ind/Pop	Area
1	*Carpobrotus edulis*	Habitat 2260	Isolated individual	/
2	*Carpobrotus edulis*	Dune front	Colony	20

6.2.3 Botanical surveys for surveillance monitoring

At this stage, the effectiveness of the eradication/containment techniques used after monitoring the evolution of plant communities in the area should be assessed. For this task it is required to have a staff with a high level of training in the field of botany able to identify the plant species present in the detection area and able to carry out a botanical analysis, albeit not extremely detailed. The operator must at least be able to identify the habitats included in Directive 92/43/EEC. It is recommended for phytosociological analyses the use of the Braun-Blanquet method, widely used in botanical studies and therefore easily correlated with other phytosociological associations already described in the relevant bibliography. This method involves the following logical steps:

- **Identification of an elementary population:** By elementary population we mean a stretch of vegetation homogeneous in terms of flora, physiognomy and structure. To determine the amplitude of the elementary population, in order to maximise the effort/sampling ratio, tabulated standard size classes divided by vegetation type shall be used. In our case, the elementary population must be represented by an area where the cover of *Carpobrotus edulis* is representative of the detection site. Populations of the hottentot figs can be found both in the dune environment, for which there is estimated an elementary population of 10-20 m^2, and in shrubby environments, where the size of the elementary population usually cover 25-100 m^2. In order to facilitate the aggregation of data, it is therefore optimal to use elementary population of 25 m^2, in order to fall within the range of the type of vegetation with the largest elementary population without exceeding the sampling of the one with the smallest one. In order to minimise the edge effect, it is recommended that the sampling is carried out on square plots with a size of 5 m per side, where possible. The elementary population shall be defined for each detection site and shall be made permanent for monitoring in the same areas in subsequent years. Therefore, it is recommended to materialize *in situ* the detection area, for example by placing metal or wood stakes at each vertex of the area suitably painted with showy colours to allow easier detection in subsequent years.
- **Realization of an inventory of all the present species (floristic list):** the operator must be able to recognize at sight the present species or to take samples to be identified subsequently in the laboratory with the help of a stereoscopic microscope and identification keys. In order to facilitate the identification of species, it is recommended that such surveys will be carried out in spring, when most species have diagnostic characteristics such as flowers and fruits. On the other hand, it is strongly discouraged to carry out sampling in winter, when the annual species may be totally absent.
- **Estimation of vegetation cover:** The operator shall make an estimate of vegetation cover for each identified species. This must be done for each layer of vegetation. Layer means a range of heights over which to assess plant species coverage as described in Table 4.

Table 4: vegetation layers.

Layer n.	Height
7	> 25 m
6	12 - 25 m
5	5 - 12 m
4	2 - 5 m
3	0,5 - 2 m
2	25 - 50 cm
1	0 - 25 cm

As regards to vegetation coverage, cover classes are defined in Table 5.

Table 5: Braun-Blanquet coverage classes.

Coverage classes	Rates
5	75-100%
4	50-75%
3	25-50%
2	5-25%
1	1-5%
+	< 1%

Information on the reproductive phenology of the plant according to the Marcello Scale (see Table 6) and the shape of the plant species according to Table 7 must also be reported.

Table 6: phenological symbols and description (Marcello Scale).

Phenological symbol	Description
000	Absence of the phenom.
+00	Onset of the phenom.
++0	Progress of the phenom.
+++	Peak of the phenom.
0++	Decline in the phenom.
00+	Phenom. at the end
000	Phenom. ended

Table 7: Form and description abbreviations.

Form	Description
W	Woods
L	Lianas
AL	Woody shrubs
E	Epiphytes
H	Herbs

The vegetation surveys must be carried out before and after the eradication phase and at the same sites, in order to identify the situation at the beginning of the survey and then annually, in order to observe the possible recovery of native vegetation or conversely the recolonization of *Carpobrotus edulis*.

In addition to vegetation analysis, surveillance monitoring shall also include visual monitoring of the previously mapped area according to the protocol described in paragraph 6.2.1. This monitoring protocol aims at individuating the presence of the species belonging to the genus *Carpobrotus*.

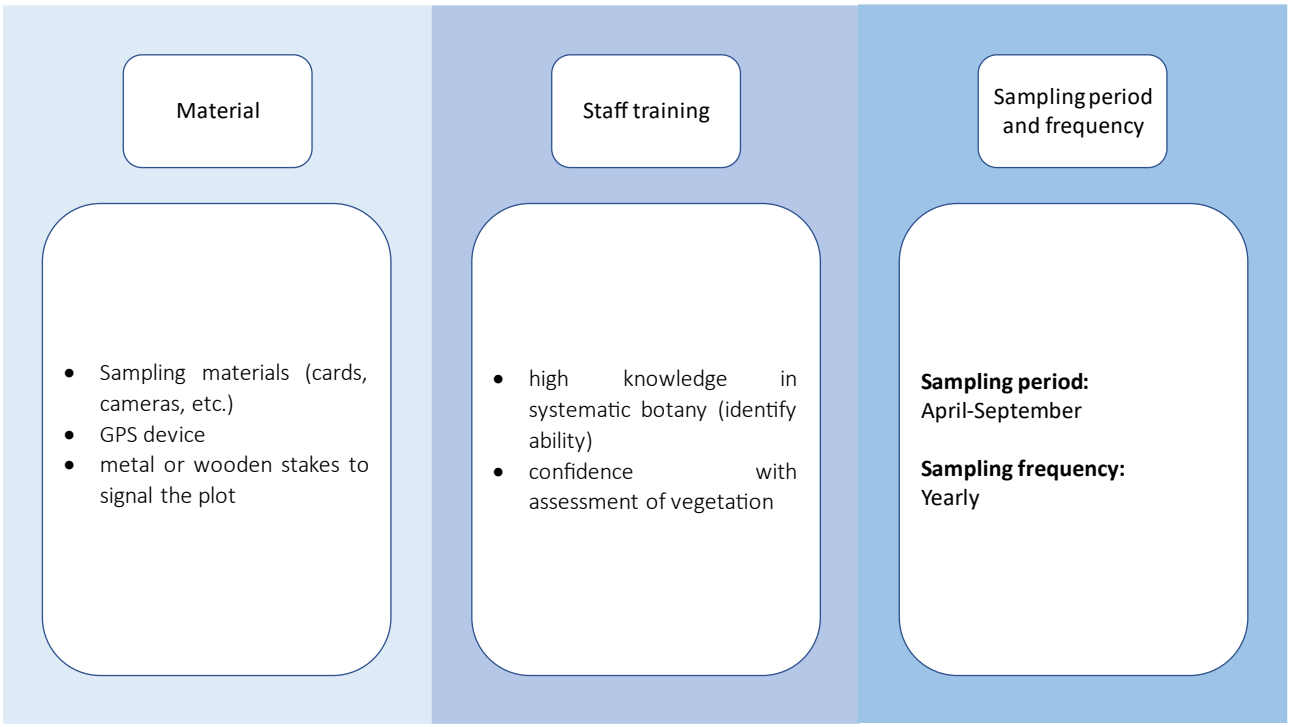


Figure 18: basic information for carrying out botanical surveys.

6.2.4 Period, frequency of monitoring and intensity of monitoring

Mapping of areas with the presence of *Carpobrotus edulis*

- *MONITORING PERIOD* - The period of identification and mapping of areas in Carpobrotus edulis should take place in the months from November to September (see par. 6.5 on the monitoring time structure), a period established taking into account the ecological needs of the other subsequent phases, which will not overlap for organizational issues.
- *MONITORING FREQUENCY* - The monitoring actions include the development of activities over the period of 11 months, divided into a first phase of identification and mapping of areas with the presence of Carpobrotus edulis of 5 months (November-March) and a second phase of calculation of these areas

(November-September). The monitoring frequency will be functional to the number of transepts, which will be monitored completely in the months from November to September.

- *MONITORING INTENSITY* - For each of the monitoring areas identified in par. 6.2.1 the following numbers of transects are identified:
    - A linear transept inside parallel to the coastline - 1 transept for a total of 8.6 km.
    - Linear transepts within natural backwater areas 50 m - 26 transects for a total of 9.9 km.
    - Linear transepts within semi-natural backwater areas 100 m - 8 transects for a total of 5.3 km.
    - Linear transepts within the existing path – 22 transepts for a total of 6.4 km

Summing up, there will be 57 transepts for a total of 30.2 km to be covered over a period of 5 months from November to March, while the following months from April to September will be needed to complete the mapping of these areas and to carry out the coverage calculations.

Botanical surveys for surveillance monitoring

- *MONITORING PERIOD* - The period for carrying out botanical surveys for surveillance monitoring will take place from April to September (see par. 6.5 on the monitoring time structure).
- *FREQUENCY OF MONITORING* – the monitoring actions include the development of the activities along the period of 6 months, from April to September, when the surveys of elementary populations, the floristic lists and the percentages of botanical coverages will be carried out. The operations will take place in the periods following the eradication activities, on an annual basis.
- *INTENSITY OF MONITORING* - The intensity of monitoring will be defined only after identifying the areas with the presence of *Carpobrotus edulis* and after removing the individuals present.

6.2.5 Data collection by sampling form

Concerning the calculation of the cover of *Carpobrotus edulis* and of the native species, in order to realize an accurate inventory of their presence and of the influence of the former on the native flora, the "Monitoring Protocol" sampling card, available in Annex B, must contain the following information:

General information

- **Detection number**: sequential relief number of each station
- **Operator:** operator/s/s name
- **Date**
- **Coordinates**
- **Altitude**
- **Steepness**: steepness of the ground
- **Geological substrate**
- **GPS track name**

Related data about *Carpobrotus edulis*

- **Coverage percentage:** vegetation coverage as a percentage of the area perimeter
- **Average height cm:** average height in cm of plants of the species
- **Phenology:** reproductive phenology of the plant: 0 absent, + in bloom, ++ in fruit
- **Notes**

Related data on native plant species

- **Coverage percentage:** vegetation coverage as a percentage of the area perimeter
- **Average height cm:** average height in cm of plants of the species
- **Notes**
- **Photo number:** number of photos taken in the survey station
- **Station design:** recommended especially in the presence of clusters of *Carpobrotus edulis*

With regard to vegetation surveys for surveillance monitoring, the operator shall note all data on the appropriate "Vegetation Record Sheet", available in Annex C, which shall contain the following information:

General information

- **Detection number:** sequential relief number of each station
- **Operator:** operator/s name
- **Date**
- **Coordinates**
- **Altitude**
- **Inclination:** inclination of the ground
- **Geological substrate**
- **Formation of vegetation**
- **Botanical series**
- **Governance and treatment:** Governance and vegetation treatment (including activities related to management methods)
- **Detection method**: if alternative methods to the Braun-Blanquet method are used
- **Area sqm**
- **Total coverage**

Data for each layer

- **Coverage percentage**
- **Average height**
- **Notes**

Data for each plant species for each layer

- **F:** shape
- **Clas. Cov:** coverage class
- **Cov. percentage:** percentage coverage
- **Phenolog:** phenological symbol
- **Notes**

6.3 Eventual risks

The risks associated with the monitoring phase are mainly related to the disturbance caused by the operators during the research steps of the nuclei of *Carpobrotus edulis* towards the local fauna, mostly concerning the populations of nesting birds. The most important and sensitive species from a conservation point of view are represented by the Kentish plover (*Charadrius alexandrinus*), the little ringed plover (*Charadrius dubius*), the greater short-toed lark (*Calandrella brachydactyla*), the tawny pipit (*Anthus campestris*) and the European nightjar (*Caprimulgus europaeus*). The monitoring phase during winter will ensure that the actions do not overlap with the nesting period of the aforementioned species, for which maximum precautions are recommended in the most sensitive areas. As regards to the botanical surveys, however, it is appropriate that they occur during the spring season, in order to allow a correct identification of the plant species. Therefore, it is necessary to make sure that there is no presence of nesting individuals, especially of Kentish plover. This species is very mimetic and nests directly on the sand on the dune front, on the back dune or in brackish lagoons. The nests of this bird are very difficult to identify, due to the absence of ornamentations or protections and the strongly mimetic colouration of the eggs. In order to recognize the presence of the nest it is necessary to pay attention to the presence of adults, which may attract the attention either with sounds of alarm and small flights, or with the typical limping displacement. The adult, infact, to remove a possible predator from the nest, can pretend to be injured and therefore an easy prey, and then return to the nest once it has reached a safe distance. In case of sighting of these signals or in general of adult individuals near the plot, the monitoring of the station must be suspended throughout the season.

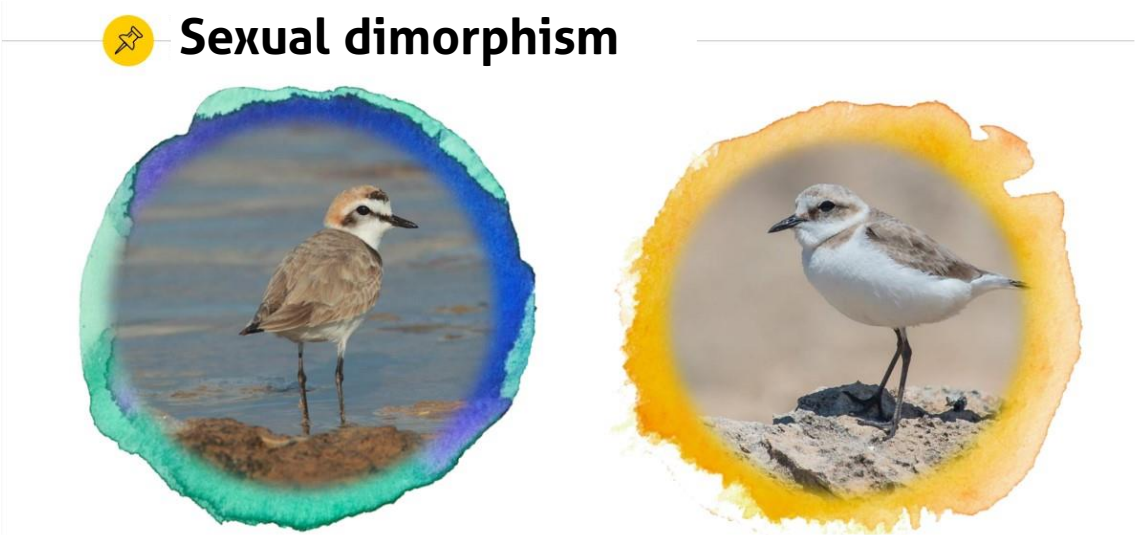


Figure 19: appearance of an adult male Kentish plover (right) and female (left). (LIFE *Choose Nature*)

Figure 20: appearance of nests and eggs of Kentish plover (LIFE *Choose Nature*)

It is also important to remember to be careful not to trample over the dune vegetation, therefore the prohibition of the use of vehicles of any kind during the operations.

On the other hand, there are no significant risks for the personnel involved, who will only have to be aware of the risks of heat, for which it is recommended not to carry out the activities during the central hours of the day, together with adopting the basic behaviours of proper conduct (abundant amounts of water, sunscreen, protective clothing).

6.4 Evaluation of monitoring outcomes

Being reported directly by the Regional Park, the monitoring plan will produce a map of *Carpobrotus* sp.pl. individuals and colonies both in natural areas and anthropized areas. Having the objective of eradicating the species belonging to this genus, the management protocol should be applied to all areas with the presence of *Carpobrotus* sp.pl., regardless of the consistency of the populations. Following the initiation of management practices in areas where the occurrence in

the wild of the hottentot fig is demonstrated, surveillance monitoring as described in paragraph 6.2.2 shall be implemented prior to and in the years following the management actions. If the outcome of the surveillance monitoring shows a vegetative recolonization of *Carpobrotus* sp.pl, the management actions must be repeated. Communication and awareness-raising actions must also be activated, for both the local population and tourists.

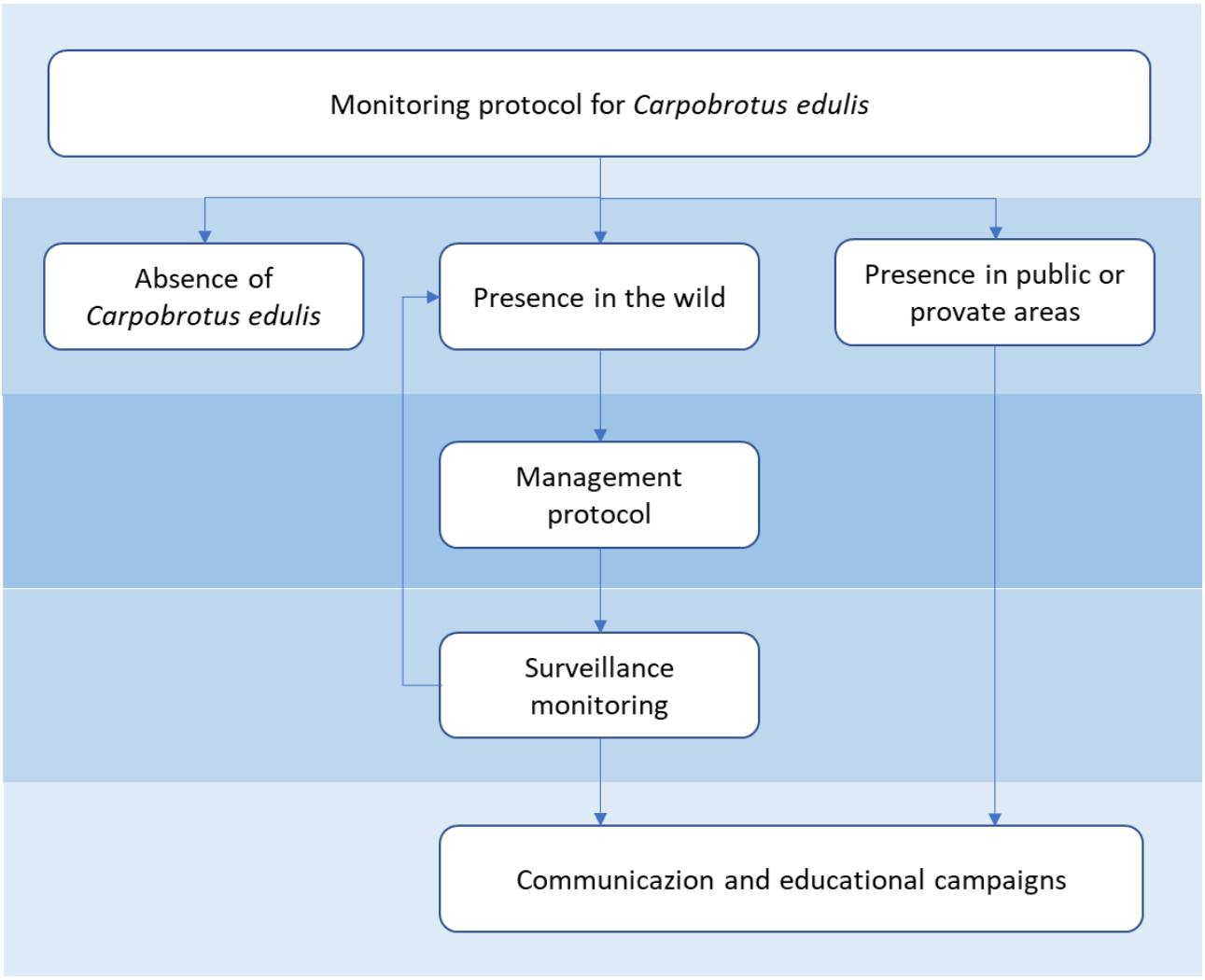


Figure 21: block diagram of evaluation of monitoring outcomes.

6.5 Temporal structure of monitoring actions

The following diagram shows the time sequence in which monitoring has to be carried out for the purposes described above. The monitoring plan will take place in the first year and in the third year of the entire management plan. Concerning the second year, the presence of eradication activities does not allow useful monitoring of the success assessments of the objectives of the plan. Remember that the mapping step of the areas in *Carpobrotus edulis* is not dependent on the solar year, since the plant is easily identifiable throughout the year.

<table>
<tr><td rowspan="5">Year 1</td><td>Months</td><td>Nov</td><td>Dec</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Agu</td><td>Sept</td><td>Oct</td></tr>
<tr><td rowspan="2">Mapping areas</td><td colspan="5">Individuation of Carpobrotus edulis</td><td colspan="7" rowspan="2"></td></tr>
<tr><td colspan="5">mapping</td></tr>
<tr><td rowspan="2">Surveillance monitoring</td><td colspan="7">Coverage calculation</td><td rowspan="2"></td></tr>
<tr><td colspan="7">Elementary population
floristic list
estimate coverage</td></tr>
<tr><td>Evaluation of the monitoring results</td><td colspan="11"></td><td>Evaluation</td></tr>
<tr><td>Field</td><td colspan="5">all areas of the Regional Park</td><td colspan="7">only for interesting areas by the presence of Carpobrotus edulis</td></tr>
<tr><td colspan="13"></td></tr>
<tr><td rowspan="4">Year 3</td><td>Months</td><td>Nov</td><td>Dec</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sept</td><td>Oct</td></tr>
<tr><td>Surveillance monitoring</td><td colspan="7" rowspan="2"></td><td colspan="5">Elementary population
floristic list
estimate coverage</td><td rowspan="2"></td></tr>
<tr><td>Evaluation of the monitoring results</td><td colspan="11"></td><td>Evaluation</td></tr>
<tr><td>Field</td><td colspan="12">Only for areas by the presence of Carpobratus edulis</td></tr>
</table>

Chapter 7. Management plan

7.1 Objective of the management plan

The management of alien species can basically involve two types of action: control or eradication.

The control of an exotic species involves the periodic removal of individuals of this species from a certain territory, without ever leading to its complete absence. This type of action is effective as long as the management activities continue and is therefore recommended for long-term management practices.

The eradication of an exotic species from a territory requires the complete removal of all individuals of that species in a single solution (even several times in time, but still included in a single intervention plan). This type of action usually involves time-limited management activities and is therefore recommended where possible. The main limits to eradication activities consist in the difficulties of realization, both in practical and economic terms; therefore, they can be carried out more easily on limited and isolated territories and are strongly correlated with the biology of the species.

In this case, the coastline of the Regional Natural Park "Dune Costiere da Torre Canne a Torre San Leonardo" is small (about 8 km) and at most 200 m wide. The species of the genus *Carpobrotus* are easy to identify, forming dense mats and having a superficial root system, but have the ability to propagate vegetatively both through fragmentation and through rhizomes. The hottentot fig, despite having problematic invasiveness characteristics, is a species for which is possible to implement an eradication plan, if conducted together with a surveillance monitoring in the medium-long term. This plan is even more desirable, where the presence of the species is incipient and not yet stabilized. In the light of these considerations, the objective of this plan, the eradication of *Carpobrotus edulis* and any congeneric species (e.g. *C. acinaciformis*) from the territory of the Regional Park appears to be achievable.

In relation to the latter species, *C. acinaciformis* is not currently reported for the protected area under consideration, but in case of discovery the same protocol as for the congeneric species is applied. Therefore, the information and considerations expressed in the following paragraphs must also refer to the latter species, if this is documented as present for the area under intervention.

7.2 Phase of eradication

At the end of the application of the Monitoring Plan, the areas with the presence of the hottentot fig will be identified and mapped inside the territory of the Park. Public and private areas used for housing, public and cultivated parks for which no authorisation for access has been granted shall be excluded from this map. The plan provides for the following protocol:

- **Complete removal of the individuals of *Carpobrotus edulis* and the litter:** in order to completely remove the individuals of *Carpobrotus* sp.pl. it is necessary to implement procedures that remove the whole plant, as the ability of vegetative reproduction by means of rhizomes allows the individuals to regenerate from the roots even after the loss of the aerial part. The use of shredders is not recommended, as even if they facilitate operations in terms of timing, they release small fragments that can vegetate later. Manual or light gardening

tools are optimal. These tools consist of protective equipment (gloves, glasses, reinforced clothing) and tools for cutting and excavating (shovels, shears, rakes). Even in this case, the excavation of the soil must be limited in order not to damage the native flora and habitats. In these procedures, it is necessary to limit the reduction of the plant in medium-small parts to avoid accidental dispersion. In areas where the hottentot fig is not present mixed with native vegetation, that is, where it appears almost totally covering, it is also appropriate to remove the litter or the surface layer of the soil where plant fragments or seeds may accumulate. This layer, not easily detectable on sandy soils is rather superficial and consists of a few centimetres. It is therefore recommended not to deepen the excavation where the soil is compact or in any case never exceed 5 cm.

- Drying of the removed material of *Carpobrotus edulis*: the previously removed material should be placed on highly resistant sheeting. Due to the meteorological phenomena that may affect the dune area, such as strong wind and storms, which can disperse light fragments of the species, an appropriate storage area must be located outside this environment. In any case, any even temporary storage area of parts of *Carpobrotus edulis* must be provided with tarpaulins or other waterproofing surface, such as cemented soil, which prevents a possible rooting on the ground. The accumulated material should be dried in the sun for several weeks until it becomes parchment-like. As a control method, it is possible to make test cuts to observe that no residual moisture is present inside the leaves, which would determine the possibility of vegetative recovery of the plant. The material should be laid out as much as possible in such a way that the different parts are not dried separately. In any case, the tarp or the cemented soil must be large enough to have a distance of safety along the edge with no plant material, to avoid the accidental dispersion of the material due to the wind.
- Burn-off of the dried material of *Carpobrotus edulis*: the previously dried material must be subjected to burning. In order to improve the efficiency of combustion material such as bushes or dry wood can be added. Usually, for a complete combustion, more burning procedures are necessary on the same pile. Such combustion, in accordance with the L.R. n 38/2016 "Regulations on fighting forest fires and interface", must not take place in the period between 1 June and 30 September, and must not be performed in windy days or with excessive heat. In addition, the extract of Article 4 of the same regional law is reported:
  "*In protected natural areas and in* "Natura 2000" *sites, stubble and plant residues resulting from agricultural forestry activities shall not be burned and shall be chipped/chopped on site. In the protected natural areas and in the* "Natura 2000" *sites, in order to contain the spread of weeds with consequent dissemination and increase of the infestation load of pathogens present on the residues of the finished crop and the infestation load, after certification by the Regional Phytosanitary Observatory Section, or in obvious conditions of impossibility to carry out other types of destruction, subject to certification by the Section for Sustainable Management and Protection of Forest and Natural Resources, the owner, holder or holder of any title of land may ignite and burn the stubble and plant residues by way of derogation from the cross-compliance procedure and the requirements laid down in Article 3.".*
  According to what has just been reported, since the hottentot fig is an allochthonous plant species, the plant residues can be toasted even if in a protected natural area, after certification by the Regional Phytosanitary Observatory Section. It is specified that this material does not in itself represent solid urban waste (S.U.W.), and therefore its management does not fall within the scope of the waste legislation unless specified otherwise. The material may be sent to landfill for incineration, if it is not possible or economically feasible to incinerate in designated areas: its management can in this case be assimilated to that of the cuttings of the public green one not destined to composting or similar procedures of recycling/reuse.

It is also recommended during each phase of the management plan to limit the use of vechicles in order to avoid the accidental transport of plant material that could colonize other areas. Every operation of loading, unloading, transport of plant material must be carried out with the utmost care to avoid the dispersion of even small fragments. It is also recommended not to use mechanical means on the coast, in order not to damage the local flora or impact the sandy coast. The material removed can be transported by wheelbarrows or manually to the back dune and only then with the use of vechicles. The recommended period for carrying out the management plan procedures is from December to April. This period is optimal because there are probably no ripening fruits, which therefore cannot be used as a source of food by the local fauna in the storage sites, and because it allows to finish the work on the dunes in February, when the breeding season of the kentish plover is not yet active, in order not to cause disturbance this sensitive species, as well as other avifauna of conservation interest.

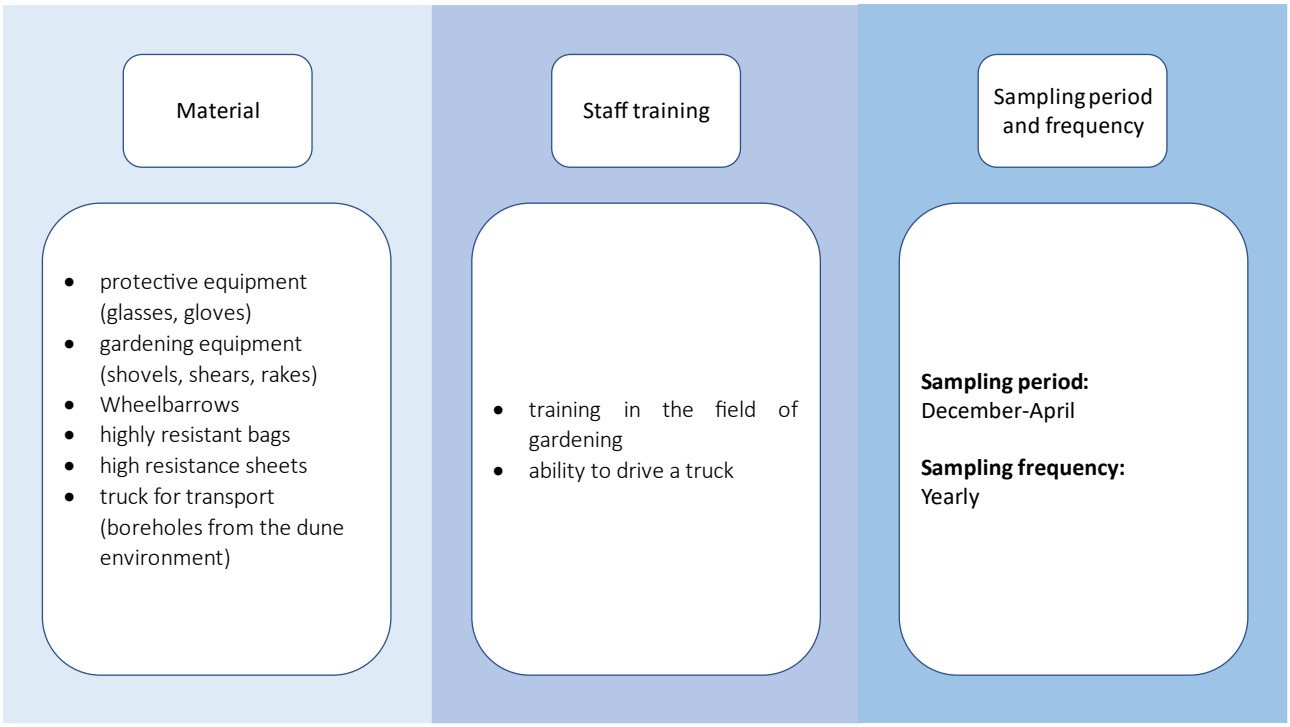


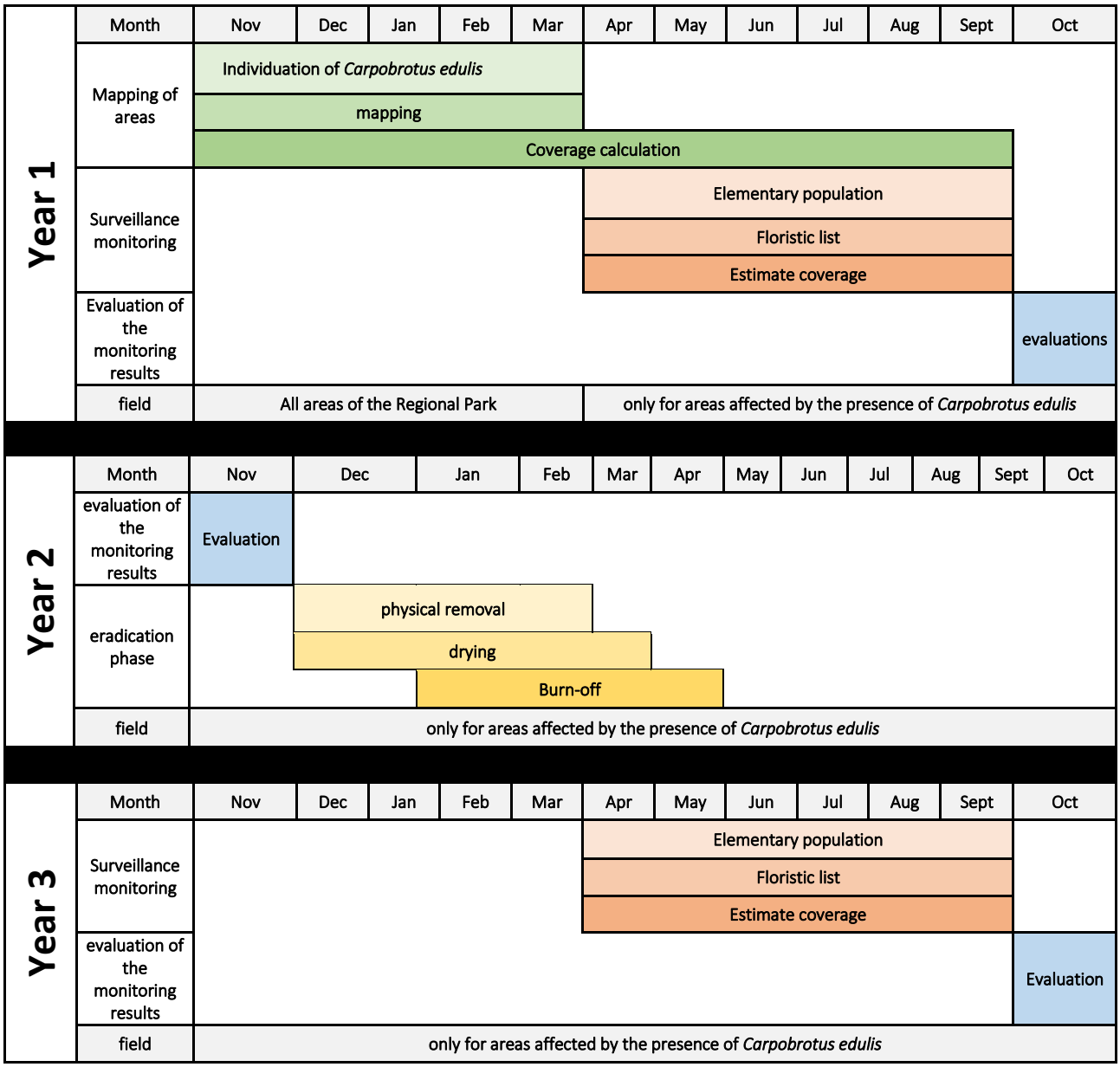
Figure 22: key information on the implementation of the Management Plan.

7.3 Temporal structure of the eradication plan

The following diagram shows the time sequence in which the stages of the eradication campaign must be carried out for the purposes described above, in association with the previous evaluation phase of the monitoring results. This phase take place for the duration of 5 months, in order not to have to make burnings in the summer season in accordance with regional legislation. The eradication phase is scheduled for the second year of the entire plan and is consequently linked to the mapping phase scheduled for the first year. Such schematization represents a structured calendar on a frequency of activity on a monthly basis.

	Month	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct
Year 2	evaluation of the monitoring results	Evaluation											
	eradication phase		physical removal										
			drying										
				Burn-off									
	field	only for areas affected by the presence of *Carpobrotus edulis*											

It is also reported that the timing of the eradication steps should be respected even if, at the end of each year, based on the results of the final evaluation phase of the monitoring plan (see the relevant paragraph for more details), the need to continue with the eradication plan also for the following year will be assessed (see paragraphs below). The time scale of the entire management plan, including the monitoring and eradication phases, shall spread over 36 months. By overlapping the monitoring phase (including also the surveillance monitoring activities) with the eradication phase, the timing of the activities can be summarized through the following Gantt diagram:



7.4 Disposal of waste plant material

As already defined in paragraph 7.2, the material resulting from the eradication activities does not represent itself solid urban waste (S.U.W.) and therefore its management does not fall within the waste discipline unless otherwise specified. The material may be sent to landfill for incineration, if it is not possible or economically feasible to incinerate in designated areas: its management can in this case be assimilated to that of the cuttings of the public green one not destined to composting or similar procedures of recycling/reuse.

7.5 Staff employed

The implementation of this management plan requires the presence of an appropriately trained technical and operational staff, who can carry out the functions of coordination, control and performance of activities on the ground.

7.5.1 Coordination team

The first phase will be the technical-operational coordination regarding the organization of work, the timing of activities, the acquisition and management of equipment and support for field activities, both for the monitoring plan and eradication actions. We recommend a staff of at least two people, whose main tasks can be summarized below:

- Planning the detailed calendar of activities.
- Research and organization of staff involved during the operational phase (see next paragraph).
- Identification of monitoring transepts.
- Equipment set-up and retrieval (GPS, field equipment, etc.).
- Collection, analysis and organization of the collected data; mapping of the areas in *Carpobrotus edulis.*

7.5.2 Operations team

In this second phase, the staff involved will have the main task of dealing with the operational phase in the field, both for monitoring and eradication.

Monitoring phase

For the monitoring phase, consisting of the mapping activities of the areas at *Carpobrotus edulis* and the botanical surveys, operators must have a high level of training in the field of botany, in order to identify the plant species located in the detection area and capable of carrying out a botanical analysis, albeit not extremely detailed.

For the identification part of *Carpobrotus edulis*, assuming that it can carry out about 10 km of linear transepts per day, for a total of 30.2 linear transepts, it can be estimated a number of working days equal to 3, executable by an appropriately trained single operator, as specified above. The same operator will then have the role, in the following months, to carry out the mapping and the calculation of the coverage of the areas occupied by *Carpobrotus edulis*.

The intensity of the botanical surveys, to be carried out over a period of 6 months, from April to September, will have to be calibrated on the basis of the results of the eradication campaign; therefore, an exhaustive quantification is currently not calculable. However, by means of a conservative estimate, it is possible to predict that an individual operator will carry out two phytosociological surveys for each working day, information from which to calculate the number of actual working days after becoming aware of the areas to be investigated.

Eradication phase

During the eradication phase, a specialized group of operators will be involved in the removal of the stands of *Carpobrotus edulis* from the dunes and from the areas behind, for which special skills will be needed in the field of gardening. For the eradication phase, there is a team of min. 2 operators employed in manual removal activities, in which all operators will be involved using gardening tools, and subsequently of collection and transport of plant material.

The same operators involved in the eradication phase will then have to take care of the deposit of the removed material, in its drying and in the subsequent disposal by landfill and/or by burning.

NB - The distinction between the coordination team and the operations team is a functional division of roles, which does not affect the possibility that the same operators carry out both functions.

7.6 Estimates of implementation costs

This paragraph provides estimates of implementation costs, broken down by year and by operational phase, which refer to the modalities described in the previous paragraphs. Rates and estimated costs are based on median values derived from market analysis, so they can vary from real costs. The estimates include the costs of the operators, the costs related to the use of means and the cost of the material to be purchased.

The effort needed to carry out the eradication phase of *Carpobrotus edulis*, and the surveillance monitoring phase is closely linked to the results derived from the identification and mapping of the specimens of *Carpobrotus edulis*, therefore also the implementation costs are variable. The table shows the estimated maximum and minimum costs, taking into account this variability.

	Team	type of work	Cost of operators (per day)	Mean cost (per day)	cost per day	Maximum days	Minimum days	Estimated maximum expenditure	Estimated minimum expenditure
year 1	coordination team	Coordination	500 €	/	500 €	20	20	10.000 €	10.000 €
							TOT. TEAM	**10.000 €**	**10.000 €**
	operations team	mapping of areas	600 €	/	600 €	3	3	1.800 €	1.800 €
	operations team	surveillance monitoring	1.200 €	/	1.200 €	15	10	18.000 €	12.000 €
	operations team	material expenditure	/	/	/	/	/	100 €	100 €
							TOT. TEAM	**19.900 €**	**13.900 €**
							TOT. ANNUAL	**29.900 €**	**23.900 €**
	Team	**type of work**	**Cost of operators (per day)**	**Mean cost (per day)**	**cost per day**	**Maximum days**	**Minimum days**	**Estimated maximum expenditure**	**Estimated minimum expenditure**
year 2	coordination team	Coordination	500 €	/	500 €	10	10	5.000 €	5.000 €
							TOT. TEAM	**5.000 €**	**5.000 €**
	operations team	eradication phase	200 €	700 €	900 €	30	20	27.000 €	18.000 €
	operations team	material expenditure	/	/	/	/	/	800 €	800 €
							TOT. TEAM	**27.800 €**	**18.800 €**
							TOT. ANNUAL	**32.800 €**	**23.800 €**
	Team	**type of work**	**Cost of operators (per day)**	**Mean cost (per day)**	**cost per day**	**Maximum days**	**Minimum days**	**Estimated maximum expenditure**	**Estimated minimum expenditure**
year 3	coordination team	Coordination	500 €	/	500 €	10	10	5.000 €	5.000 €
							TOT. TEAM	**5.000 €**	**5.000 €**
	operations team	surveillance monitoring	1.200 €	/	1.200 €	15	10	18.000 €	12.000 €
							TOT. TEAM	**18.000 €**	**12.000 €**
							TOT. ANNUAL	**23.000 €**	**17.000 €**
							TOT. PROJECT	**85.700 €**	**64.700 €**

7.7 Eventual risks

Similarly to the monitoring phase, the risks related to the eradication phase are mainly linked to the disturbance caused by the operators during the research phases of the nuclei of *Carpobrotus edulis* with regard to the local fauna, whose main target is the populations of nesting birds, whose most important and sensitive species from a conservation point of view are represented by the Kentish plover (*Charadrius alexandrinus*), the little ringed plover (*Charadrius dubius*), the greater short-toed lark (*Calandrella brachydactyla*), the tawny pipit (*Anthus campestris*) and the European nightjar (*Caprimulgus europaeus*). The monitoring phase during the winter phase will ensure that the species do not overlap with the nesting period of the aforementioned species, for which maximum precautions are recommended in the most sensitive areas.

The native dune vegetation must be protected during the eradication activities. Therefore, the removal of the hottentot fig must take place in the most precise way possible avoiding damage and removal of local species. In particular, maximum attention must be paid to herbaceous, annual or perennial plants of the psammophilous environment, which usually have a slow growth and which constitute important species for the recovery of the dunal ecosystem. As for shrubs or tree species such as individuals of *Juniperus* sp.pl. or Mediterranean sclerophylls, it is recommended to avoid cuts or damage. In fact, although small cuts do not affect the health of these plants, the shading below the foliage is an important deterrent for the recovery of *Carpobrotus edulis*. Also, with regard to the collection and movement of the collected material, it is recommended to avoid trampling of the dune vegetation, using where possible the existing path, as well as reaffirming the ban on the use of motor vehicles or similar on the dune environment.

On the other hand, there are no significant risks for the personnel involved, who will only have to beware of the risks of heat, because of which is recommended not to carry out the activities during the central hours of the day, in addition to adopting the basic behaviours of proper conduct (abundant amounts of water, sunscreen, protective clothing). The period of activity, related to the winter and spring months, limits the possibility of days when insolation may be problematic.

7.8 Monitoring the progress of the intervention and future actions

The protocol of the management plan, if correctly applied, should provide for the removal of all individuals of *Carpobrotus* sp.pl from the Regional Park. It is however possible that the species recolonize the area as a result of dispersion by seed or by vegetative propagation by fragmentation or by rhizoids. Therefore, it is necessary to draw up a surveillance monitoring plan as described in paragraph 6.2.2. In fact, the sites where the presence of the hottentot fig was found must be analysed annually, both to evaluate the recovery of the native vegetation, the ultimate end of the operations, and to observe the presence of a possible recolonization. In case the vegetative growth of *Carpobrotus edulis* is observed, it is necessary to carry out the actions foreseen by the Management Plan. These actions must be carried out quickly, both to avoid a more widespread colonization of the species and to reduce the operational costs of management.

The monitoring of the vegetation by means of floristic surveys must continue at least until the species *Carpobrotus edulis*, or other congeneric species, are present in the station for three consecutive years. It is specified that by station, we mean the whole area included in the perimeter identified during the monitoring phase and not only the plot dedicated to botanical analysis.

It is possible, in any case, that we observe the receival of occasional reports of the presence of *Carpobrotus edulis*, not individuated during the monitoring plan or due to a growth after the development of the entire plan. In this case, ad hoc activities, similar to those described in paragraph 6.2 (mapping, vegetation analysis) and paragraph 7.2 (management actions) shall be provided.

These actions must be related to prevention and communication strategies described below (Chapter 8).

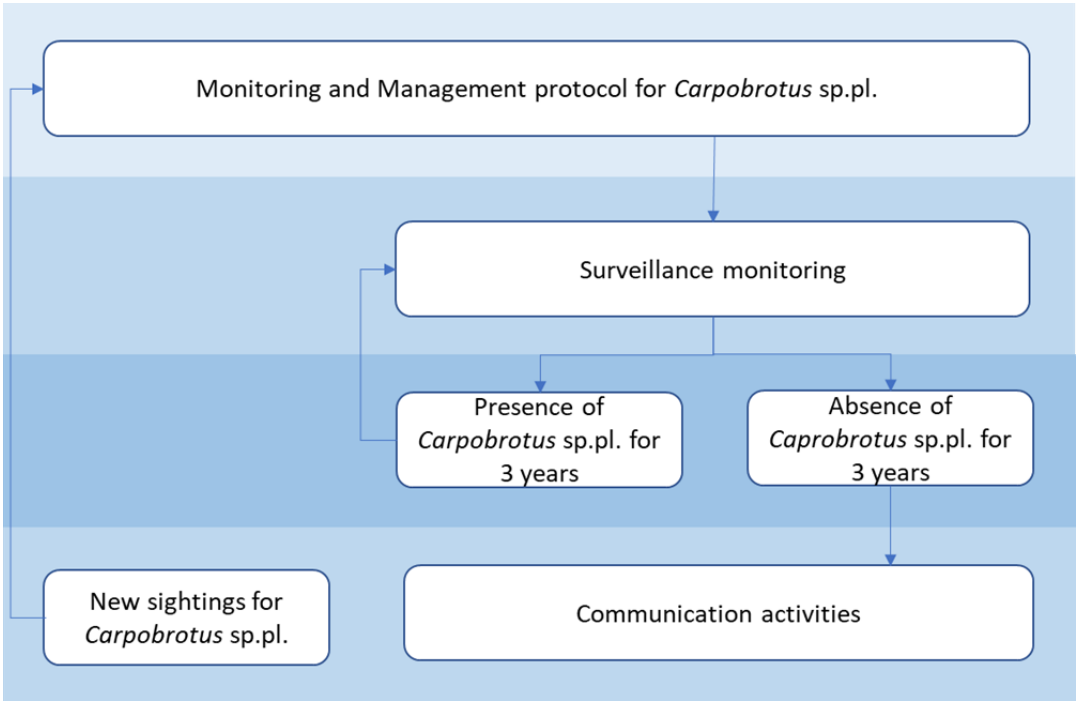


Figure 23: block diagram of future actions.

Chapter 8. Prevention strategies and communication

These chapter contains the main guidelines concerning prevention and communication strategies to adopt for the management of *Carpobrotus* species. The strategy is divided in three steps: Pre-Monitoring plan, Pre-Management plan and post-Management Plan.

- pre-Monitoring Plan step: communication is mainly dedicated to the Regional Park stakeholders, especially to the staff of the Regional Natural Park "Dune Costiere da Torre Canne a Torre San Leonardo". Secondarily, the local municipalities and the privates who manage the properties of the targeted areas must be taken in account, to get the proper permissions to proceed. In order to do so, specific informative and non-technical material must be produced, with the organization of dedicated roundtables to allow a correct flow of information.
- pre-Management Plan: in this step, citizenship and authorities must be informed about the operative procedures of the Plan, through meetings, seminars and conferences aiming at informing the people about IAS (with a focus on *Carpobrotus* sp.pl.) and their threats to biodiversity and economy. Particular attention must be dedicated to the trade of exotic plant species, for ornamental and/or commercial purposes, together with communicating the conservational value of the Park and in general to the fragility of insular ecosystems. Specific signs/billboards must be placed close to the areas of intervention, explaining the purposes of the Plan, the issues related with *Carpobrotus* sp.pl. and the species and the habitats threatened by its presence. All the material must be produced both in Italian and in English.

  Internet and more specifically the social platforms can be used, as a practical tool to quickly spread the information about the project.
- post-Management Plan: this step is focused con communicating the outcomes of the management activities, through the production of reports which will be provided to the stakeholders. The results must be communicated to the citizenship as well, through specific meetings/seminars/conferences.

  Special attention will be given to the future actions and to the prevention strategies aiming at avoiding new colonization processes in the Regional Park, including citizen science projects involving the collaboration of the local population.

Similarly to the previous step, internet and social platforms can play a crucial role in this direction.

Figure 24: example of a final seminar of a project (http://www.lifelagnature.org/).

Finally, specific signs and billboards concerning the proposed activities, the purposes of the project, the description of the threatened species and habitats must be produced, eventually comparing the situation before and after the interventions. Modalities to report new sightings of *Carpobrotus* sp.pl. must be cleared out, as well as the authorities to communicate with.

Table 8: brief description of the main communication activities proposed in the present chapter.

Activity	*Target*	Frequency	Place
Communication seminars	Citizen, tourists	Bimonthly (during summer months)	Park and Municipalities headquarters of Ostuni e Fasano, squares and public areas.
Technical seminars	Researchers	Yearly	Park and Municipalities headquarters, Universities
Coordination roundtables	Municipal staff of Ostuni and Fasano, tourist operators, environmental technicians, coast guard, local police	Quarterly	Municipalities headquarters of Ostuni and Fasano
Activity Report	Citizens, tourist operators, environmental technicians	Yearly (with particular interest for the final report)	Park and Municipalities headquarters, Universities
Websites and social networks	Citizens	Weekly	Social networks of the local public institutions involved in the project
Informative panels	Citizens, tourists	To be set up the first year	Information points, Areas along the coast (focusing on areas close by restaurants or recreational areas)
School activities	Kids, teenagers, teachers	Yearly, estimating 12h for each classroom	Primary and secondary schools.

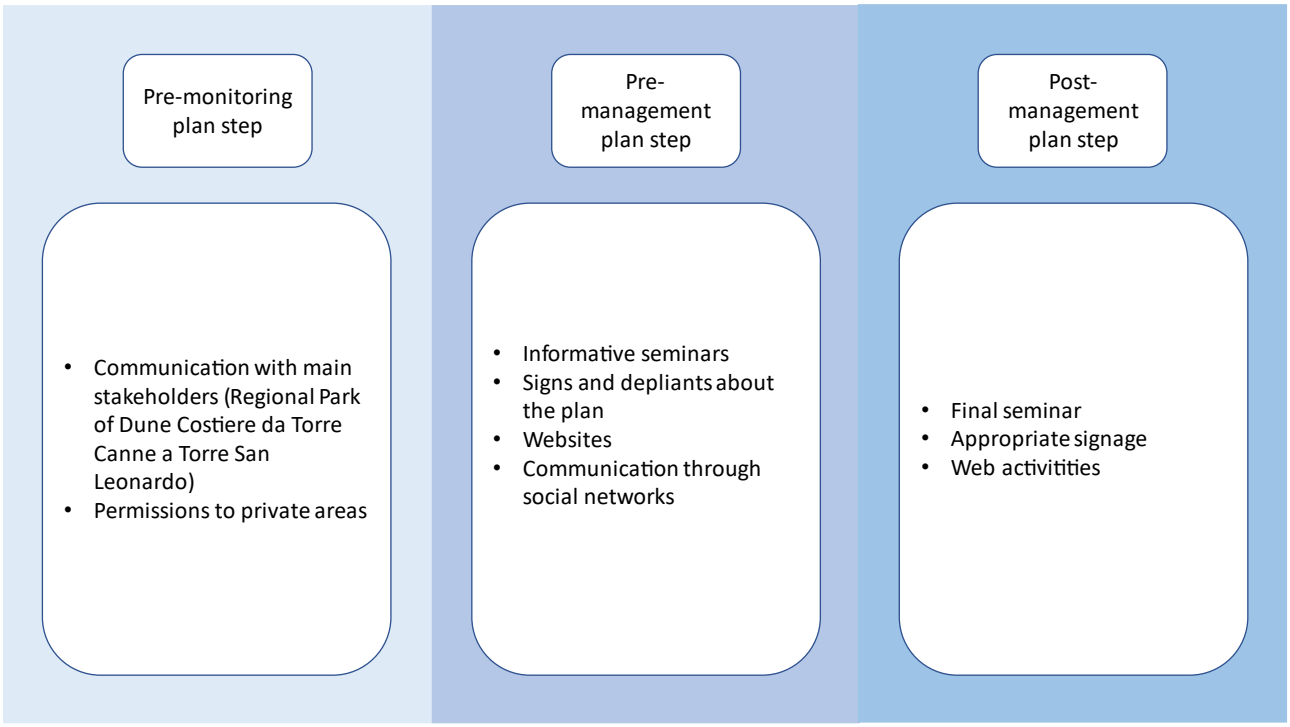


Figure 25: communication and prevention strategies of the different steps of the Plan.

Chapter 9. Conclusions

The application of the Monitoring and Action Plan for the hottentot fig inside the Regional Natural Park "Dune Costiere da Torre Canne a Torre San Leonardo", if conducted in accordance with the prescribed protocols, will provide:

- **Mapping and characterization of areas with presence of *Carpobrotus edulis/C. acinaciformis*:** This step aims at planning with a higher efficiency the management interventions. Mapping allows to selectively monitor the areas more susceptible of being colonized by the hottentot fig after eradication, facilitating the post-management monitoring activities. The main issue is related to the mapping of private areas, requiring specific permissions. This issue can be solved by proper communication activities.
- **Surveillance monitoring to evaluate the change in composition of plant communities:** through the botanical surveys it will be possible to monitor the change in composition of the plant communities, from the beginning of the project until the following years. This step also aims at individuating new colonies by *Carpobrotus* sp.pl. in the previously mapped areas. The main issue is related to finding highly trained technical staff, which can be solved by eventually hiring external staff.
- **Eradication of all individuals of *Carpobrotus edulis/C. acinaciformis*:** Through the manual removal of the individuals and the underneath litter, desiccation and burning of the removed plants, it will be possible to eradicate *Carpobrotus* sp.pl. from the Park. The management protocol must be respected with the highest attention, in order to avoid that some fragments may reproduce asexually and spread. In addition, particular attention must be given to the native flora, in order not to damage the local biodiversity which represents the best resource for the restoration of an healthy dunal ecosystem.
- **Communication strategies to prevent future recolonization of *Carpobrotus edulis*:** the importance of prevention is fundamental for the good outcomes of the Plan. Proper communication strategies must be adopted to inform the citizenship on IAS and the importance of protecting local species and habitats, specifically on *Carpobrotus* sp.pl. and on flora and fauna of coastal habitats. This step can be carried out through the realization of seminars, depliants, events, websites, social networks and so on, in order to reach private citizens, tourists and more generally the main local stakeholders.

The activities are in accordance with the objectives of the action plan, i.e. eradication, where possible, and control of the hottentot fig on the coastal habitats of Regional Natural Park "Dune Costiere da Torre Canne a Torre San Leonardo". Specifically, continuous activities through time, whereas new individuals will be found in the area, are fundamental in order to avoid negative outcomes in the following years. Surveillance monitoring activities in the most critical areas (where the species has already been observed) aim at ensuring the effectiveness of the Plan in medium-long terms, additionally encouraged by the local citizenship involvement. This method allows to manage spatially restricted *Carpobrotus* sp.pl. populations, saving human and economic resources.

It is finally fundamental to underline how these activities are part of a bigger framework of projects involved in the control of this species both in sandy environments (*Life*+ LAG'Nature, *Life* Enebro, *Life* CalMarSi, *Life* Zone Umide Sipontine) and in rocky environments (es. *Life*+ Montecristo 2010, *Life Puffinus* Tavolara, *Life PonDerat*, *Life LETSGO* Giglio), supporting the necessity of this kind of activities. In addition, the proposed protocols, with specific precautions, may be applied to the management of other IAS, or to different territories. Given the necessity of preserving the dunal

ecosystems, the application of the present plan is particularly adapted for protecting the natural resources at a regional, national and European level.

Chapter 10. References

10.1 Bibliografic References

ANDREU J., MANZANO-PIEDRAS E., BARTOMEUS I., DANA E. D., VILÀ M. 2010. Vegetation response after removal of the invasive *Carpobrotus* hybrid complex in Andalucía, Spain. Ecological Restoration, 28(4), 440-448.

BECCARISI L., GIANNUZZI C. G., D'ANDRIA G., GRECO M. 2020. *Habitat and flora monitoring in the Regional Nature Reserve of "Palude del Conte e duna costiera di Porto Cesareo (Puglia, Italy).* eighth International Symposium "Monitoring of Mediterranean Coastal Areas. Problems and Measurement Techniques". Livorno (Italy)

BECCARISI L., MARINÒ F., MEDAGLI P., ZIZZI T., MINONNE F., 2015. *Inventario della flora vascolare della Riserva Naturale di Torre Guaceto (Puglia)*. Thalassia Salentina, 37.

BENEVANT OLMOS J. M., COLLADO ROSIQUE P., MARTÍ CRESPO R. M., MUNOZ CABALLER A., QUINTANA TRENOR A., SANCHEZ CODONER A., VIZCAINO MATARREDONA A. 2008. *La restauracion de la dunas litorales de l'Albufera de Valencia. LIFE* Enebro.

BOURGEOIS K., VIDAL E., SUEHS C. M., MÉDAIL F. 2004. *Extreme invasional meltdown: multi-trophic interactions catalyse Mediterranean island invasions.* MEDECOS. Ecology, Conservation and Management (eds Arianoutson M, Papanastasis VP), 1-5.

BRACCINI S., FOGGI B., PONTENANI C., BRACCIOTTI S., 2014. *Action Plan Progetto LIFE Montecristo 2010 La tutela dei ginepreti costieri di Pianosa e l'eradicazione di specie esotiche vegetali.*

BRAUN-BLANQUET J., FÜLLER G.D., CONRAD H.S., 1932. *Plant sociology, the study of plant communities*. New York-London: McGraw-Hill.

CARTA L., MANCA M., BRUNDU G., 2004. *Removal of Carpobrotus acinaciformis (L.) L. Bolus from environmental sensitive areas in Sardinia, Italy*. X MEDECOS International Conference, Rhodes, Greece. Millpress, Rotterdam.

CBD, 2000. Decision V/8. *Alien species that threaten ecosystems, habitats or species*. UNEP/CBD/COP/5/8. Secretariat of the Convention on Biological Diversity, Nairobi, Kenya.

CBD, 2002. *Decision VI/23: Alien species that threaten ecosystems, habitats and species.* Document UNEP/CBD/COP/6/23. Secretariat of the Convention on Biological Diversity Montreal, Canada.

CELESTI GRAPOW L., PRETTO F., BRUNDU G., CARLI E., BLASI C. 2010. *Le invasioni di specie vegetali in Italia.* Strategia Nazionale per la Biodiversità.

CHENOT J., AFFRE L., PASSETTI A., BUISSON E., 2014. *Consequences of iceplant (Carpobrotus) invasion on the vegetation and seed bank structure on a Mediterranean island: response elements for their local eradication.* Acta botanica gallica. 161(3). 301-308.

DRIUS M., JONES L., MARZIALETTI F., DE FRANCESCO M. C., STANISCI A., CARRANZA M. L. 2019. Not just a sandy beach. The multi-service value of Mediterranean coastal dunes. Science of the total environment, 668, 1139-1155.

DUMONT G., MAZZACURATI A., 2014. *Carpobrotus, il tappeto della morte*. Acta Succulenta, 3 (1), 29-72.

FORTE L., CAVALLARO V., PANTALEO F., D'AMICO F. S., MACCHIA F. 2002. *The vascular Flora of the "Bosco Isola" at Lesina (Foggia–Apulia).* Flora mediterranea, 12, 33-92.

FORTE L., CAVALLARO V., PANTALEO F., D'AMICO F. S., SIGNORILE G., MACCHIA F. 2005. 3.0 *La Flora vascolare del "Bosco Isola" di Lesina.* Biologia ed Ecologia di Cistus clusii Dunal, 57.

GIUNTI M., 2015. *Il progetto di eradicazione del Carpobrotus a Giannutri.* NEMO srl.

HEYWOOD V. H., BRUNEL S. 2012. *Florovivaismo, verde ornamentale e specie esotiche invasive: codice di comportamento.* Società botanica italiana Onlus.

ISPRA, 2013. *Metodi Biologici per le acque superficiali interne* - Delibera del consiglio federale delle Agenzie ambientali. Seduta del 27 novembre 2013 Doc. n. 38/13GF. pp:234.

KOLAR C. S., LODGE D. M., 2001. *Progress in invasion biology: predicting invaders.* Trends in ecology & evolution, 16(4), 199-204.

LIPU – LIFE CHOOSE NATURE. 2020. Dune. Un ecosistema da proteggere. Il caso del Fratino.

LOWE S., BROWNE M., BOUDJELAS S., DE POORTER M., *100 of the World's Worst Invasive Alien Species - A selection from the Global Invasive Species Database* (PDF), su issg.org, The Invasive Species Specialist Group (ISSG), a specialist group of the Species Survival Commission (SSC) of the World Conservation Union (IUCN), dicembre 2000 (aggiornato novembre 2004).

MARCELLO A., 1935. *Nuovi criteri per le osservazioni fitofenologiche*. N.Giorn. Bot. Ital. 42:543-56.

MINISTERO DELL'AMBIENTE E DELLA TUTELA DEL TERRITORIO E DEL MARE, 2020. *Piano nazionale di gestione del Kudzu (Pueraria montana)*.

MINISTERO DELL'AMBIENTE E DELLA TUTELA DEL TERRITORIO E DEL MARE, 2020. *Piano nazionale per la gestione della testuggine palustre americana (Trachemys scripta).*

MINISTERO DELL'AMBIENTE E DELLA TUTELA DEL TERRITORIO E DEL MARE, 2021. *Piano di gestione nazionale del persico sole (Lepomis gibbosus).*

MIFSUD S. 2021. *Morphology of the invasive Carpobrotus (Aizoaceae) in Europe: Malta as a case study.* Mediterranean Botany, 42.

O'ROURKE E., LYSAGHT L. 2014. *Risk assessment of Carpobrotus edulis*. Inland Fisheries Ireland.

PERFETTI A. (A CURA DI), 2010. *Conservazione degli ecosistemi costieri della Toscana settentrionale 2005-2009*. Ente Parco Regionale MSRM.

PERRINO E. V., SIGNORILE G., MARVULLI M., 2013. *A first checklist of the vascular flora of the Polignano a Mare coast (Apulia, southern Italy)*. Natura Croatica: Periodicum Musei Historiae Naturalis Croatici, 22(2), 295-318.

PERRINO E. V., TOMASELLI V., COSTA R., PAVONE P. 2013. *Conservation status of habitats (Directive 92/43 EEC) of coastal and low hill belts in a Mediterranean biodiversity hot spot (Gargano – Italy).* Plant Biosystems, 147 (4), 1006–1028

PIGNATTI S., 2017. *Flora d'Italia*. Volume secondo. Edagricole.

PROJECT LIFE + LAG'NATURE., 2009. *Méthodes de diagnostic et d'évaluation des actions.*

PROJECT LIFE + LAG'NATURE., 2013. *Guide for lagoons sustanaible management*.

TRICARICO E., LAZZARO L. GIUNTI M., BARTOLINI, F. INGHILESI A. F., BRUNDU G., COGONI A., IIRITI G., LOI M. C., MARIGNANI M., CADDEO A., CARNEVALI L., GENOVESI P., CAROTENUTO L., MONACO A., 2019. *Le specie aliene invasive: come gestirle. Guida tecnica per professionisti*. pp. 92 + Appendice 1 e 2.

WESTHOFF V., VAN DER MAAREL E., 1978. *The Braun-Blanquet approach*. In Classification of plant communities (pp. 287-399). Springer, Dordrecht.

WILLIAMSON M. 1996. *Biological Invasions.* Chapman e Hall, London, UK.

10.2 Consulted websites

Acta Plantarum: https://www.actaplantarum.org/

CABI – Center for Agricolture and Bioscense International: https://www.cabi.org/

Dryades Project: http://dbiodbs.units.it/carso/chiavi_pub00

Gestione risorse naturali e forestali Regione Puglia – specie esotiche invasive: http://foreste.regione.puglia.it/specie-esotiche

Global Biodiversity Information Facilities: https://www.gbif.org/

iNaturalist: https://www.inaturalist.org/

Life Asap: https://lifeasap.eu/index.php/it/

Life CalMarSi https://lifecalmarsi.eu/

Life CSMON: http://www.csmon-life.eu/

Life LETSGO GIGLIO: https://www.lifegogiglio.eu/

Life Puffinus Tavolara: http://www.lifepuffinustavolara.it/

Life Zone Umide Sipontine: http://www.lifezoneumide.it/

Manuale Italiano di interpretazione degli habitat della Direttiva 92/43/CEE: http://vnr.unipg.it/habitat/index.jsp

MapReachter ISPRA – Istituto Superiore per la Protezione e la Ricerca Ambientale: http://geoviewer.nnb.isprambiente.it/

Ministero della Transizione Ecologica – specie esotiche invasive: https://www.mite.gov.it/pagina/specie-esotiche-invasive

Natura 2000 Viewer: https://natura2000.eea.europa.eu/

Project LIFE PonDerat: http://www.ponderat.eu/

Project LIFE + LAG'Nature Ensemble protégeons non lagunes: http://www.lifelagnature.org/

Puglia.con – conoscenza condivisa per il governo del territorio: http://sit.puglia.it/

Annex A - Survey on IAS in the Apulian territory

The following survey is part of the "BEST Project - Addressing joint Agro- and Aqua-Biodiversity pressures Enhancing SuSTainable Rural Development - Interreg Programme V-A Greece-Italy 2014/2020" (www.interregbest.eu), aiming to elaborate a monitoring protocol for evaluating threats to biodiversity caused by the presence of invasive alien species, together with a dedicated action plan for biodiversity conservation. We need to obtain a simple and clear information from the institutions directly involved in managing local flora and fauna about the most-pressing invasive alien species on the territory, ultimately looking for a monitoring protocol for the management of the 5 priority target species.

We are presently asking you a few minutes of your time to answer the following questions.

Full name

Name of the institution

E-mail contact

Which are the terrestrial plant invasive alien species that cause major threats within your territory/protected area? (Write at least one species up to a maximum of 5, or write "not relevant")

Which are the terrestrial animal invasive alien species that cause major threats within your territory/protected area? (Write at least one species up to a maximum of 5, or write "not relevant")

Which are the aquatic plant invasive alien species that cause major threats within your territory/protected area? (Write at least one species up to a maximum of 5, or write "not relevant")

Which are the aquatic animal invasive alien species that cause major threats within your territory/protected area? (Write at least one species up to a maximum of 5, or write "not relevant")

List the biotic and abiotic features (habitats and ecosystems, vulnerable species/populations) most affected by the the species mentioned above.

Define the area where the effects of the alien species take place.

Are there already ongoing monitoring protocols or action plans (eradication/containment) with respect to these species (i.e. LIFE+ Projects)? If available, share the link to the project

Within your territory of competence, are there any prevention programs with respect to future introductions of alien species? If so, which ones? If available, share the link to the program/project

Annex B

Monitoring protocol for *Carpobrotus* sp.pl. inside the Regional Natural Park "Dune Costiere da Torre Canne a Torre San Leonardo"

Site Code…… Operators …… Date……Locality……

Altitude…… Steepness (°)…… geological substrate…… GPS track……

Carpobrotus edulis	Coverage %	Mean height	Presence of young individuals	Phenology	Notes

Carpobrotus acinaciformis	Coverage %	Mean height	Presence of young individuals	Phenology	Notes

Other species	Coverage %	Mean height	Notes

Number of photo
Drawing of the site

Annex C

VEGETATION SURVEY CARD

Site Code…..... Operators ..... Date .....

Locality ….....

Exposition

N	NE	E	SE
S	SW	W	NW

Coordinates.....

Altitude..... Steepness (°) ..... geological substrate .....

vegetational composition.....

vegetational series .....

management .....

survey method. ..... surface sqm .....total coverage……..... %

STRUCTURAL ANALYSIS

Layer n.	**Height**	**Coverage %**	**Medium height m**	**Notes**
7	> 25 m			
6	12 - 25 m			
5	5 - 12 m			
4	2 - 5 m			
3	0,5 - 2 m			
2	25 - 50 cm			
1	0 - 25 cm			

COVERAGE
5 = continuous (> 75 %)
4 = interrupted (50 - 75 %)
3 = sparse (25 - 50 %)
2 = low (5 - 25 %)
1 = sporadic (1 - 5 %)
+ = almost no coverage (< 1 %)

BRAUN-BLANQUET SCALE:
5 = coverage > 75 %)
4 = coverage 50 - 75 %)
3 = coverage 25 - 50 %)
2 = abundant, but with coverage < 25 %)
1 = well represented, but with cov. < 5 %)
+ = present, but with very low coverage

PHENOLOGICAL SYMBOLS (MARCELLO)
000 = absence of the phenomenon
+00 = beginning of the phenomenon
++0 = progression of the phenomenon
+++ = apex of the phenomenon
0++ = decline of the phenomenon
00+ = ending of the phenomenon
000 = ended of the phenomenon

FORM
W = woods
L = lianas
AL = woody shrubs
E = epiphytes
H = herbs
M = bryophytes and lichens

Num.	Floristic composition	Layer	F	Cov. Class	Cov. %	Phenology	Notes
1		7					
		6					
		5					
		4					
		3					
		2					
		1					
2		7					
		6					
		5					
		4					
		3					
		2					
		1					
3		6					
		5					
		4					
		3					
		2					
		1					
4		6					
		5					
		4					
		3					
		2					
		1					
5		6					
		5					
		4					
		3					
		2					
		1					
6		6					
		5					
		4					
		3					
		2					
		1					
7		6					
		5					
		4					
		3					
		2					
		1					
8		5					
		4					
		3					
		2					
		1					

Num.	Floristic composition	Layer	F	Cov. Class	Cov. %	Phenology	Notes
9		5					
		4					
		3					
		2					
		1					
10		5					
		4					
		3					
		2					
		1					
11		5					
		4					
		3					
		2					
		1					
12		5					
		4					
		3					
		2					
		1					
13		5					
		4					
		3					
		2					
		1					
14		5					
		4					
		3					
		2					
		1					
15		5					
		4					
		3					
		2					
		1					
16		5					
		4					
		3					
		2					
		1					
17		5					
		4					
		3					
		2					
		1					
18		4					
		3					
		2					
		1					

Num.	Floristic composition	Layer	F	Cov. Class	Cov. %	Phenology	Notes
19		7					
		6					
		5					
		4					
		3					
		2					
		1					
20		7					
		6					
		5					
		4					
		3					
		2					
		1					
21		6					
		5					
		4					
		3					
		2					
		1					
22		6					
		5					
		4					
		3					
		2					
		1					
23		6					
		5					
		4					
		3					
		2					
		1					
24		6					
		5					
		4					
		3					
		2					
		1					
25		6					
		5					
		4					
		3					
		2					
		1					
26		5					
		4					
		3					
		2					
		1					

Num.	Floristic composition	Layer	F	Cov. Class	Cov. %	Phenology	Notes
27		5					
		4					
		3					
		2					
		1					
28		5					
		4					
		3					
		2					
		1					
29		5					
		4					
		3					
		2					
		1					
30		5					
		4					
		3					
		2					
		1					
31		5					
		4					
		3					
		2					
		1					
32		5					
		4					
		3					
		2					
		1					
33		5					
		4					
		3					
		2					
		1					
34		5					
		4					
		3					
		2					
		1					
35		5					
		4					
		3					
		2					
		1					
36		4					
		3					
		2					
		1					

Num.	Floristic composition	Layer	F	Cov. Class	Cov. %	Phenology	Notes
37		7					
		6					
		5					
		4					
		3					
		2					
		1					
38		7					
		6					
		5					
		4					
		3					
		2					
		1					
39		6					
		5					
		4					
		3					
		2					
		1					
40		6					
		5					
		4					
		3					
		2					
		1					
41		6					
		5					
		4					
		3					
		2					
		1					
42		6					
		5					
		4					
		3					
		2					
		1					
43		6					
		5					
		4					
		3					
		2					
		1					
44		5					
		4					
		3					
		2					
		1					

Num.	Floristic composition	Layer	F	Cov. Class	Cov. %	Phenology	Notes
45		5					
		4					
		3					
		2					
		1					
46		5					
		4					
		3					
		2					
		1					
47		5					
		4					
		3					
		2					
		1					
48		5					
		4					
		3					
		2					
		1					
49		5					
		4					
		3					
		2					
		1					
50		5					
		4					
		3					
		2					
		1					
51		5					
		4					
		3					
		2					
		1					
52		5					
		4					
		3					
		2					
		1					
53		5					
		4					
		3					
		2					
		1					
54		4					
		3					
		2					
		1					