

**B E S T
PRACTICE
G U I D E**

to Manage Vegetation
and Promote Biodiversity
in Linear Infrastructures





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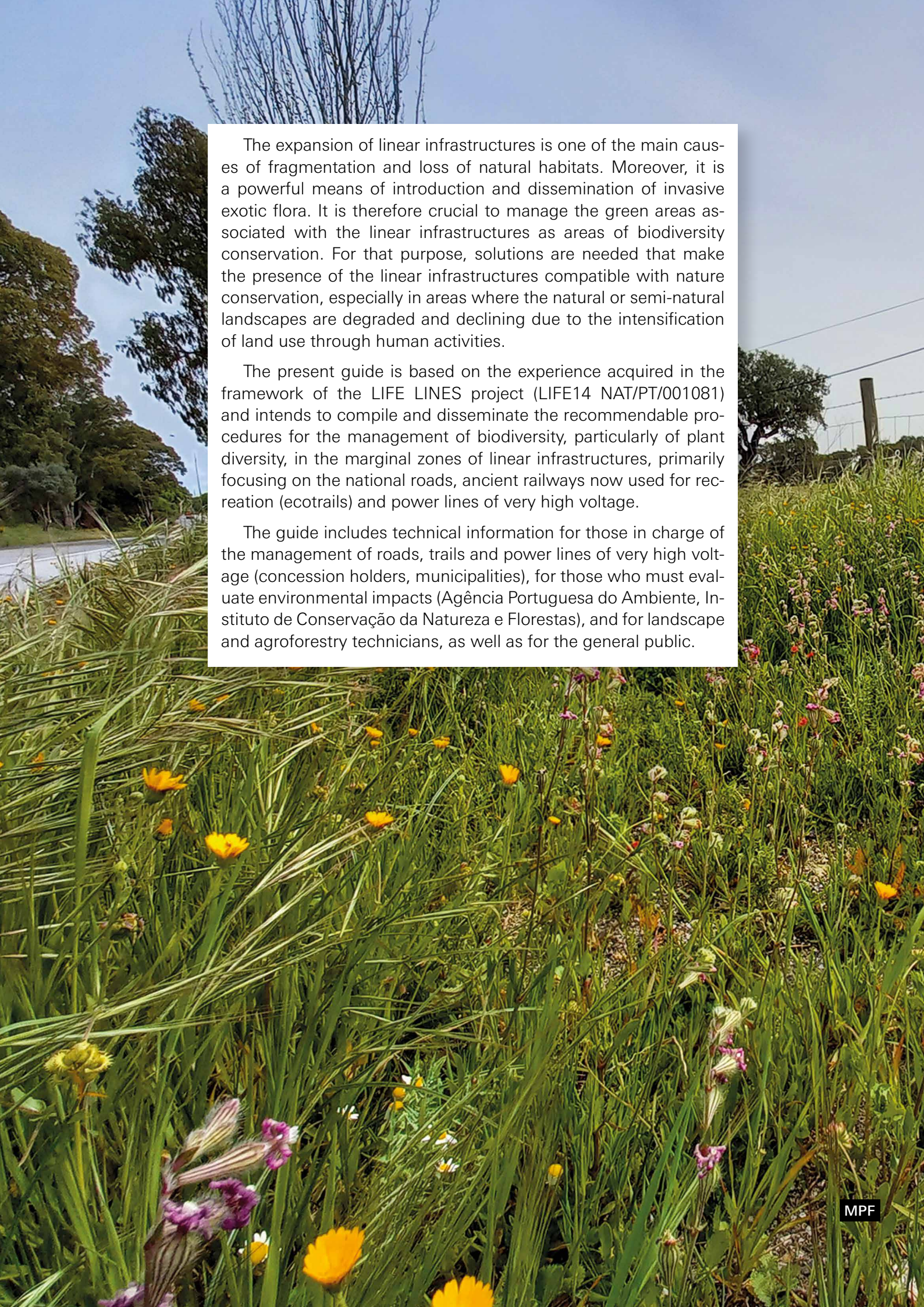
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The expansion of linear infrastructures is one of the main causes of fragmentation and loss of natural habitats. Moreover, it is a powerful means of introduction and dissemination of invasive exotic flora. It is therefore crucial to manage the green areas associated with the linear infrastructures as areas of biodiversity conservation. For that purpose, solutions are needed that make the presence of the linear infrastructures compatible with nature conservation, especially in areas where the natural or semi-natural landscapes are degraded and declining due to the intensification of land use through human activities.

The present guide is based on the experience acquired in the framework of the LIFE LINES project (LIFE14 NAT/PT/001081) and intends to compile and disseminate the recommendable procedures for the management of biodiversity, particularly of plant diversity, in the marginal zones of linear infrastructures, primarily focusing on the national roads, ancient railways now used for recreation (ecotrails) and power lines of very high voltage.

The guide includes technical information for those in charge of the management of roads, trails and power lines of very high voltage (concession holders, municipalities), for those who must evaluate environmental impacts (Agência Portuguesa do Ambiente, Instituto de Conservação da Natureza e Florestas), and for landscape and agroforestry technicians, as well as for the general public.



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Index

The LIFE LINES project	6
Linear infrastructures: a key means to promote biodiversity	8
Management of invasive flora in linear infrastructures	9
Techniques to control invasive plant species	12
Control of invasive species in LIFE LINES – Cost-Benefit analyses	24
Biodiversity management in linear infrastructures	26
Biodiversity in roads and trails	28
Promoting native flora on roads and trails in LIFE LINES – Cost-Benefit analyses	36
Biodiversity under power lines of very high voltage	38
Promoting native flora under power lines of very high voltage in LIFE LINES – Cost-Benefit analyses	42
Species of native flora – how to propagate them!	44
Species cards	54
Exotic invaders	55
Recommended natives	73
Herbaceous species	74
Shrub species	96
Glossary	112
Bibliography	114

The LIFE LINES Project

Thousands of animals die every year in linear structures of transport and energy, struck on roads and railways, or by collision and electrocution in power lines of medium- and high voltage. The impact of these deaths threatens the preservation of biological diversity, but there are solutions to lessen such effects.

The **Project LIFE LINES – Linear Infrastructure Networks with Ecological Solutions** (LIFE14NAT/PT/001081) was created to contribute to the development of a **green infrastructure** that promotes **refugia for plants and animals**, as well as their **safe movement in the surroundings of the linear infrastructures**, ensuring the ecosystem services and mitigating the negative impact of those structures on biodiversity.

The project was coordinated by the University of Évora, and the partners were the University of Aveiro, the Faculty of Sciences of the University of Porto, the municipalities of Évora and Montemor-o-Novo, Infraestruturas de Portugal S.A., and the NGOs MARCA – Associação de Desenvolvimento Local and QUERCUS. LIFE LINES focuses on promoting and restoring biodiversity in an territory that it is still well preserved but where a series of linear infrastructures threaten animal and plant species.

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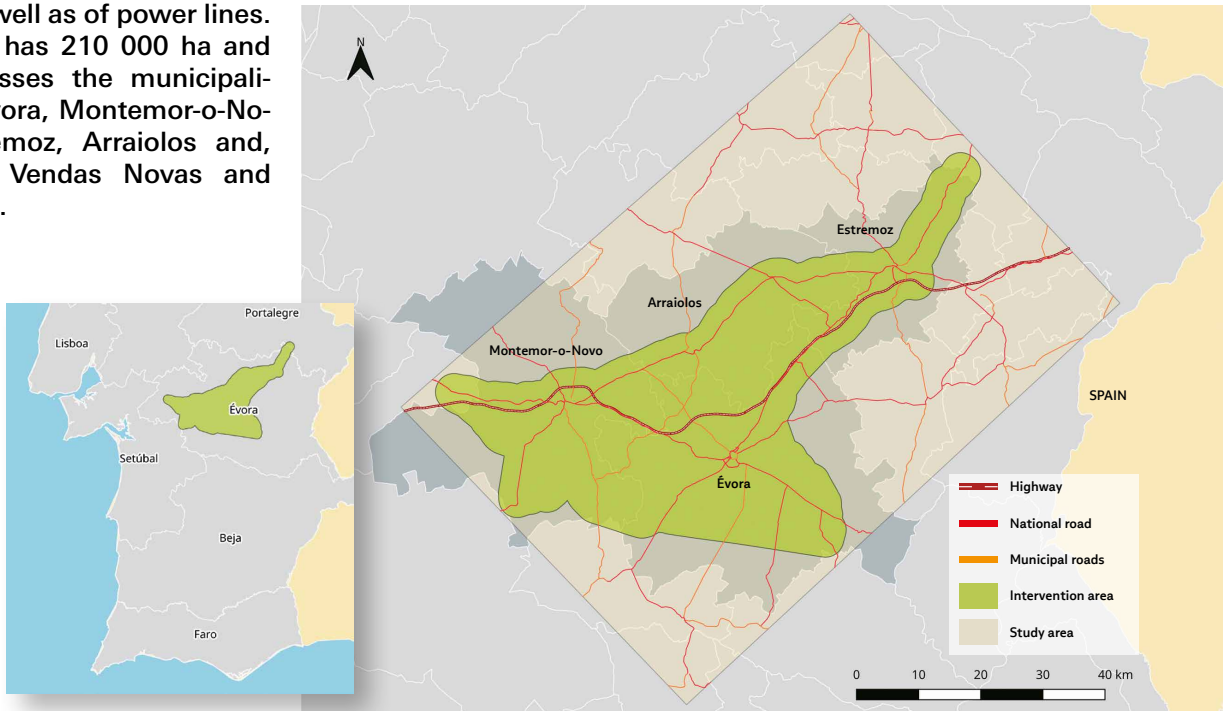
The intervention area of LIFE LINES is crossed by the main land transport corridor between Lisbon and Madrid. There is a high density of highways as well as of power lines. The area has 210 000 ha and encompasses the municipalities of Évora, Montemor-o-Novo, Estremoz, Arraiolos and, partially, Vendas Novas and Monforte.



2015-2021



Alentejo Central



Objectives of the Project:



Linear infrastructures: a key means to promote biodiversity

Linear infrastructures, particularly roads and power lines, are nowadays quite spread in the landscape and represent an important economic and social asset. The expansion of these infrastructures has been seen in all continents, particularly in the northern hemisphere, but it is a relatively recent event and coincides with the second half of the 20th century. Portugal is no exception, and it is even one of the European countries with highest

density of paved roads and highways per capita; the national territory is furthermore crossed by thousands of kilometres of railways and power lines.

Despite the undeniable benefits for society, linear infrastructures represent one of the greatest threats to biodiversity conservation. At present, infrastructures such as roads and power lines are the primary cause of habitat fragmentation and one of the main causes of non-natural mortality of wild fauna and habitat loss. Furthermore, they are ideal means for the introduction and dissemination of exotic invasive plant species. So, it is crucial to find solutions that make the presence of the linear infrastructures compatible with nature conservation. Over the last 20 years, numerous scientific studies have been done on the impacts of these infrastructures, and most of the recent constructions already take the safeguard of fauna populations into account, allowing an easier safe movement for animals or limiting their approach to those infrastructures.

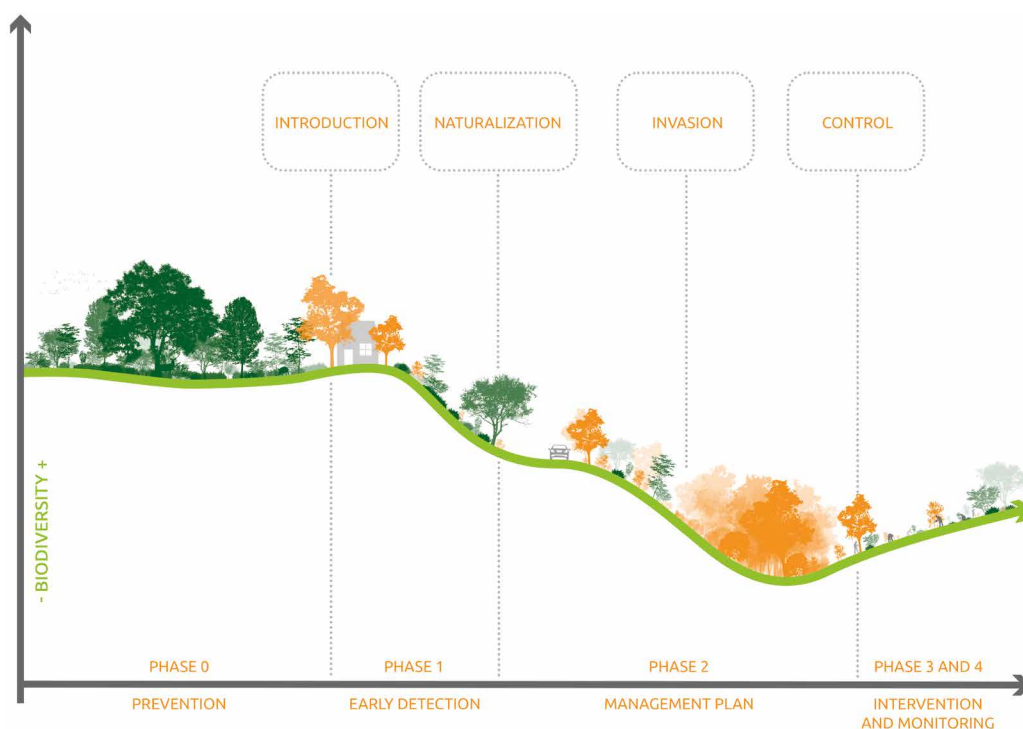
When associated with other mitigating measures, the creation of Green Infrastructures in association with the linear infrastructures can promote multifunctionality and sustainability, thus contributing to reduce biodiversity loss. The management of the marginal green areas of linear infrastructures – hereafter simply called road verges - can be oriented towards the promotion of refugia or ecological corridors for many native species. These areas can thus represent an important tool to promote the conservation of native flora and fauna and, simultaneously, contribute to increase landscape connectivity. This kind of management is particularly relevant where the natural or semi-natural landscapes are degraded and declining due to intensified land use, as in the Iberian Peninsula, and where the road verges correspond to significant areas that can be made suitable as habitats for native species and reservoirs of biodiversity with potential to protect threatened species, as well as to improve the functionality of habitats and ecosystems.

Management of invasive flora in linear infrastructures

The green areas that are close or directly dependent on the infrastructures can represent a danger for the native flora because they offer a relatively large area with uniform management that greatly facilitates the dispersal of invasive exotic species, well-adapted to that type of management.

The invaders are exotic species with great dispersal capacity that cause serious economic and environmental damages. The gravity of their introduction in national territory is legally acknowledged since 1999, with subsequent updating by Decreto-Lei n.º 92/2019, de 10 de julho. The objective of this law is to regulate the introduction and avoid the dissemination of exotic species in nature, according to the National strategy for the conservation of Nature and biodiversity for 2030 (Resolução do Conselho de Ministros n.º 55/2018 de 7 de maio). This law* (article 16th) forbids the possession, cultivation, breeding, commerce, introduction into the wild and repopulation of the species listed in the Annex II of the same document, where 200 plant species are indicated as invasive in Portugal.

Invasive plants can rapidly attain high densities and promote environmental and landscape changes. The negative impacts can be socio-economic and ecological, and even on public health, in the case of species that cause allergies or diseases. The ecological impacts include, for example, the reduction of water available for native species, disturbance of the trophic webs, modification of soil characteristics or competition for space and other resources. These changes often cause irreversible damages.



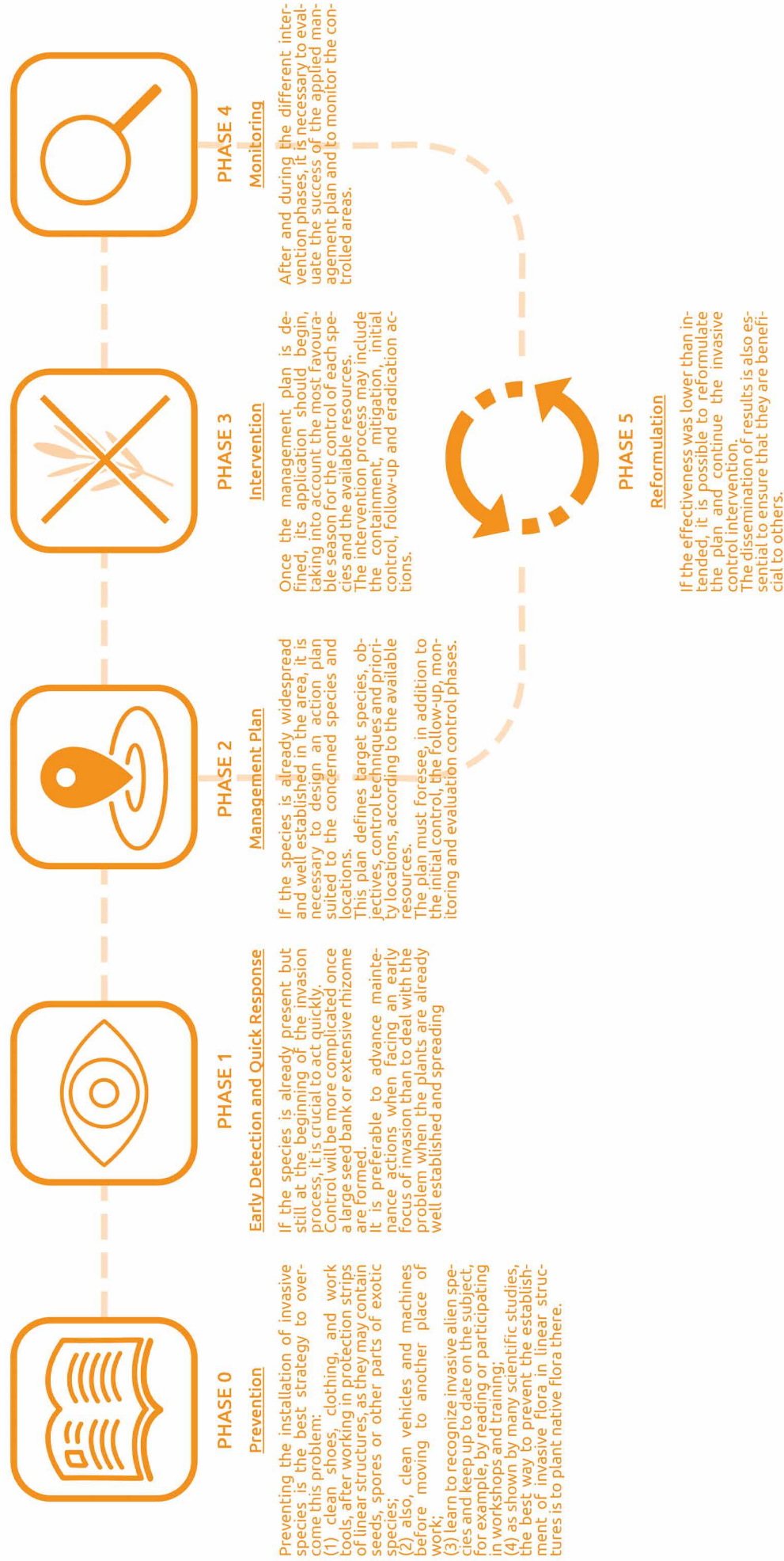
For this reason, invasive species are considered one of the main causes of biodiversity loss at the global scale.

Three phases of propagation of invasive species can be considered – **Introduction, Naturalization, and Invasion** – depending on the dispersal level of the species. As they expand, the biodiversity, particularly of native species, drastically decreases and will only recover if **measures to control** the invaders are implemented.

The linear infrastructures are particularly favourable for the dispersal of invasive flora, and they can be considered as corridors for invasion. The means of transport favour the dispersal of seeds, spores and other plant propagules along railways and roads. In those structures, and also in power lines, maintenance works like vegetation clearance also favour the dispersal by increasing the areas of low-density cover and by carrying spores, seeds or other propagules that stick to the machines, shoes and other materials that touch the soil or the plants. Once established on the road verges, invasive plants can easily expand to the adjacent habitats, especially if these are grasslands or agricultural fields. Also of concern is the proliferation, along the linear infrastructures, of invasive plants that are strongly allergenic.

Usually, control measures and restoration of invaded areas are applied when economic losses occur. This is particularly evident in agricultural or fishing areas, forests or when the ecosystem services fail, as in the case of food production, water supply, climate regulation or even the aesthetic and cultural value of landscapes. Invasive plants in Europe are estimated to cause annual losses of at least 12.5 thousand million euros. In mainland Portugal, particularly over the last decades, the number of exotic plants has been greatly increasing in natural environments, reaching about 670 species, which corresponds to approximately 18% of the number of native species.

The management of biological invasions involves three aspects: **Prevention, Early detection and rapid response, and Management plan**, which includes the intervention, monitoring and reformulation (adaptive management) phases.



Techniques to control invasive plant species

MECHANICAL CONTROL

PULLING

MANUAL PULLING

This method is generally used to remove herbaceous species or young individuals of woody species resulting from germination. It can also be applied to plants grown from lignotubers (i.e., resprouts from a previously cut plant, usually woody) or roots, although this is more difficult.

The plants can be pulled by hand or with the aid of some tool, such as a hoe or a hand hoe. The plant must be entirely removed, and larger roots must not stay in the ground, as they can originate new individuals. In compacted soils, the pulling should be done in the rainy season, to make the operation easier.

PULLING OF RHIZOMES

This should be done in the rainy season, when the soil is less compacted. First, cut the aerial part of the plant and remove it. With a hoe or an adequate machine, dig up the rhizomes, leaving no fragments behind. Dispose of the rhizomes so that they will not root again and originate new plants.





Advantages:

- Simple and efficient application;
- It can be performed by any person who learned the technique and is able to identify the target species;
- It can be performed by large teams (for example, volunteers) in areas where the ecosystem is not harmed by trampling;
- It does not require chemical products that are harmful to the environment or human health.

Disadvantages:

- Expensive and lengthy if the area is large and professional workers are involved;
- It cannot be applied when soils are compacted because the complete removal of roots or rhizomes is difficult;
- In slope areas, mechanical removal is difficult; moreover, the slopes may become unstable.

Appropriate for:

- Small plants of *Acacia spp.*, *Ailanthus altissima*, *Robinia pseudoacacia*, *Hakea spp.*, *Opuntia ficus-indica*, *Ricinus communis*, *Watsonia meriana*, *Carpobrotus edulis*, *Ipomoea indica*, *Phytolacca americana*, *Oxalis pes-caprae*;
- *Cortaderia selloana* (by hand in small plants, mechanically in big plants);
- *Arundo donax* (rhizomes).

RING BARKING

This method is appropriate for trees with smooth and continuous bark – *Acacia dealbata*, *A. melanoxylon*, *Pittosporum undulatum* – because the bark must be entirely removed. To debark, the first step is to carve a ring around the trunk, at a comfortable height for the operator. This incision should cut the bark and reach the wood. The bark must be completely removed (including the cambium, the pinkish layer) from the ring to the bottom of the stem and, if possible, to the roots (particularly in species that sprout from lignotubers). The operation is effective only when the cambium is active, which can occur at different times of the year depending on the geographic region. The best time of the year is when temperatures are mild and there is also some humidity, generally by the end of winter and early spring, but in riparian areas it can be applied year-round. To ensure success, all the trees of the invasive species must be ring-barked in the target area, as the non-treated individuals can facilitate the survival of the treated ones. The tree should be totally dry before it is felled.

Advantages:

- It is efficient, if applied correctly and to the indicated species; it can be applied to trees of all sizes;
- It can be performed by any person who learned the technique and is able to identify the target species;
- It can be performed by large teams (for example, volunteers) in areas where the ecosystem is not harmed by trampling;
- It does not involve chemicals that are harmful to the environment or human health;
- It facilitates the follow-up because resprouting from lignotubers or root seldom occurs.

Disadvantages:

- Expensive and lengthy if the area is large and professional workers are involved;
- It can only be applied at certain times of the year;
- Temporary negative visual impact on the landscape (dead trees).

Appropriate for:

- *Acacia spp.* and *Ailanthus altissima* with straight and smooth stems.



CUTTING

It can be applied to all the species, although of low efficiency in those that resprout.

The plant should be cut as close to the ground as possible. If resprouts develop, they should be eliminated when attaining 25 – 50 cm of height either through cutting (technique of successive cuttings), pulling or spraying with herbicide. If regeneration is by seed, pulling is better than cutting.

Advantages:

- An easy method for any person, when dealing with small plants that are thornless and have no sharp-edged leaves;
- Rapid and relatively cheap method, if the plant does not resprout after cutting;
- It does not require chemical products that are harmful to the environment or human health.

Disadvantages:

- In some species, resprouting is stimulated by cutting;
- Strong investment on follow-ups because almost all the invasive species have strategies to overcome cutting and regenerate;
- Tree felling requires specialized and big machinery, and the use of personal protective equipment (PPE).

Appropriate for:

- Seedlings;
- *Hakea sericea* (closest as possible to the ground, before fruit maturation, and controlled fire 12-18 months after cutting, when seeds start to germinate);
- Plumes of *Cortaderia selloana*, as soon as they become visible and before the seeds are formed, whenever pulling is not possible;
- *Arundo donax* (successive cuttings).



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MECHANICAL + CHEMICAL CONTROL

CUT AND HERBICIDE

It can be applied to all the species when the adult individuals have stem diameters large enough for the application of herbicide (about 2 cm). It is less efficient in species that resprout from underground organs.

The tree should be cut as close to the ground as possible, and the stump brushed or sprayed immediately with herbicide. The herbicide should not drop to the ground. The right type and concentration of herbicide vary with the target species and the local conditions. Adding a dye to the solution is a good way to avoid duplications and making the application more effective. The dilution of the herbicide should be done on the day it will be applied, not before.

If there are subsequent resprouts, they should be eliminated when attaining 25-50 cm, either through cutting (technique of successive cuttings), pulling or spraying with herbicide.

This method should not be used in windy days, to avoid contamination of other plants, soil and water with the herbicide.

Advantages:

- It facilitates the follow-up, as it avoids resprouting from lignotubers and roots (if applied to the right species);
- Relatively rapid and cheap;
- Localized surface application.

Disadvantages:

- It requires specialized workers;
- It requires specific equipment and the use of PPE;
- It does not avoid follow-ups, as there will always be some plants that survive and resprout;
- It can only be used under certain meteorological conditions (no rain or wind).

Appropriate for:

- *Acacia spp.*, *A. altissima* and *Robinia pseudoacacia*, *Hakea spp.*
- *Cortaderia selloana*, when mechanical removal is not possible.



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CHEMICAL CONTROL

INJECTION OF HERBICIDE

STEM INJECTION THROUGH DRILLING

Using a drill, make holes into the bark and the outer wood layer (sapwood), around the stem. The holes should be about 15 cm apart and have a 45° angle relative to the ground.

Apply the herbicide immediately after perforation, with a syringe or a wash bottle, and fill the hole, but avoid overflowing.



STEM INJECTION WITHIN NOTCHES

With an axe, a sickle or a handsaw, make several downwards angled (45°) cuts at any height of the trunk, through the bark into the outer and light-coloured wood layer (sapwood).

The cuts should be all made at the same height and 2-4 cm apart. Small individuals need only 2 or 3 cuts, which should not be too deep, to avoid breaking the plant.

The herbicide is injected into the notches (using a wash bottle) immediately after they are made; about 1 ml (0.5-2 ml, depending on the size of the incision) should be slowly applied, so that all the liquid remains inside the wound.

For deciduous species, the best time for application is spring or summer, with dry weather and when the leaves are fully expanded.

Advantages:

- There are drills equipped with an herbicide injector, however a normal drill can be used as long as the herbicide is immediately applied after punching. After treatment, the tree will rapidly turn brown and look dead. However, it is impor-

tant to let it stand one more year, to ensure that it spends all the reserves stored in the roots;

- It facilitates the follow-up, as it avoids resprouting from lignotubers and roots;
- Relatively small quantities of herbicide are used, and it does not contact the external environment, thus avoiding its contamination;
- It is more damaging to the root systems than other methods that also employ herbicides;
- Localized surface application.

Disadvantages:

- Lengthy and expensive for large areas;
- Requires a drill with power autonomy (battery);
- It has temporary negative visual impact on the landscape (dead trees);
- It requires specific equipment and the use of PPE (personal protective equipment).

Appropriate for:

- *Acacia spp.*, *A. altissima*, *Robinia pseudoacacia*;
- *Opuntia ficus-indica* (stems, before fruiting).



FOLIAR APPLICATION OF HERBICIDE TO SPROUTS

In the year after the cut, acacias or other plants forming abundant seed banks in the soil can present remarkable regeneration ability, as germination can be quite high.

To avoid this situation, native species should be sown or planted in the intervened area to compete with the invasive species. If this is not possible, the seedlings must be removed, at least in the year after cutting.

Before deciding to use herbicides, evaluate the possibility of removal, either by hand or with brush-cutter, when the seedlings are taller than 20 cm.

If this is not possible, then spray the seedlings with herbicide, adjusting the spray range to the size of the plants.

Advantages:

- Effective and rapid.

Disadvantages:

- It cannot be used in all situations because it implies the use of chemical products that harm the environment and human health;
- It requires specialized workers, specific equipment, and the use of PPE;
- Non-target plants might be affected by spraying.

Appropriate for:

- *Acacia spp.*, *A. altissima* and *Arundo donax*.





Control of invasive species in LIFE LINES – Cost-Benefit Analyses

The selection of methods to control invasive species should take their advantages and disadvantages into account, as well as their suitability for the target species and to the linear infrastructure where it must be applied. So, there is not a “best” method to control a given species, but rather a method or set of methods that are more adequate for a specific situation.

In the LIFE LINES project, a number of techniques were used along roads and trails to control *Acacia dealbata*, *Acacia melanoxylon*, *Ailanthus altissima*, *Arundo donax* and *Robinia pseudoacacia*.

In the following table, the cost-benefit evaluations are shown for the invasive species targeted in the framework of the linear infrastructures.

Target species	Control method	Effectiveness	Difficulty of implementation	Time to complete	Human resources	Cost	Time for effects visualization	Sprouts reappearance	Risk for the native flora	Risk of terrain instability	Global evaluation
<i>Acacia spp.</i> <i>Ailanthus altissima</i> <i>Robinia pseudoacacia</i>											
Adults	Ring barking	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	Very favourable
	Stem injection through drilling	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	Favourable
	Stem cut + herbicide application	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	Unfavourable
Sprouts	Manual removal	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	Very favourable
	Foliar spraying	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	Reasonable
<i>Arundo donax</i>											
Adults	Pulling of rhizomes	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	Very favourable
	Successive cuttings	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	Fair
Sprouts	Manual removal	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	Very favourable
	Foliar spraying	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	Fair

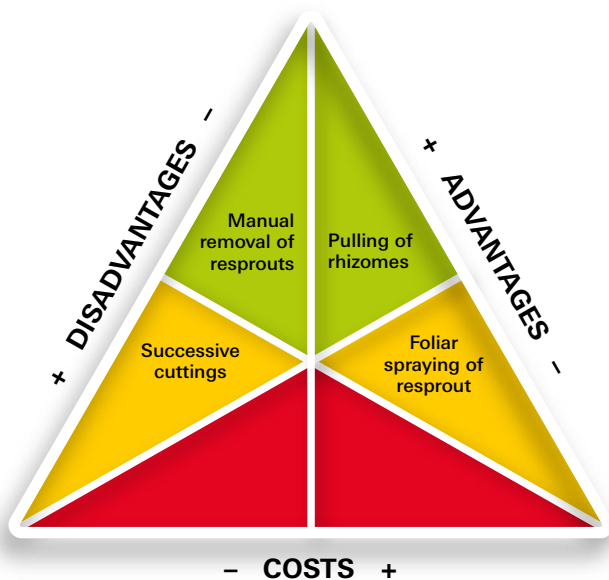
●●●● – Very high; ●●●● – High; ●●●● – Medium; ●●●● – Low; ●●●● – Very low

The evaluation was made considering the following parameters:

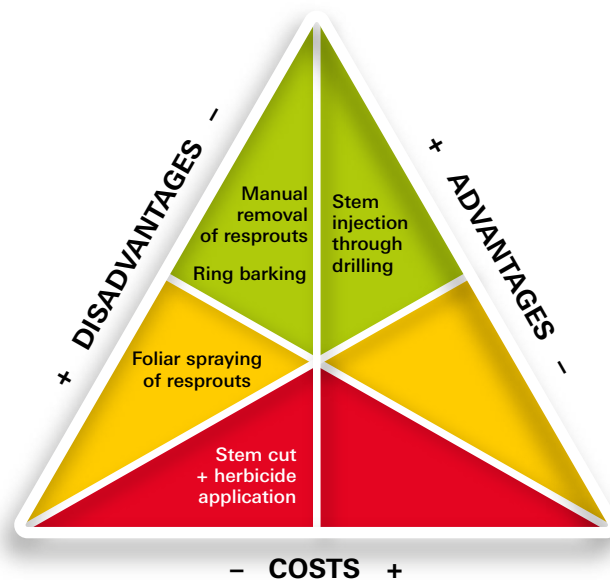
- **Effectiveness:** success in the control of plant species.
- **Difficulty of implementation:** need of technical knowledge or specific machinery or equipment.
- **Time to complete:** need for lengthy procedures, involving several phases or times of the year.
- **Human resources:** number and expertise of the human resources needed.
- **Cost:** qualitative evaluation of the cost of implementation.
- **Time for effects visualization:** estimate of the time the results take to become visible.
- **Sprouts reappearance:** time for the emergence of resprouts, and their abundance, after treatment.
- **Risk for the native flora:** possible impacts of the control procedure on the local native flora (for example, resulting from soil disturbance, herbicide application and/or non-selective cutting).
- **Risk of terrain instability:** instability associated with the method of control (removal of soil, rhizomes, or lignotubers).
- **Global evaluation:** weighted analysis of all the parameters.

To make the reading easier, a summary of the previous table is schematically presented next, where the control methods are categorized according to their advantages, disadvantages, and monetary cost.

Arundo donax



Acacia spp., Ailanthus altissima and Robinia pseudoacacia



Biodiversity management in linear infrastructures

As mentioned before, the marginal zones of the linear infrastructures can become relevant to the maintenance of biodiversity, especially when considering that in Portugal the marginal areas associated with paved roads occupy more than 250,000 ha, which is more than the total area of protected areas in the country. So, using them as ecologically multifunctional and sustainable areas is a significant goal for conservation.

The promotion of fauna and flora in the surroundings of the linear structures must be planned according to the specific objectives for that site, taking its characteristics into account as well as the target species. Promoting biodiversity around linear infrastructures should also consider the safety of the populations, the regular maintenance of the infrastructures and the current legislation.

In Portugal, the responsibility for the management of vegetation on road verges is usually of IP – Infraestruturas de Portugal, the road and highway concession holder, in highways, and of the municipalities, in the case of municipal roads. This management aims to maintain the stability of roadslopes, to keep road safety (e.g., removal of obstacles, ensure road and road signs visibility), and to reduce wildfire hazards. Vegetation management should comply with the criteria defined in the legislation supporting the Forest Fire Defense System (Decreto-Lei n.º 124/2006, de 28 de junho and subsequent alterations).

At present, most of this vegetation management consists of maintaining a low layer of herbs and shrubs through recurrent cutting. This is relevant for the promotion of local biodiversity, as the occurrence of flora and fauna species on road verges depends directly on their management, and cutting greatly affects the vegetation structure and the composition of the communities of native plants. Recurrent cutting alters the competition relations between plant species, favouring geophytes and an-



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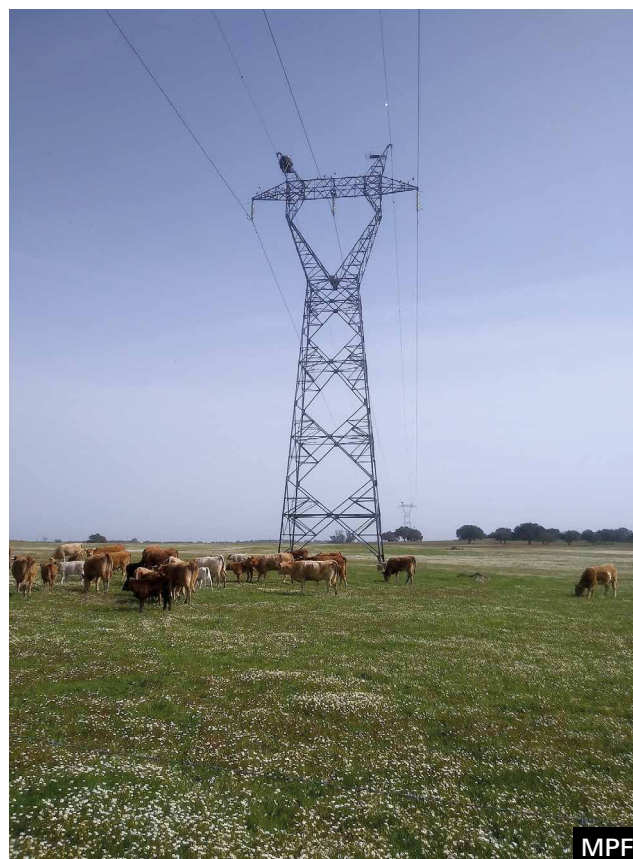
nual plants with early flowering, influences the growth and structure of the vegetation and increases the amount of light that reaches the ground. Consequently, the promotion of the flora, and hence of the fauna, on road verges must take these factors into account, as well as the surrounding matrix.

Trails, such as ecotrails, are also frequently managed, mainly by clearing the vegetation, and are subjected to the same legislation as roads. However, since the implications for road safety are not as great, and the trail corridors are normally wide, the control of the vegetation is less frequent. This favours a management that is more adequate to promote biodiversity.

In the case of power lines of very high voltage, the responsibility for the management of the surrounding vegetation is of REN – Redes Energéticas Nacionais. This management is made in the service or protection strips (45 m wide) established along the power line, including the forest areas that are part of the municipal plans for protection against forest fires (Planos Municipais de Defesa da Floresta Contra Incêndios – PMDFCI) and based on the current legislation (Decreto-Lei n.º 124/2006 de 28 de junho and subsequent alterations).

These protection strips, including the bases of the power line towers, can be managed to promote biodiversity, if the vegetation there does not increase the risk of fire and does not jeopardize the safety and maintenance of the power lines, namely if it is of small size and composed of slow-growing plants.

So, stimulating native biodiversity should be done according with the type of linear infrastructure, respecting the legislation, with the permission of the agencies in charge and in collaboration with them.



Biodiversity in roads and trails

A. Management of native vegetation

Nowadays, the vegetation surrounding the linear infrastructures is generally managed by cut and clearing, to ensure the safety of these infrastructures and of their users, providing good visibility and protection against fires. This type of management is based on legislation (Decreto-Lei n.º 124/2006 de 28 de junho and subsequent alterations), particularly concerning the height of the vegetation in the areas established for fuel management. The promotion of native flora in these areas must be made according to current legislation.



In roadside fuelbreaks, the legislation imposes the maintenance of a low herb layer and the minimization of the shrub and tree layers. If such strips include protected vegetation in the framework of nature and biodiversity conservation (identified in forest management, in other territorial management or in Natura 2000 Network management) the law establishes that the municipal commission for protection against forest fires (Comissão Municipal de Defesa da Floresta Contra Incêndios) defines specific criteria for fuel management, in accordance with the natural values to be preserved. As such, in areas where road sides act as habitats for species listed in the Habitats Directive (Diretiva 92/43/CEE), conditions should be maintained and promoted to ensure the conservation status of that habitat.

In areas of roads that do not include fuel management strips, vegetation management must take into account the road safety and the potential fire risk nearby, but must also ensure the conservation of native flora and fauna communities.

Although this survey has not been made in Portugal, it is known, for example, that more than 30% of the known colonies of Cabrera mouse (*Microtus cabrerae* (Thomas, 1906) is a species listed in Annexes II and IV of the Habitats Directive) occur on road verges where soil moisture is high, and the risk of fire ignition and propagation is absent. In sites where these colonies are known to occur (frequently smaller than 500 m²), nuclei of rushes or bushes (at least 2 x 2 m) should be kept in the area farthest from the road. The surrounding vegetation must be carefully cleared in order to keep the herbs at a height of at least 20 cm.



Since vegetation management in marginal zones also has implications for the mortality of wild fauna, it is proposed to vary according to the volume of traffic, when the legislation allows it.

Roads with traffic flow higher than 3000 vehicles/ day

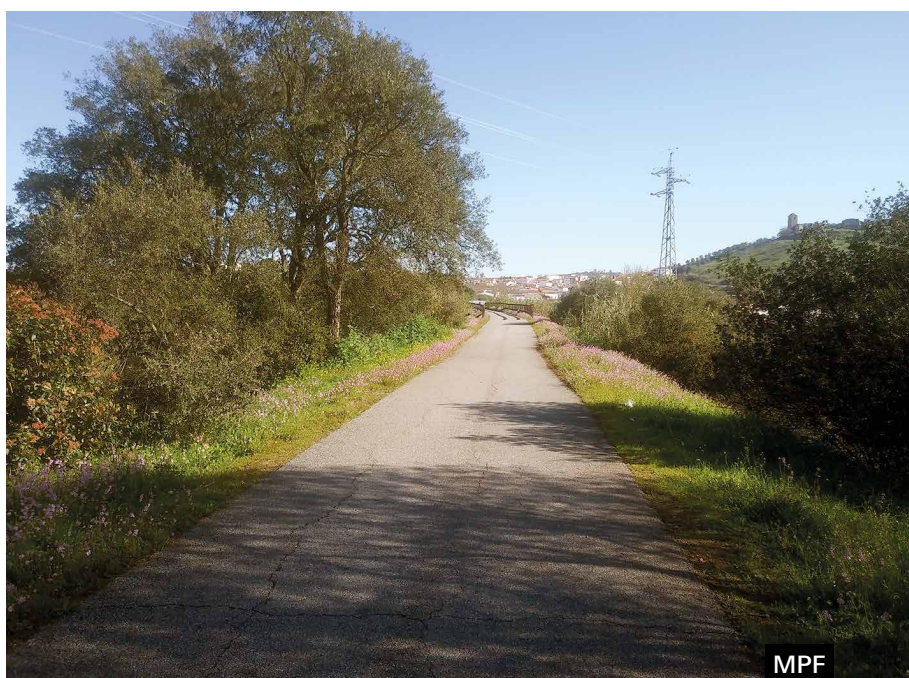
Distance from the road	Landscape	Herbs	Shrubs	Trees
First 3 m	Indifferent	Low layer. Mow to ensure road safety and minimize fire risk	No shrubs	No trees
Beyond 3 m	Production forests or dense scrubs	Keep a low layer. Mow only if necessary, after the flowering period	Keep small and isolated shrubs	Keep
	Urban, agricultural or agrosilvopastoral (montados) areas	Keep a low/medium height layer. Mow only if necessary, after the flowering period At approximately every 500 m, keep or promote "islands" of native vegetation (herbs and/or shrubs) with an area not smaller than 2 x 2 m ² , even if the surrounding vegetation has been cleared.	Keep small/ medium sized shrubs	Keep

Roads with traffic flow lower than 3000 vehicles/ day

Distance from the road	Landscape	Herbs	Shrubs	Trees
First 3 m	Production forests or dense scrubs	Low layer. Ensure road safety and minimize fire risk	No shrubs	No trees
Beyond 3 m		Dense cover of herbs and shrubs of small/ medium size		Keep
First 1.5 m	Urban, agricultural or agrosilvopastoral (montados) areas	Low layer. Mow only to ensure road safety and minimize fire risk		Keep
Beyond 1.5 m		Dense cover of herbs and shrubs, regardless of their height. Promotion of a shrub and/or continuous strip to act as ecological corridor and refugia on the medium/long term		



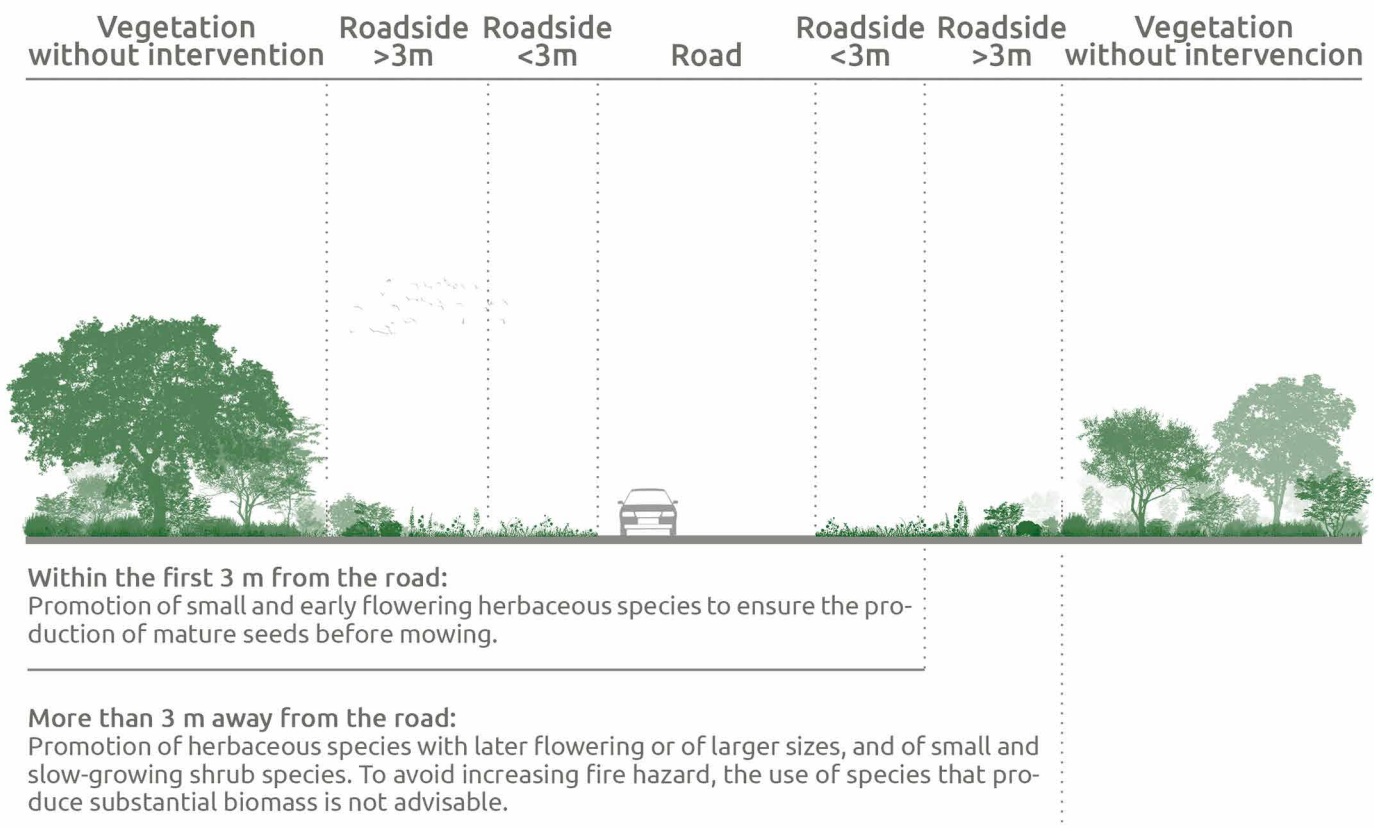
Whenever possible, vegetation clearance around the roads and trails should allow the native plants to flower and disperse their seeds. The first 1.5 – 3 m from the road are recurrently and indiscriminately cleared to ensure road safety and visibility, but there is no need to extend that operation further, especially if beyond the fuel management strips. So, from 1.5 – 3 m to 10 m from the road the herbs should be mown only once and if necessary, always after the period of seed dispersal, and the shrubs should not be cut on an annual basis. This will ensure the sustainability of this band of vegetation and allow the maintenance of native flora while decreasing the risk of invasion by exotic species. These narrow areas also provide habitats for pollinators and seed dispersers (insects and birds), as well as ecological corridors for micro-mammals. They provide further benefits such as absorbing the precipitation, decreasing the risk of slope erosion and the frequency of floods, and reducing the infiltration of road pollutants (particles from the vehicles and from the paved road itself).



The application of herbicides should only be used to control invasive flora, and not to manage native vegetation. The use of herbicides to control invasive species should be done only when strictly necessary and in such a manner that the local native vegetation is not affected.

B. Promoting the biodiversity

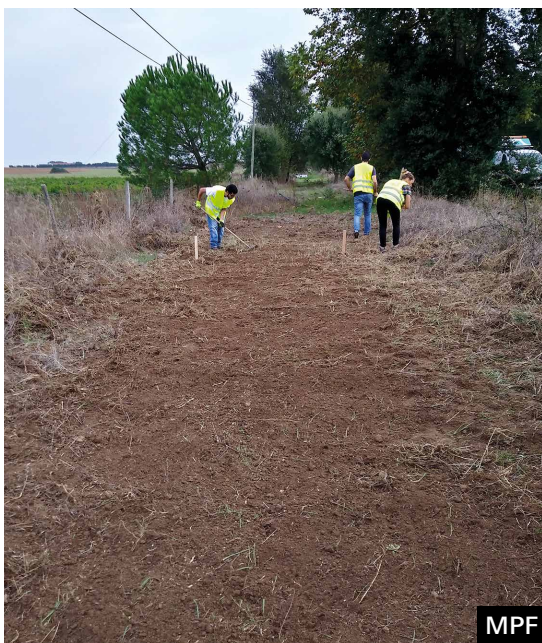
The promotion of biodiversity in marginal areas of roads and trails is directly linked to the management of those structures. It should take into account the different vegetation layers, the characteristics of the marginal zone and the width of the target area. The following scheme proposes how to act along the roads and trails; this should be adapted to the actual situation of each site and the applicable legislation. However, in the case of trails, trees or shrubs can be planted on the sides, if they will not decrease the visibility and a distance of at least 4 m between crowns is ensured, as well as zones to allow the passage of machinery.



As previously mentioned, the first 3 m from the paved road are regularly mown in this type of linear infrastructure, to ensure road visibility and safety. This restricts the stimulation of plant diversity but can be partly overcome by an appropriate choice of species and, whenever possible, by acting on the most suitable times of the year. For a general promotion of herbaceous flora, a mixture of the most common native species can be introduced (sowing herb corridors), to enrich the existing plant diversity. In this case, the provenance of the seeds should be appropriate for the target areas, and hydroseeding is recommended. However, there are cases where the margins can act as refugia for plant species whose natural habitat is degraded or decreasing in the surrounding area. In such cases, the promotion of these species is advised, through manual sowing of smaller areas (nuclei), further away from the road or trail. The same can be done to promote small woods in the area furthest from the road, thus ensuring these plants are protected from recurrent cutting and, simultaneously, the creation

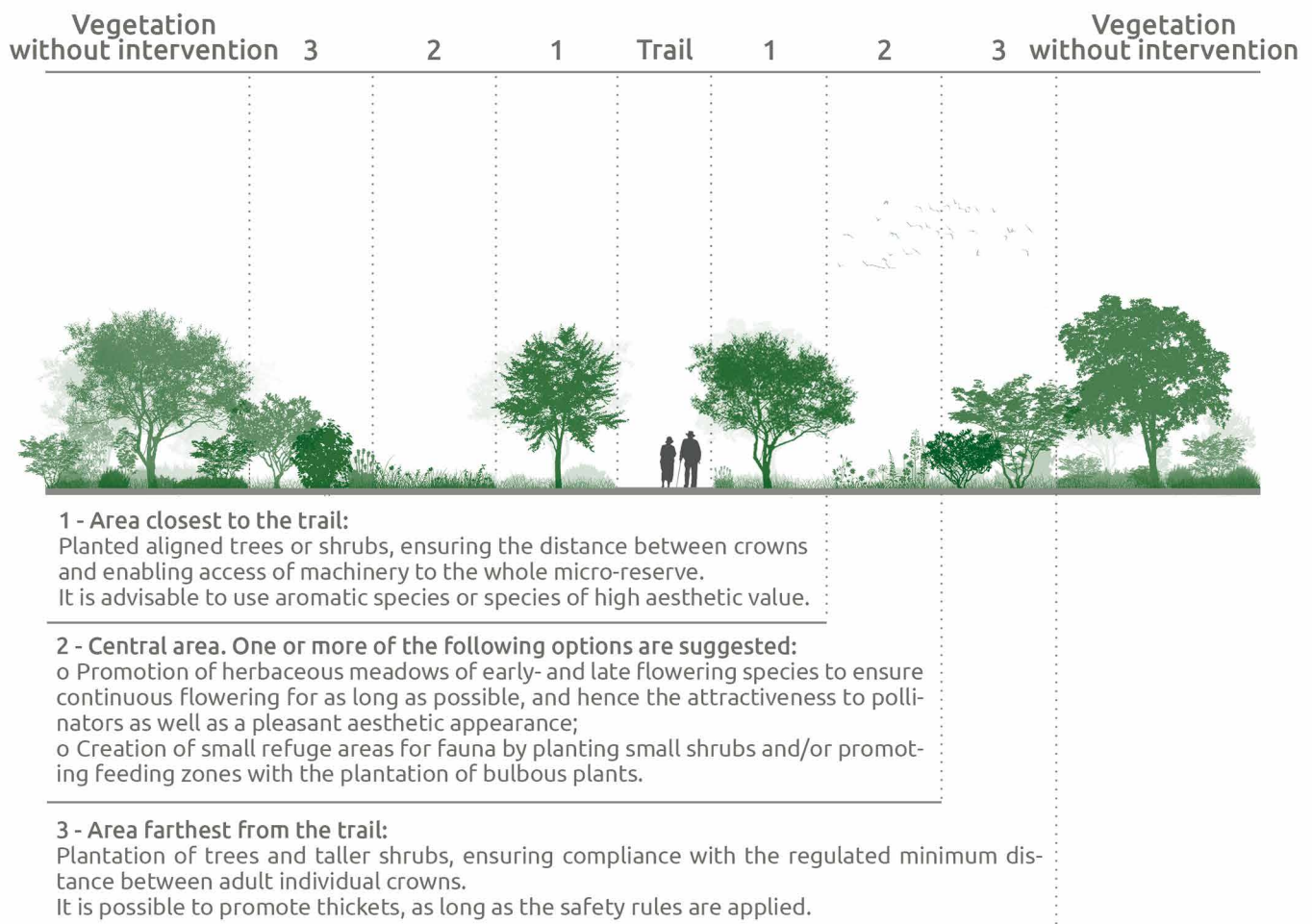
of refugia and/or feeding zones for pollinators and micro-mammals, without greatly increasing the risk of roadkill of these species.

Shrubs and trees should be fostered as far from the road as possible and considering the existence of fuel management strips. It is recommended that the trees are planted taking their adult size into consideration and ensuring that their crowns are at least 4 m apart. In the case of shrubs, especially if they grow close to the ground, small clusters or nuclei might be created that will function as refugia for micro-mammals.



The trails, or ecotrails, where the margins are wider, are excellent places to create micro-reserves of biodiversity. These are small plots along the path, representing islands of biodiversity, interlinked by the green area surrounding them. Although their primary objective is to create habitat for native flora and fauna, the implementation of these plots should take into account the proximity of urban /residential areas and the interests of the local population.

It should be highlighted that the management of these micro-reserves should ensure their functionality over time. However, the legislation must be respected, and public safety secured, namely by allowing the access of machinery to all the area of the micro-reserve. The management of these areas must ensure that mowing and selective cuttings are performed only in late spring, after fruiting, so that seed dispersal is not compromised. Moreover, the selective cutting should prevail over mowing, to ensure that the shrubs are not damaged.





Promoting native flora on roads and trails in LIFE LINES – Cost-Benefit Analyses

The selection of techniques to promote the native flora alongside roads and trails must consider their effectiveness, mode of application (including the facility of application and the workers needed) and monetary cost. As for the control of invaders, there is no optimal method to promote the native flora, but rather a method or a set of methods that are more adequate for each situation.

In the following table, the cost-benefit evaluation is presented for each of the solutions suggested for the promotion of native flora in marginal zones of roads and trails.

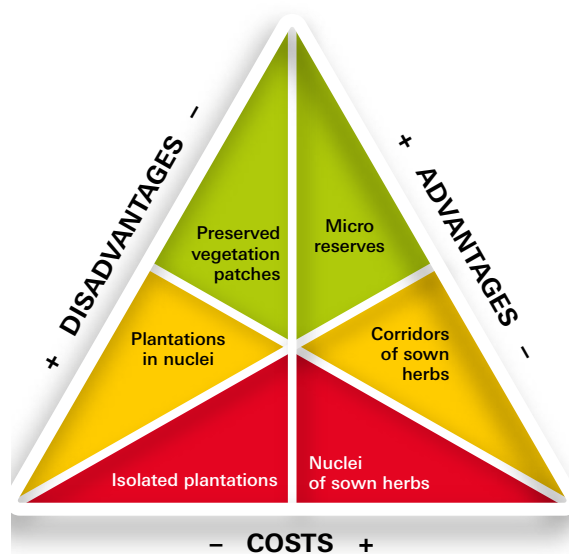
Actions to promote biodiversity	Effectiveness	Difficulty of implementation	Time to complete	Human resources	Cost	Time for effects visualization	Durability	Maintenance	Increase of plant diversity	Promotion of protected flora	Improvement of connectivity	Promotion of habitat for pollinators and micromammals	Global evaluation
Isolated plantations	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	Unfavourable
Plantations in nuclei	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	Fair
Preserved vegetation patches	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	Very favourable
Corridors of sown herbs	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	Fair
Nuclei of sown herbs	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	Unfavourable
Micro-reserves	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	Favourable

●●●● – Very high; ●●●● – High; ●●●● – Medium; ●●●● – Low; ●●●● – Very low

The evaluation took the following aspects into consideration:

- **Effectiveness:** success in promoting native flora.
- **Difficulty of implementation:** need of technical knowledge, machinery or specific material.
- **Time to complete:** time needed to implement the action.
- **Human resources:** number and expertise of the human resources needed.
- **Cost:** qualitative cost of the action.
- **Time for effects visualization:** time before the effects of the action are visible.
- **Durability:** how long do the results last.
- **Maintenance:** need of maintenance after the initial action, such as irrigation periods or interventions in the surrounding structures.
- **Increase of plant diversity:** effect of the action on the number and cover of native species and on the development of different vegetation layers.
- **Promotion of protected flora:** effect on the number and cover of native species of conservation interest.
- **Improvement of connectivity:** contribution to increase the connectivity between habitats alongside roads and trails.
- **Promotion of habitat for pollinators and micro-mammals:** contribution to the creation of different sorts of habitats for fauna, namely by promoting shrub clusters, herbaceous corridors and diversified vegetation layers.
- **Global evaluation:** weighted analysis of all parameters.

A summary of the above analysis is presented next, in a triangular scheme which sorts the methods of flora promotion according to their advantages, disadvantages and monetary costs, for application to road verges and trails.



Biodiversity under power lines of very high voltage

Due to the intensification of agriculture and raising of livestock, the European landscape is becoming uniform, to the point of reducing natural or semi-natural habitats to small, scattered patches. As mentioned before, this situation is aggravated by the expansion of linear infrastructures. For example, power lines, namely those of very high voltage, and their associated service strips, are widely present and cross urban areas as well as nature protected areas, such as Natura 2000 network of Special Protection Areas (SPA). In this context, using the bases of

the power towers and the service strips can be relevant to promote natural resources and protect biodiversity. The existence of patches of natural or semi-natural habitats associated to these strips, especially in agricultural landscapes, can encourage, for example, the presence of pollinators that ensure the continuity of crops and/or pastures.



EA

The management of biodiversity along these infrastructures should be adapted to the surrounding landscape and respect the current legislation:

- **Agricultural zones:** using the bases of the towers of very high voltage power is generally not economically viable because they are too small for agricultural machinery; therefore, they are not sown, contrary to the service strips. Consequently, such bases naturally become refugia for wild fauna and flora and can act as biodiversity islands. For that to occur, it is recommended that these areas are cleared only when strictly necessary for agricultural activities around it, and that the shrubs naturally growing there are not cut. If possible, sowing and herbicide application should be avoided in areas within 5 m from the high-tension tower base.
- **Livestock zones:** although the power tower bases are difficult to sow and therefore contribute little to feed the livestock, it is nevertheless trampled and grazed, which prevents the development of spontaneous vegetation. So, fencing these areas with a wide mesh net (10–15 cm) is suggested to prevent the access of livestock while allowing the passage of microfauna, thus creating islands of biodiversity. The evolution of the native vegetation in these areas can provide habitat for native flora and microfauna; however, this is a slow process and might lead to the dominance of certain plant species. Alternatively, an active promotion of the native flora – and consequently of fauna – is suggested, through seeding of herb species and plantation of shrubs, in agreement with the environmental characteristics of the site and the nearest natural habitats. The absence of pressure from large herbivores can, in time, lead to the dominance of certain plant species which can reduce the habitats for fauna. So, if necessary, it is recommended that grazing is allowed every 4 years at the power tower base or, alternatively, that herbs are mown (thus keeping the shrubs intact).
- **Forest zones:** a 45 m wide service strip is normally established along the entire power line, to reduce fire risk. In these areas, trees and branches are cut, and the understory is cleared, resulting in some discontinuity in the vegetation structure. However, the service strips can be used for other economic activities (for example, natural or sown pastures, some agriculture, feeding areas for game species) or to promote native species, including tree species that are compatible with the safety distance requirements between crowns (isolated plantations), and between the trees and the power lines. For example, rabbits are crucial to the survival of many carnivores and are therefore a priority species for conservation; their habitat can be promoted in the service strips. For that purpose, a patchwork of feeding areas and refugia by maintaining or sowing herb prairies (corridors of herbs) should be created, together with the maintenance or plantation of small clusters of shrubs.



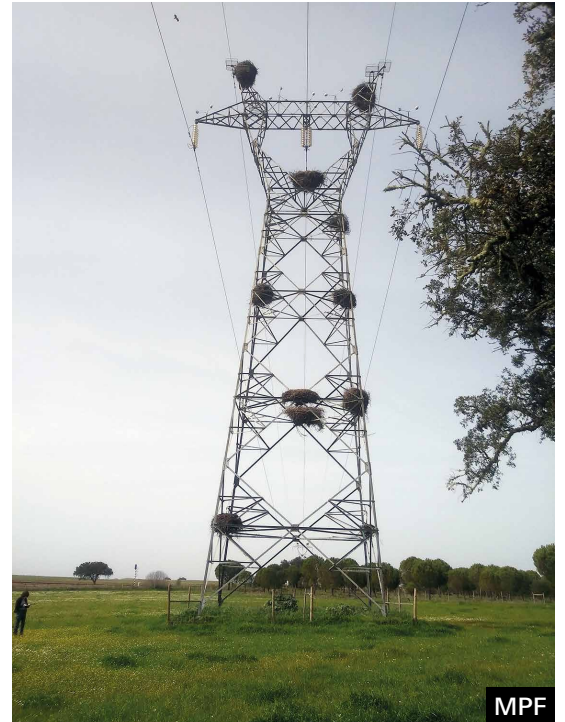
MPF

The islands of biodiversity (isolated micro-reserves) created at the very high voltage tower bases can be assets for biodiversity in themselves, but are even more important if designed as stepping stones (see Glossary) in a uniform matrix with scarce vegetation, allowing the connection between areas of well preserved natural or semi-natural habitats. For example, areas of *montado* (Mediterranean evergreen oak forests) separated by open areas for grazing, can be linked by sowing herbs and shrubs that naturally occur at the base of power line towers, which should be fenced to prevent the access of large herbivores. This increases landscape connectivity by allowing a sequence of feeding areas and refugia for microfauna (such as pollinator insects or small mammals) and favours the dispersion of seeds of the native flora, facilitating the connection and dispersal of the native populations present in the two patches of *montado*.



The selection of plant species to promote, both at the base of high voltage power towers and in the service strips, must consider the soil and climate characteristics of each site, and respect the local native vegetation that is, or may be, present, favouring the species of small size and slow growth. Here, as in other cases, tree plantations must consider the expected size of the adult individuals and ensure their crowns will be at least 4 m apart.

It is also important to consider that successful actions depend not only on the right selection and combination of plant species, but on the conditions of each target area as well. When these are the bases of the power towers, the success might be conditioned by the natural use of power towers by storks. In Portugal, particularly in the South, power towers are often used as nesting places for storks, and their excrements can change the chemical composition of the soil underneath. In these cases, vegetation structure naturally becomes more uniform and only plant species that tolerate soil acidification persist in this environment, thus limiting the success of actions such as seeding or planting.



Promoting native flora under power lines of very high voltage in LIFE LINES – Cost-Benefit Analyses

The actions to promote native flora near power lines of very high voltage must consider their effectiveness, suitability for the target area, mode of application (including the facility of application and the necessary workers) and the monetary cost. There is no perfect method, rather a method or a set of methods that are more adequate for a given situation.

In the following table, the cost-benefit evaluation is presented for each of the methods suggested for the promotion of native flora in the framework of power lines of very high voltage.

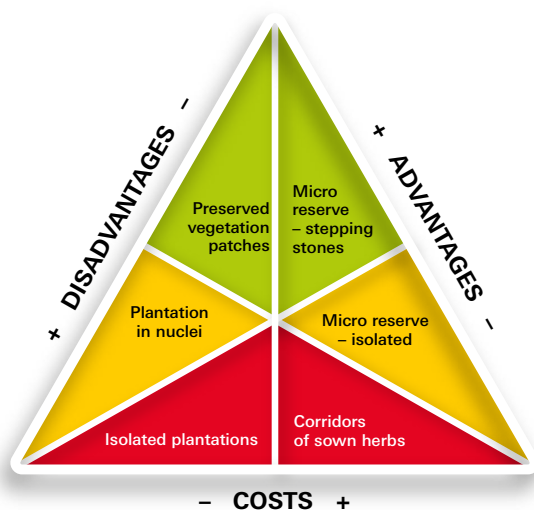
Actions promoting biodiversity	Effectiveness	Difficulty of implementation	Time to complete	Human resources	Cost	Time for effects visualization	Durability	Maintenance	Increase of plant diversity	Promotion of protected flora	Improvement of connectivity	Promotion of habitat for pollinators and micromammals	Global evaluation
Isolated plantations	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	Unfavourable
Plantation in nuclei	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	Fair
Preserved vegetation patches	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	Very favourable
Corridors of sown herbs	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	Unfavourable
Micro-reserve – stepping stones	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	Favourable
Micro-reserve – isolated	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	●●●●	Fair

●●●● – Very high; ●●●● – High; ●●●● – Medium; ●●●● – Low; ●●●● – Very low

The evaluation took the following aspects into consideration:

- **Effectiveness:** success in promoting the native flora.
- **Difficulty of implementation:** need of technical knowledge, machinery or specific material.
- **Time to complete:** time needed to implement the action.
- **Human resources:** number and expertise of the human resources needed.
- **Cost:** qualitative monetary cost of the action.
- **Time for effects visualization:** time before the effects of the action are visible.
- **Durability:** how long do the results last.
- **Maintenance:** need of maintenance after the initial action, such as irrigation periods or interventions in the surrounding structures.
- **Increase of plant diversity:** effect of the action on the number and cover of native species and on the promotion of different vegetation layers.
- **Promotion of protected flora:** effect on the number and cover of native species of conservation interest.
- **Improvement of connectivity:** contribution to increase the connectivity between habitats alongside roads or trails.
- **Promotion of habitat for pollinators and micromammals:** contribution to create different sorts of habitat for fauna, namely through the promotion of shrub clusters, herbaceous corridors and diversified vegetation layers.
- **Global evaluation:** weighted analysis of all parameters.

A summary of the above analysis is presented next, in a triangular scheme which sorts the methods of flora promotion according to their advantages, disadvantages and monetary costs, for application to service strips and power line towers of very high voltage.



Species of native flora – how to propagate them!

A. Obtain seeds and propagules

The target species should be native and, preferably, originating from the region where the action will take place, to ensure an easy adaptation to the local environmental conditions and the maintenance of the genetic characteristics of the local populations. Moreover, the selection of species should consider the plant habit, growth rates, water and light requirements, soil preferences and biotic interactions with native fauna. The local climatic conditions and the management method are also factors that must be considered.

The introduction of native flora along the linear structures can be made by plantation or seeding.



EA

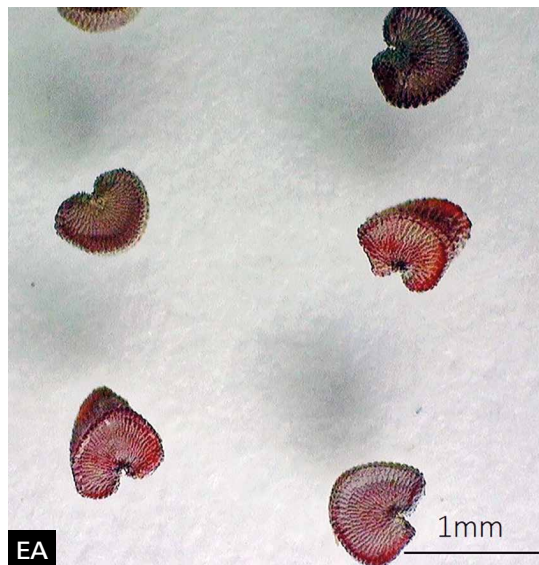
SEEDS

The seeds of native species can be obtained from certified seed producers or from the National Centre of Forest Seeds (Centro Nacional de Sementes Florestais – CE-NASEF). However, in some cases, the seeds must be directly collected from the wild since the commercial diversity and availability of seeds and their provenances can be limited, especially for herb species, whose provenance is often not the region where the action will take place.

The collection of native seeds is a widely used procedure for the *ex situ* conservation of genetic resources, as well as to ensure the *in situ* conservation through recovery or promotion of native species. However, the collection of seeds by the general public can damage or threaten the populations of native species.

It should be noted that the collection of seeds and their subsequent sowing in another place can genetically modify the neighbour populations of the same species, threatening the future viability of those populations. Besides, the introduction of a species into a new place, even if native, can enhance the weedy character of that species or lead to hybridizations, affecting the genetic integrity of the populations.

Therefore, the collection of seeds from the wild and their use should be carried out with a permit from the governmental agencies and according to the legislation (Portaria n° 1187/92 de 22 de dezembro and Decreto-Lei n.º 91/2012 de 12 de abril).



To collect seeds, it is also necessary to:

- Contact an institution responsible for the collection of seeds and obtain information about the procedure. In Portugal, it is required to obtain a permit by ICNF to collect seeds in protected areas or from protected species. In the other cases, the collection procedure should follow the ENSCONET Manual for collection of seeds from wild species, available at http://ensconet.maich.gr/PDF/Collecting_protocol_English.pdf;
- Verify if the species is legally protected at the national level. The classification of the species should also be consulted in the international (<https://www.iucnredlist.org/>) and national (e.g., in Portugal <https://listavermelha-flora.pt/>) red lists;
- Verify if the species is listed in some international agreement or directive that confers it a particular status, such as:
 - Habitats Directive – https://ec.europa.eu/environment/nature/legislation/habitatsdirective/index_en.htm
 - Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) – <http://www.cites.org>
 - Regulation of the European Council (EC) No 338/97, including annexes – http://www.ec.europa.eu/environment/cites/legis_wildlife_en.htm
 - Bern Convention – <http://conventions.coe.int/Treaty/EN/Treaties/Html/104.htm>
 - The International Treaty on Plant Genetic Resources for Food and Agriculture – <http://www.fao.org/plant-treaty/en/>
- Obtain permission from the landowner.



CPC

Since the collection of seeds requires some legal procedures and proficiency in some specific techniques, it is recommended that the seeds are purchased whenever possible. The collection from the wild should be done only if strictly necessary.

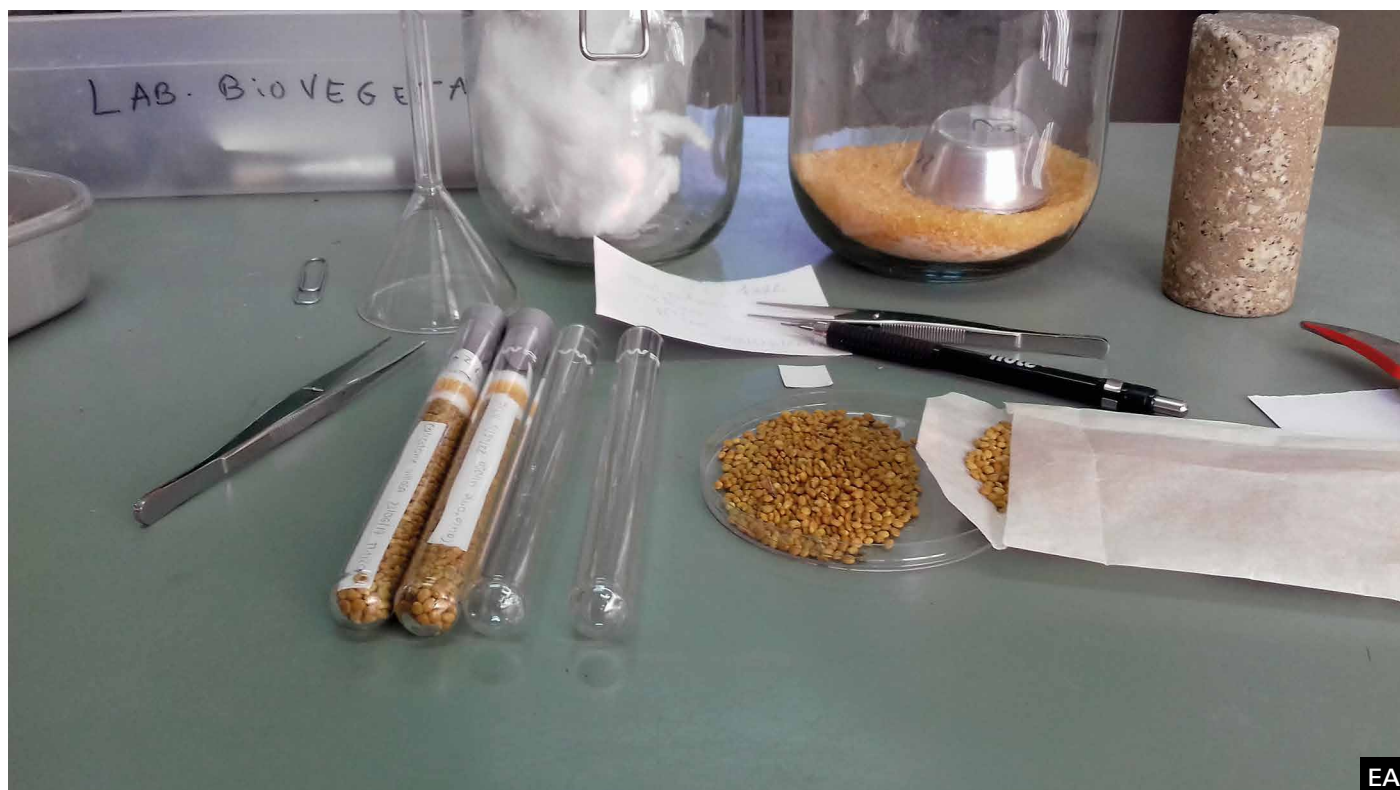
If the collection from the wild is inevitable, the following procedure is recommended:

- Search for populations of the target species in the proximity of the site where the action will take place;
- Select and tag sufficiently robust populations (with a high number of healthy individuals, adult and producing seeds) that will not be impaired by the collection of seeds;
- Whenever possible, evaluate the viability of a small sample of seeds of the population before collection;
- Adjust the technique of collection to each target species;
- Collect only mature seeds. Note that not all plants of a given population have mature seeds at the same time; also, in the same plant, different seed maturation phases can be found;
- Collect the seeds from as many individuals as possible without damaging the population (minimum: 50 plants, preferably 200 plants);
- Collect less than 20% of the mature seeds of the population; this does not apply if the population is about to be destroyed;
- Avoid collecting seeds from the same population on two consecutive years;
- Collect the seeds as much at random as possible;
- Try to collect seeds that encompass the diversity of the population. For example, avoid collecting seeds only from plants with more seeds, or from larger plants;
- Avoid collecting seeds from the ground, as they can be degraded;
- At the collection site, store the seeds in a closed but not air-tight container, for example a paper bag;
- Doubly identify the seed lots, for example, write it on the paper bag and also on a piece of paper put inside the bag. The identification should include at least the name of the species, the date and the place of collection;
- Collect a specimen of the species for herbarium preservation, to support future confirmation of the species identification.

After the collection and before using them, the seed lots should be treated. This includes cleaning, drying, viability analysis and quantification of seeds. These processes ensure that only the seeds of the target species are used and that they are in good conditions. More detailed information can be found in ENSCONET manuals, available at (http://ensconet.maich.gr/PDF/Curation_protocol_English.pdf).

If the seeds are not to be used soon (6 months), they must be properly stored; airtight glass containers are recommended for this purpose, with a silica gel bag inside to monitor humidity. Some seeds, like acorns, cannot be stored under such conditions; for short periods they can be kept in moist sand, in a cool place, until they are sown at the target place, or sown in seedling-pots for subsequent plantation there.

The seeds of herbaceous species can be directly applied at the target place or sown in nurseries to produce more seeds. To produce new plants of bulbous species, shrubs and trees, seeds are recommended.





YOUNG PLANTS

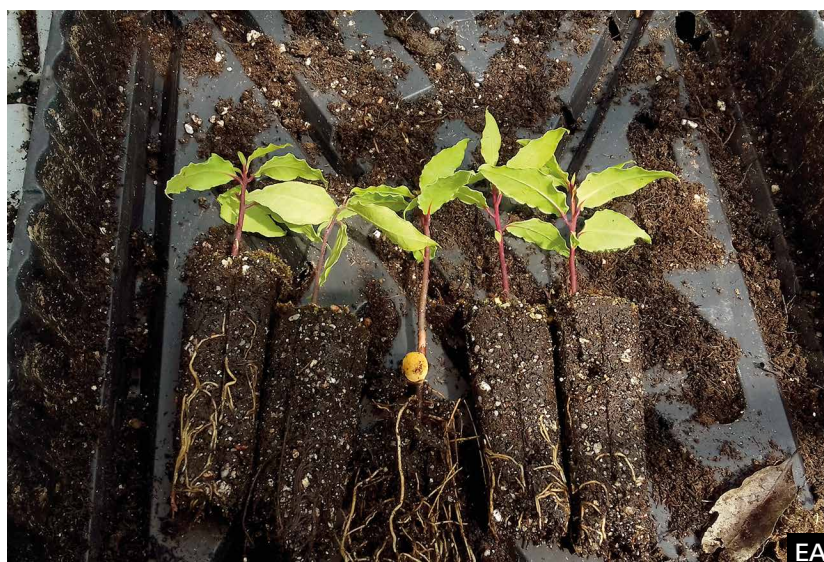
The acquisition of shrubs and trees should be done from certified nurseries which guarantee the genetic quality of forest materials and the compliance with the current legislation (Decreto-Lei n.º 13/2019 de 21 de janeiro).

The plants should originate from propagules of nearby areas, similar to the target site.

The conditions for production are specific for each species and must be respected in order to obtain robust plants that can be transplanted to the target site. The following information about the species requirements should be obtained:

- Type of substrate;
- Light and temperature;
- Watering;
- Type and size of seedling pot.

Some weeks before plantation, the plants should be allowed to acclimate outdoors, at some place near the target site.



B. Techniques to sow and plant native species

Herbaceous species, especially annuals, should be sown directly into the target area, whereas shrubs and trees should be sown in nursery containers and later planted at the target site. Although many biannual or perennial herbaceous can easily propagate vegetatively, and thus more rapidly produce adult plants, that process does not promote the genetic diversity.

SOWING

Sowing is generally used to propagate annual plants and its purpose should suit the circumstances and the target place. If there are invasive plant species at the target site, their expansion should be controlled prior to the introduction of the native species, which then will contribute to the control strategy, as explained before.

In Portugal, the margins of the linear infrastructures frequently present some native vegetation, resulting from the passive colonization from the surrounding areas. As such, the introduction of native species will complement the already existing diversity. The total cover of the ground or the drastic change of the existing vegetation is seldom the goal of sowing and, therefore, large-scale seeding is recommended only in very specific cases, for example to reduce the risk of slope collapse.

The seeding can include just one species or a mixture of species. The selection of species, mixture composition and/or seeding densities depend on the objective, the type of infrastructure and the edaphoclimatic conditions of the place. The quantity of seeds must be calculated taking the quality of the seed lots into account, as well as the objective of its introduction and the characteristics of the species.

Mediterranean species should be sown in autumn, to ensure enough water availability for germination and seedling growth.

If adequately managed, plants introduced through seeding are self-sustainable for several years, and a high diversity is maintained resulting both from the initially introduced seeds that did not immediately germinate (dormancy) and from the seeds produced by the new plants. However, it is expected that species interactions will change over time and a new seeding is needed some years after the initial one.



There are several seeding techniques, but the most common are by hand, broadcasting sowing and hydroseeding, depending on the size of the area to be sown.

In any of those cases, a previous preparation of the soil is necessary, to ensure appropriate humidity conditions for seedling development. This preparation should be more or less intensive, depending on the situation, and generally includes:

- Regularization of the ground surface, by removal of stones, irregularities and large crevices
- Addition of a layer (approx. 15 cm thick) of organic soil if necessary
- Smoothing the surface with a motor grader or with the back of a backhoe's bucket, or by hand, using a hoe; in some cases, the earth should then be slightly compacted.



After these procedures, the soil is prepared for sowing according to the most suitable technique:

- **In small areas (for example, micro-reserves):** the **conventional sowing** is the most adequate technique and consists of a manual or mechanical distribution of seeds on the surface and burying them afterwards. Seed burying can be made by raking the soil, followed by rolling, or by two crossings with a "Cross Kill"-type roller. After burying, an initial and uniformly distributed watering is recommended, to increase the success rate.
- **In large areas: hydroseeding** is advisable and consists of spraying the seeds over the ground in the form of a slurry, by means of a hydroseeder. Fertilizers and organic amendments can be added to the seeds, as well as tackifiers and/or seed protectors, depending on the characteristics of the target place and/or species.



CPC

PLANTATIONS

Plantation is used to introduce shrubs and trees, but also to promote small nuclei of perennial herbs such as those from bulbous species. The plants come generally in rootball or in nursery containers, and should be healthy, with no dead or damaged roots.

The plantation process begins with the opening of a hole of suitable size for the plant. This hole should be filled with organic soil, a ternary fertilizer and a root stimulator, but a previous roughening of the bottom and sides of the hole is recommended, to allow a better adherence of the soil that will fill it. Then, in the centre, another hole, large enough to fit the rootball, should be made and the plant placed there. The stem base of the plant should stay at the soil surface, to avoid root suffocation. Excavating a berm around the perimeter of the planting hole is recommended, to facilitate water retention. After plantation, a first watering should be made.

Native plants are well adapted to the environmental constraints, including water shortage, and do not need a maintenance irrigation. However, a regular maintenance irrigation is advisable in the two first years after plantation, particularly during summer, as well as a control of noxious weeds, to optimize the development of the planted individuals. Despite all these cares, it might be necessary to later replace dead or very poorly developed plants.

The plants should be tagged or protected, in a manner suiting their size, so that they are not accidentally damaged during the maintenance of the linear infrastructure margins. Tree-shelters might be adequate for shrubs and smaller trees, whereas plant tutors are more adequate for larger trees.



Species cards



EXOTIC INVASIVE SPECIES



Detection period



Flowering period



Fruiting period



Origin and distribution



Control techniques



Precautions

Scientific name

Acacia dealbata Link.

Common name

Silver wattle, Mimosa

Family

Fabaceae



Southeast of Australia and Tasmania.

Purpose of introduction:

Ornamental, to fix frequently waterlogged soils, timber.



(1) in seedlings and young plants, pulling by hand*, preferably during the rainy season to facilitate removal of the root; (2) in young plants and adults with a straight and clean trunk, debarking*; (3) in adults, injection of herbicide* in the vascular system through wounds or hole; (4) in adults, when other methods cannot be applied, felling followed by localized application of herbicide.

*methodology recommended for **Linear Infrastructures**



Felling, sometimes even if followed by herbicide application, is poorly effective because it stimulates resprouting from roots and lignotubers, so it must be used only as a last option. After felling or pulling, gather all the residues in one place, to avoid the dispersal of seeds. The black wattle (*Acacia mearnsii*) is a similar species, with paler flowers, to which the same control methods can be applied.

Scientific name

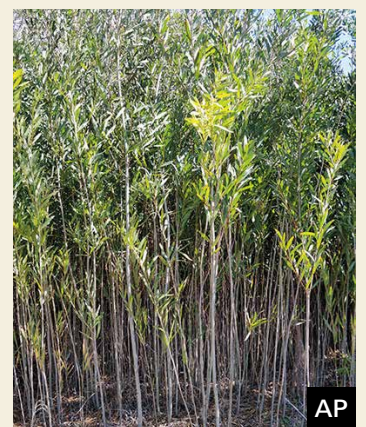
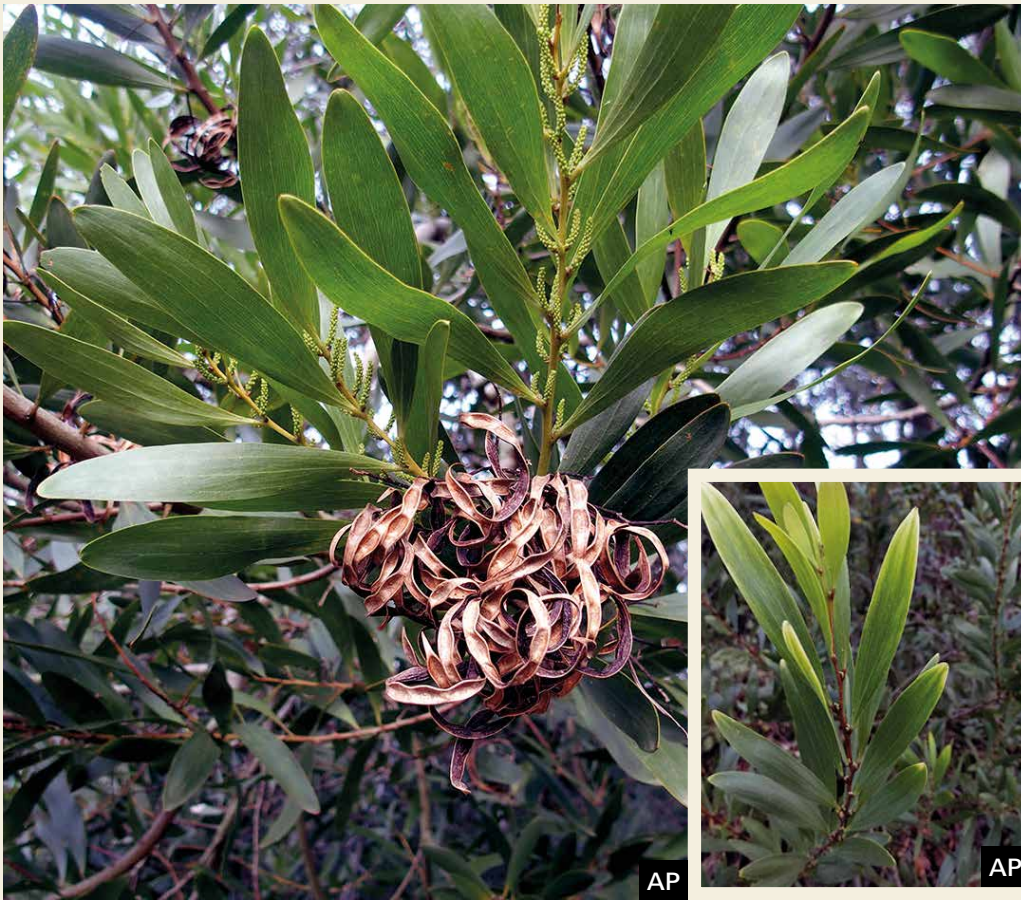
Acacia longifolia (Andrews) Willd.

Common name

Golden wattle

Family

Fabaceae



Southeast of Australia.

Purpose of introduction:

Erosion control, mainly in coastal dunes, and ornamental.



(1) in seedlings and very young plants, pulling by hand*, preferably during the rainy season to facilitate removal of the root; (2) in young plants and adults with a straight and clean trunk, debarking*; (3) in adults, injection of herbicide* into the vascular system through wounds or holes; 4) in adults, when other methods cannot be applied, felling followed by localised application of herbicide.

*methodology recommended for **Linear Infrastructures**



Felling, sometimes even if followed by herbicide application, is poorly effective because it stimulates resprouting from roots and lignotubers, so it must be used only as a last option. After felling or pulling, gather all the residues in one place, to avoid the dispersal of seeds.

Scientific name

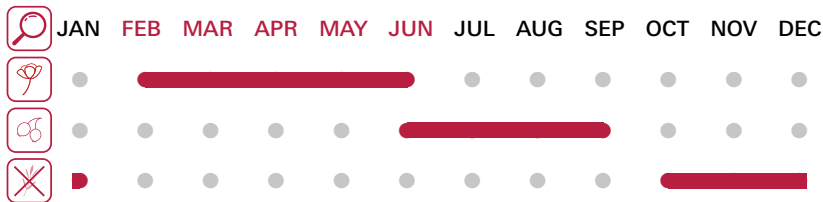
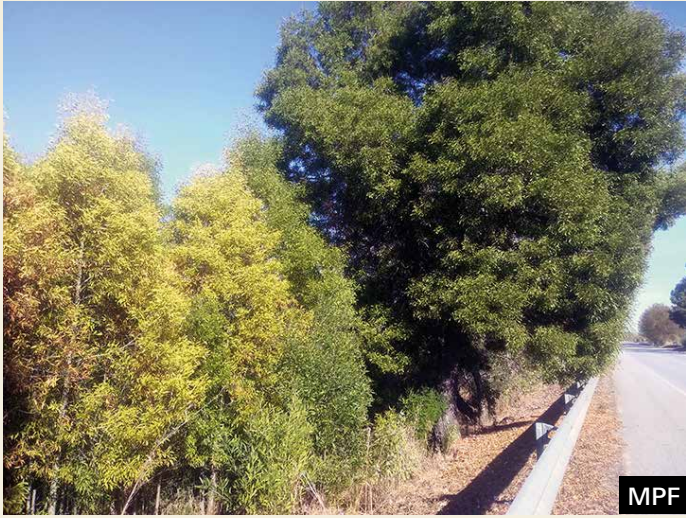
Acacia melanoxylon R. Br.

Common name

Blackwood, Australian blackwood

Family

Fabaceae



Southeast of Australia and Tasmania.

Purpose of introduction:

Purpose of introduction: Ornamental, to fix frequently waterlogged soils, for timber and for shade.



(1) in seedlings and young plants, pulling by hand*, preferably during the rainy season to facilitate removal of the root; (2) in young plants and adults with a straight and clean trunk, debarking*; (3) in seedlings or resprouts smaller than 25 cm, cut with a brushcutter in warm days; (4) in adults, injection of herbicide* in the vascular system through wound or hole; (5) in adults, when other methods cannot be applied, felling followed by localized application of herbicide.

*methodology recommended for **Linear Infrastructures**



Felling, sometimes even when followed by herbicide application, is poorly effective because it stimulates resprouting from roots and lignotubers, so it must be used only as a last option. After cutting or pulling, gather all the residues in one place, to avoid the dispersal of seeds.

Scientific name

Acacia pycnantha Bentham, *Acacia retinodes* Schlecht. e *Acacia saligna* (Labill.) H. L. Wendl.

Common name

Golden wattle, Water wattle and Orange wattle

Family

Fabaceae



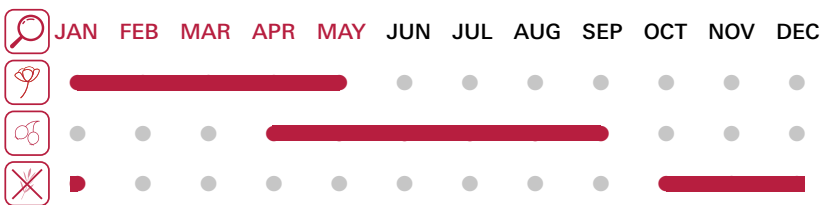
AP



AP



AP



Southeast, south and west of Australia and Tasmania, respectively.

Purpose of introduction:

Ornamental, control of erosion in coastal dunes (*Acacia saligna*) and tannin extraction (*Acacia pycnantha*).



(1) in seedlings and very young plants, pulling by hand*, preferably during the rainy season to facilitate removal of the root; (2) in young plants and adults with a straight and clean trunk, debarking*; (3) in adults, when other methods cannot be applied, felling followed by localized application of herbicide.

*methodology recommended for **Linear Infrastructures**



Felling without herbicide application can be little effective and stimulate resprouting from lignotuber, which makes the control more difficult. After felling or pulling, gather all the residues in one place, to avoid the dispersal of seeds. The three species are similar, with some differences in leaf morphology and flowering season.

Scientific name

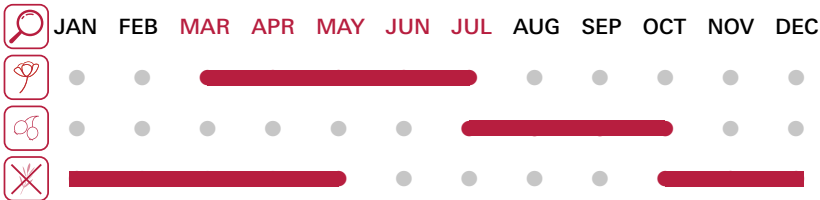
Ailanthus altissima (Mill.) Swingle

Common name

Tree-of-heaven

Family

Simaroubaceae



China.

Purpose of introduction:

Ornamental in urban spaces and roadsides.



(1) in seedlings and young plants, pulling by hand*, preferably during the rainy season to facilitate removal of the root; a rake can also be used to loosen the first roots; (2) in plants of diameter > 5 cm, injection with herbicide* in the vascular system through several wounds, where the herbicide must be immediately applied; (3) in adults, when other methods cannot be applied, felling followed by localised application of herbicide.

*methodology recommended for **Linear Infrastructures**



When pulling the plants, make sure that no large roots or their fragments are left in the soil, as they can easily resprout. Felling without application of herbicide is poorly effective as it stimulates resprouting from roots, thus making the control more difficult.

Scientific name

Arundo donax L.

Common name

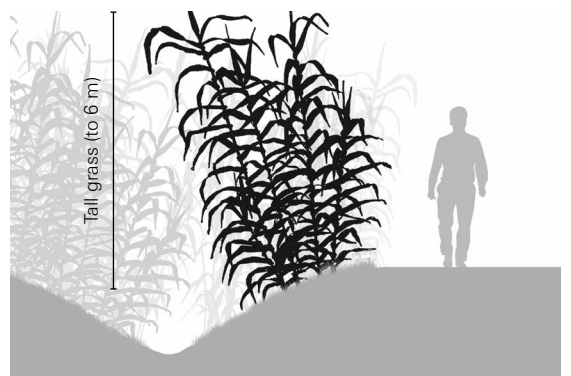
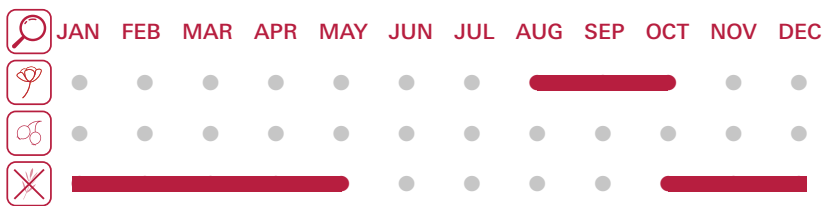
Cane, giant reed

Family

Poaceae



MPF



Eastern Europe and temperate and tropical Asia.

Purpose of introduction:

Possibly for slope stabilization, hedges and flooding control.



(1) manual removal, in the case of recently established nuclei of young plants (< 2 m tall) with small rhizomes*; (2) cut and removal of rhizomes, in the case of established clusters, with extensive rhizomes*; (3) clear-cut and cover of the whole area with an impermeable, resistant and opaque canvas for several months, in river banks and slopes; (4) successive cuts of the aerial part of the plant (preferably before they reach 0.5 m) to exhaust the rhizome reserves, in the case of large areas; although it does not always eliminate the canes, this low-cost technique prevents their propagation and decreases their density.

*recommended method for Linear Infrastructures.

*methodology recommended for **Linear Infrastructures**



When pulling and removing the plants, do not leave any fragments or rhizomes on the ground, because they easily regenerate and originate new plants. Harrowing the invaded areas only contributes to dispersal because it cuts and drags the rhizomes, originating new sources of invasion. All the extracted rhizomes should be destroyed by burning and the aerial parts cut into small chips which can remain in place.

Scientific name

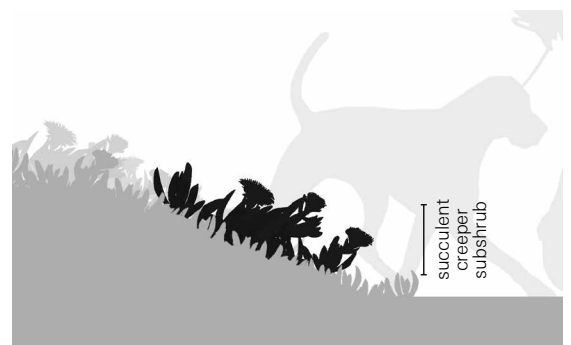
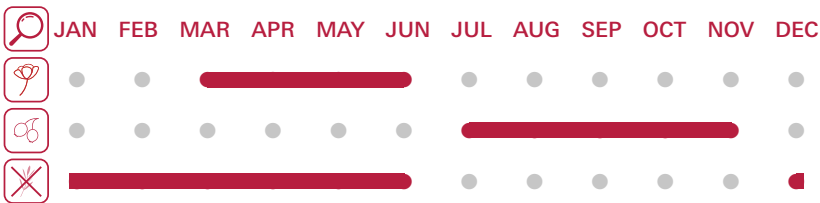
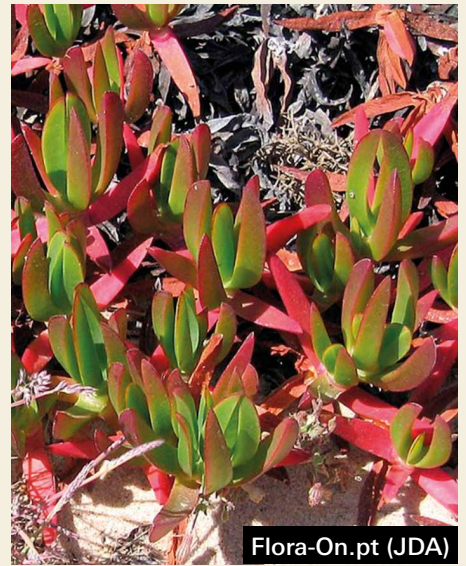
Carpobrotus edulis (L.) N. E. Br.

Common name

Ice plant, Hottentot fig

Family

Aizoaceae



South Africa.

Purpose of introduction:

Ornamental, and to fix dunes and slopes.



(1) pulling by hand at any time, from sandy substrates; in compact substrates, pulling during the rainy season to facilitate root removal; they can be piled up on spot, with the roots downside up so that they do not touch the ground.



When removing the plants, do not leave any bigger roots, stem fragments or fruits in contact with the soil, as they can easily become new sources of propagation. Harrowing the invaded areas only contributes to the expansion of this species, by fragmenting and dragging the stems, which root very easily.

Scientific name

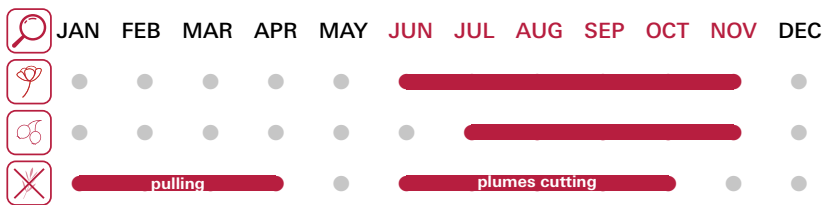
Cortaderia selloana (Schult. & Schult.f.) Asch. & Graebn.

Common name

Pampas grass

Family

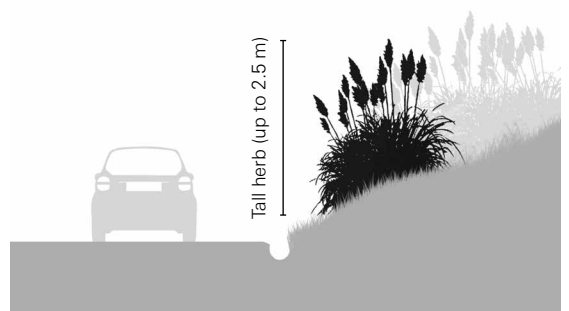
Poaceae



South America (Chile and Argentina).

Purpose of introduction:

Ornamental.



(1) in seedlings and very young plants, pulling by hand*, preferably during the rainy season to facilitate removal of the root; (2) in larger plants, mechanical pulling; (3) cut and removal of roots / rhizomes, when pulling is not possible; (4) annual cut of the plumes, before seed dispersal, ensuring that they are safely transported in bags and destroyed later; (5) cut of the stems followed by herbicide application, when other methodologies are not applicable.



When pulling and removing the plants, make sure no rhizomes or roots are left in the soil, as they can easily regenerate. The pulling should be performed with personal protective equipment, because the leaves are quite sharp.

Scientific name

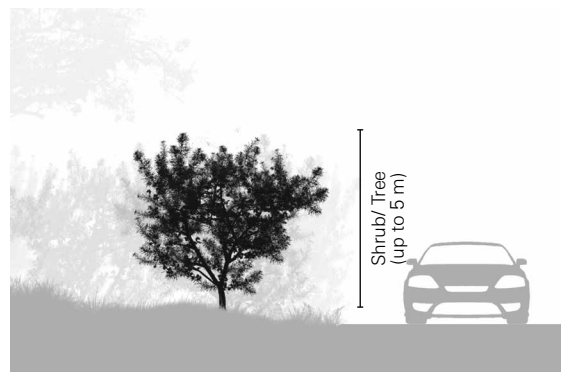
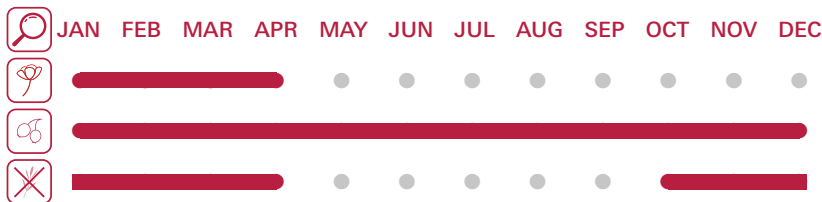
Hakea salicifolia (Vent.) B.L. Burtt. e *Hakea sericea* Schrader

Common name

Willow-leaved hakea and silky hakea

Family

Proteaceae



South and southwest of Australia and Tasmania.

Purpose of introduction:

Ornamental, hedges for protection against the wind, mainly on the coast.



(1) in seedlings and very young plants, pulling by hand*, preferably during the rainy season to facilitate removal of the root; (2) in young plants and adults, cut as closest as possible to the ground, before fruit ripening, and apply controlled fire 12 to 18 months later, when the seeds start to germinate (*Hakea sericea*); (3) in adults, when other methods are not applicable, cut with localised application of herbicide.



The fruits contain numerous seeds that, once released, rapidly germinate if they find suitable conditions. Fire promotes fruit breaking and opening, and the release and germination of the seeds, so this method requires follow-up. The leaves of *Hakea sericea* are prickly. The fruits produced over different years accumulate in the canopy and only release the seeds when there is a fire.

Scientific name

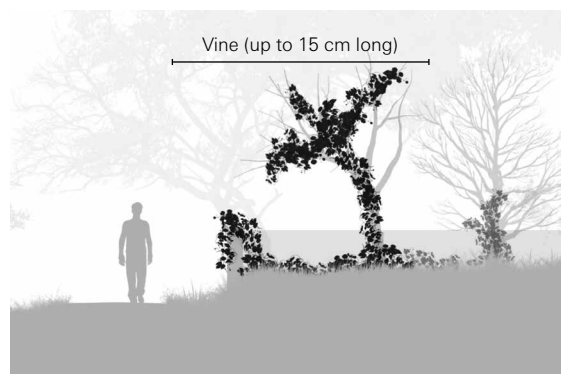
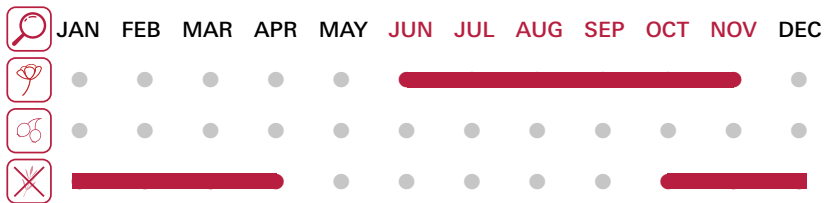
Ipomoea indica (Burm.) Merr.

Common name

Blue morning glory

Family

Convolvulaceae



Tropical south America, Asia and Hawaii.

Purpose of introduction:

Ornamental.



(1) Pulling by hand during the rainy season, to facilitate the removal of roots; (2) cutting the stems near the ground, with subsequent application of a post-emergent systemic herbicide (glyphosate) on the cut surface, when other methods cannot be applied.



Upon pulling and removal, do not leave roots or fragments in the soil, as they will originate new plants.

Scientific name

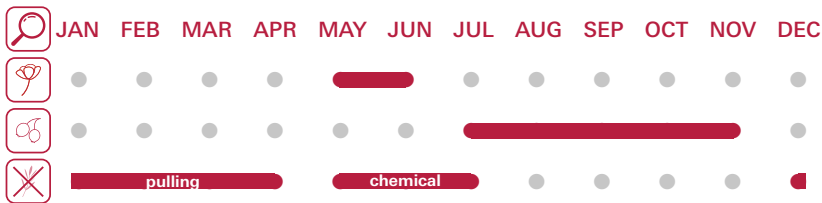
Opuntia ficus-indica (L.) Miller

Common name

Prickly pear

Family

Cactaceae



Tropical America (from Mexico to Colombia).

Purpose of introduction:

Ornamental, hedges and fruits.



(1) Manual or mechanical pulling during the rainy season to make the removal of the root easier; (2) cutting of the stems and removal of the roots, by manual or mechanical means; (3) injection of herbicides into the stems, before the development of the fruits.



Before ripening, the fruits already contain viable seeds. The stems are thorny, so personal protective equipment should be used to handle them. During removal, do not leave bigger roots, stem fragments or fruits on the ground, as they can easily originate new sources of invasion.

Scientific name

Oxalis pes-caprae L.

Common name

Sourgrass, buttercup oxalis

Family

Oxalidaceae



Invasoras.pt



AP



invasoras.pt



South Africa.

Purpose of introduction:

Probably as ornamental.



Perennial herb
(up to 40 cm)



(1) in small areas, frequent pulling by hand to prevent bulb formation; (2) where there are no native species to preserve, soil solarisation with a transparent plastic cover.



Due to the high production and fragmentation of bulbs, soil harrowing is disapproved, as it increases the propagation of this species..

Scientific name

Phytolacca americana L.

Common name

Pokeweed

Family

Phytolaccaceae



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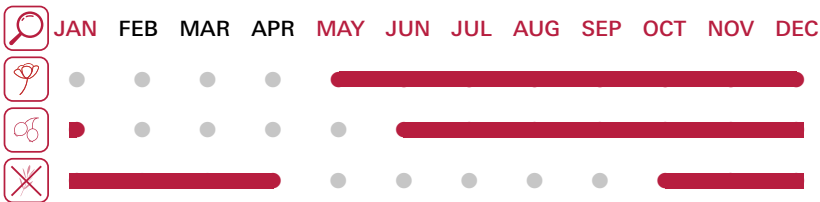
Flora-On.pt (JDA)



Invasoras.pt



Flora-On.pt (JDA)



North America.

Purpose of introduction:

Medicines and dyes.



(1) pulling by hand, during the rainy season to facilitate removal of the roots.



During removal, do not leave bigger roots in the soil. The stems, leaves and fruits of this plant are toxic.

Scientific name

Ricinus communis L.

Common name

Castor bean

Family

Euphorbiaceae



Tropical Africa.

Purpose of introduction:

Food, medicinal and industrial purposes (production of castor bean oil).



(1) pulling by hand, during the rainy season, to facilitate removal of the root; (2) cutting followed by localised application of herbicide, as a last option only, and before fruit maturation.



Once dry, the capsules explosively release the seeds to long distances, which can originate new sources of invasion during the removal of these plants. The seeds are extremely toxic and can cause severe allergies and even death if eaten.

Scientific name

Robinia pseudoacacia L.

Common name

Black locust

Family

Fabaceae



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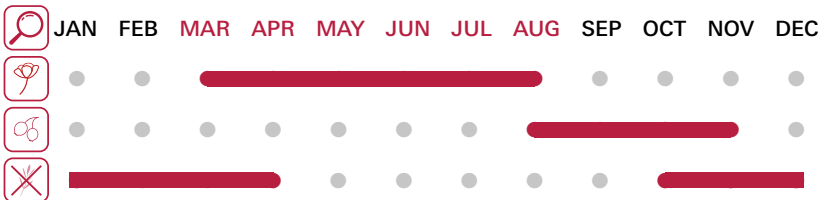
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Centre and east of North America.

Purpose of introduction:

Ornamental, medicinal, timber and soil stabilization.



(1) in seedlings and very young plants, pulling by hand*, preferably during the rainy season to facilitate removal of the root; (2) in plants with diameter > 5 cm, injection of herbicide* into the vascular system through several wounds, where the herbicide must be immediately applied; (3) in adults, when other methods cannot be applied, felling followed by localised application of herbicide.

*methodology recommended for **Linear Infrastructures**



When pulling the plants, make sure that no large roots or their fragments are left in the soil, as they can easily resprout. Felling without application of herbicide is poorly effective as it stimulates resprouting from roots, thus making the control more difficult.

Scientific name

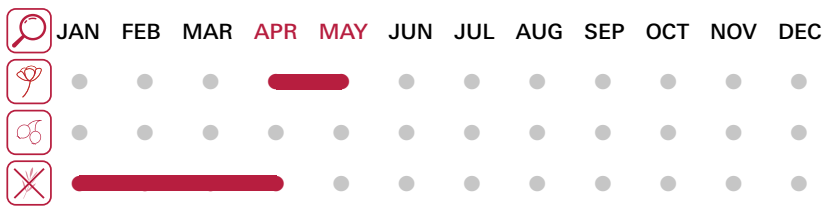
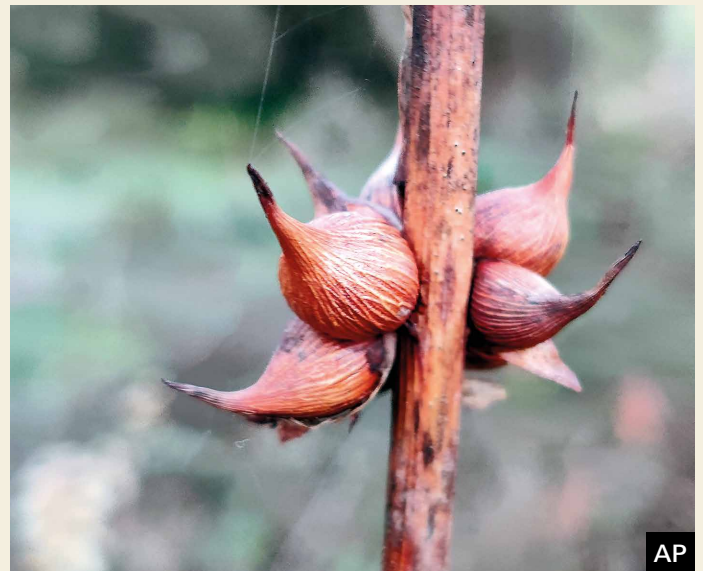
Watsonia meriana (L.) P. Mill.

Common name

Bulbil bugle-lily

Family

Iridaceae



South Africa.

Purpose of introduction:

Ornamental.



(1) in isolated plants, pulling by hand to unbury the bulbils; (2) cut leaves before the formation of stems with aerial bulbils; this is not a definitive method because it just weakens the bulbils already present in the soil, but prevents their propagation.



In invaded areas where bulbils already formed, pay attention to bulbils that might stick to the clothes and thus be transported elsewhere.

Species cards



RECOMMENDED NATIVE SPECIES



Herbaceous species



Shrubs



Propagules recolection period



Flowering period



Fruiting period



Propagation period



Ecology



Ecological interest

Scientific name

Aegilops spp. (*A. geniculata* Roth e *A. triuncialis* L.)

Common name

Goatgrass

Family

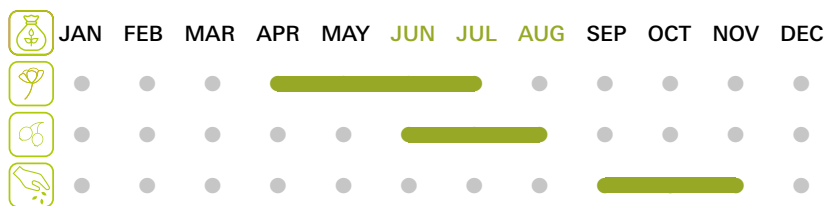
Poaceae



Flora-On.pt (JDA)

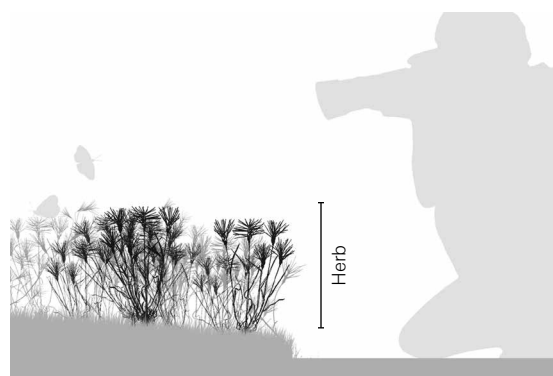


Flora-On.pt (CA)



Grasslands, pastures, wastelands and borders of trails. Widespread throughout mainland Portugal, generally in dry places.

Life form: Therophyte/ Annual.



Habitat for butterflies.



Manual seed collection from the ripe spikelets, which easily detach from the plant and are brownish. Precautions: wear gloves, as the awns can easily pierce the skin.



Seeding: the spikelets should previously be separated from each other. No pre-treatment is required, but extracting the seeds from the spikelets may facilitate germination. Seeding to produce seeds should be done outdoors directly on the soil.

Type of infrastructure for which it is recommended: roads and trails.

Scientific name

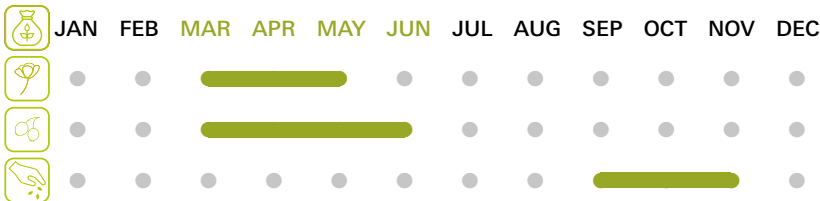
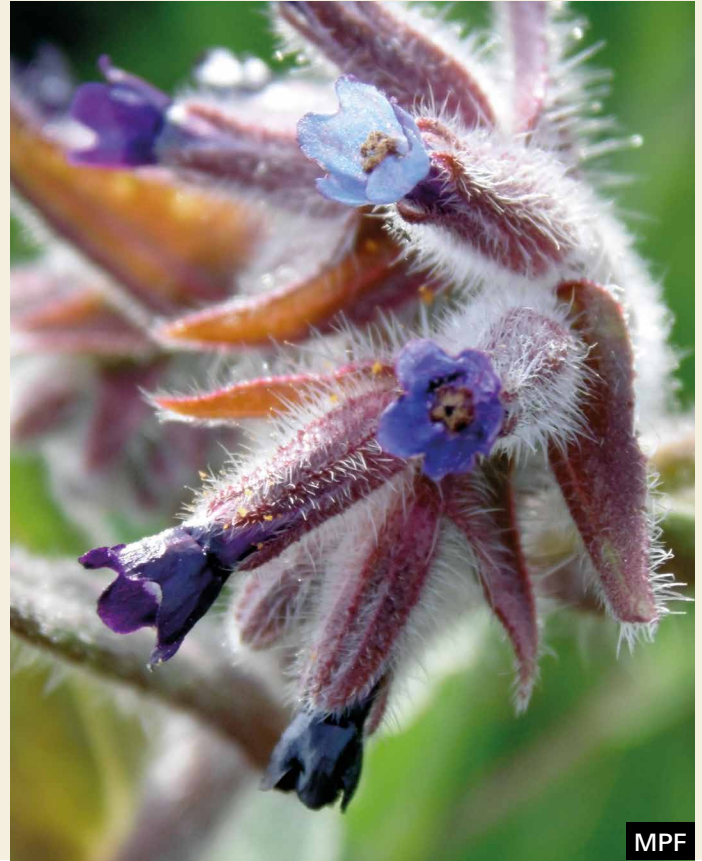
Anchusa undulata L.

Common name

Undulate alkanet

Family

Boraginaceae



Grasslands, pastures, somewhat moist wastelands, margins of roads and trails. Widespread throughout mainland Portugal, in any type of soil, but especially inland.

Life form: Hemicryptophyte/ Perennial.



Promotes the pollinators. Endemic to the Iberian Peninsula.



Hand collection of the ripe (black) seeds. In general, seed maturation is not synchronous within a plant, therefore a continuous and careful collection must be made over time. Precautions: wear gloves, as the hairs of the inflorescences and leaves easily pierce the skin.



Seeding: no pre-treatment is required. It can be sown outdoors, directly into the target place, or in nurseries to produce plants that will be subsequently planted. In the latter case, seeding should be done in small containers with a 50:50 peat and sand mixture, and kept moist but not wet.

Type of infrastructure for which it is recommended: roads and trails.

Scientific name

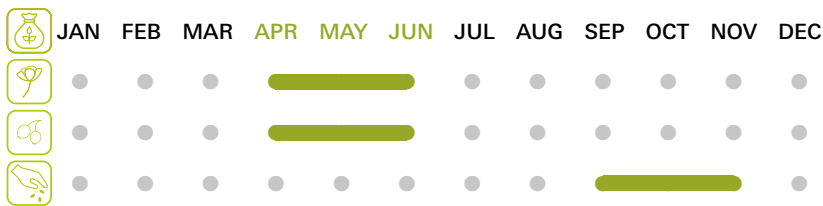
Brachypodium distachyon (L.) P.Beauv.

Common name

Stiff brome

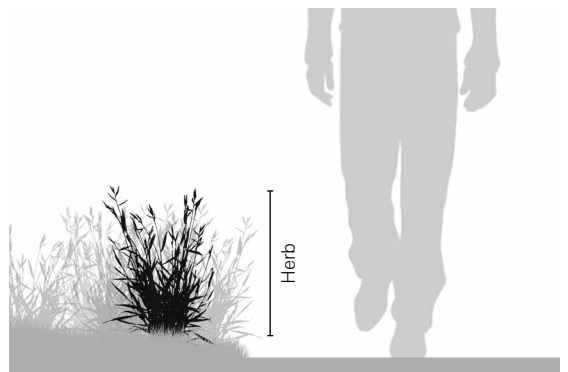
Family

Poaceae



Annual grasslands, pastures, borders of trails and clearings of open scrubs. Widespread throughout mainland Portugal, especially on dry soils..

Life form: Therophyte/ Annual.



Promotes habitats for butterflies.



Hand collection of the ripe (brown and dry) spikelets. Precautions: wear gloves, as the awns of the spikelets can easily pierce the skin.



Seeding: the seeds should be separated prior to seeding, although they need not be peeled nor pre-treated. Seeding should be done outdoors directly into the soil.

Type of infrastructure for which it is recommended: trails and micro-reserves.

Scientific name

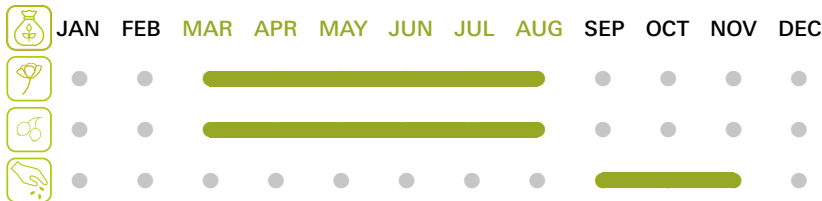
Campanula lusitanica L.

Common name

Bellflower

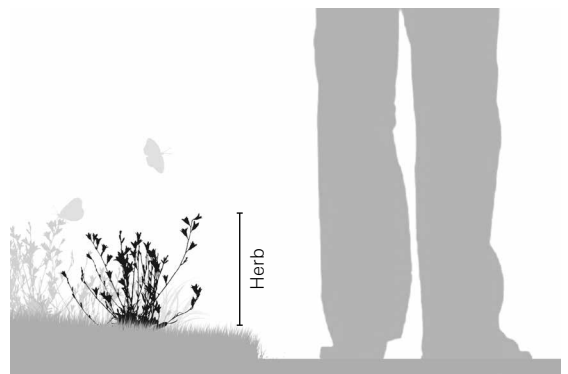
Family

Campanulaceae



Fallows, annual grasslands and pastures, slopes, ditches and rocky sites. It prefers zones with some shade and acid soils. It is spread in most of mainland Portugal.

Life form: Therophyte/ Annual.



Promotes the occurrence of pollinators.



Seed collection can be made by shaking the ripe (brownish) capsules into a bag. Alternatively, the capsules can be collected by hand in the field and shaken indoors later, to release the seeds. Due to the small size of seeds, crushing the capsules to release them is not advisable, as the residues are difficult to separate from the seeds, even with sieves.



Seeding: no pre-treatment is required. Seeding should be done outdoors into the shady parts of the target place, and not too deep.

Type of infrastructure for which it is recommended: roads, trails and micro-reserves.

Scientific name

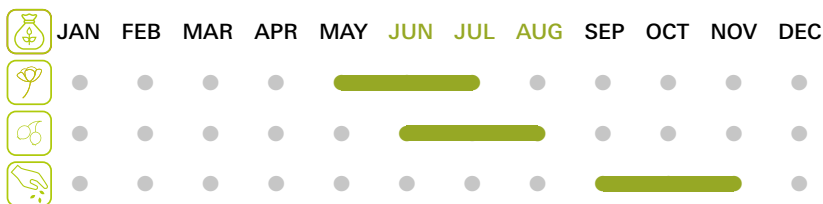
Cynara humilis L.

Common name

Wild thistle

Family

Asteraceae



Borders of trails, ravines, wastelands, clearings of woods and shrublands. Occurs mainly in the Centre and South of mainland Portugal, in dry places and on any type of soil.

There are populations exhibiting only white flowers.

Life form: Hemicryptophyte/ Perennial.



Promotes habitat for butterflies and other pollinators.



Manual collection of the dry inflorescences, with a pair of shears. The seeds can be manually extracted by picking the pappi or cutting the inflorescence in two. This species is frequently colonized by larvae which feed on the seeds and so the extraction of seeds immediately after collection, and their conservation in the cold until seeding are advised. Precautions: wear gloves.



Seeding: no pre-treatment is required. Seeding can be done outdoors, directly into the target place, or in small containers (indoors or outdoors) on a mixture of peat and sand (50:50) to produce plants that will be planted later.

Type of infrastructure for which it is recommended: trails and micro-reserves.

Scientific name

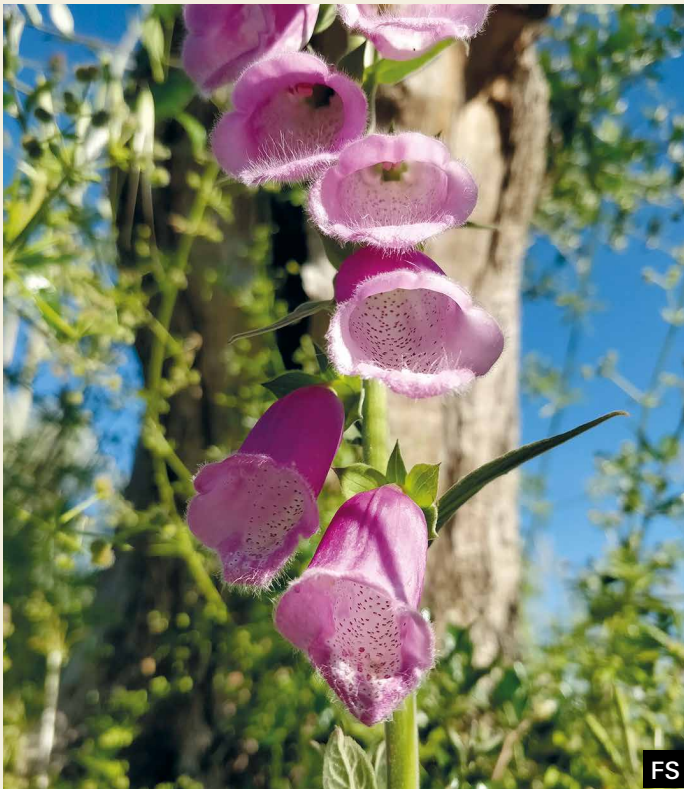
Digitalis thapsi L.

Common name

Foxglove

Family

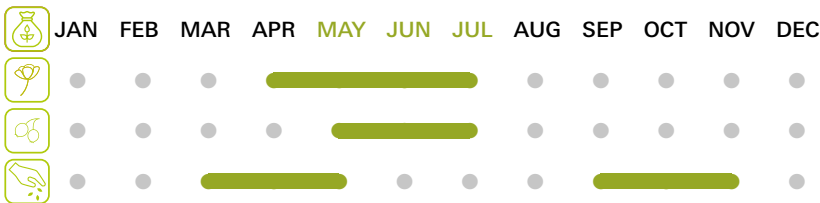
Plantaginaceae



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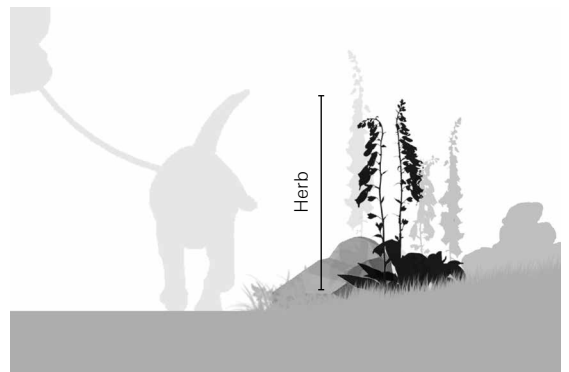


MPF



Crevices of rocky outcrops, clearings of grasslands on stony slopes and fallows. Widespread throughout mainland Portugal, in any acid soils, frequently in areas of granite, quartzite and schist.

Life form: Hemicryptophyte/ Perennial.



Endemic to the Iberian Peninsula.



Hand collection of the ripe (brownish) capsules. The plant is very sticky, so a better, though more lengthy method is to shake the capsules into a paper bag, to release the ripe seeds and avoid their "glueing" to the plant. Precautions: wear gloves, the plant is toxic.



Seeding: no pre-treatment is required. Seeding can be done outdoors into the target place, or in small containers (indoors or outdoors) on a peat and sand mixture (75:25) to produce plants for later plantation.

Type of infrastructure for which it is recommended: micro-reserves.

Scientific name

Gladiolus illyricus W.D.J. Koch

Common name

Wild gladiolus

Family

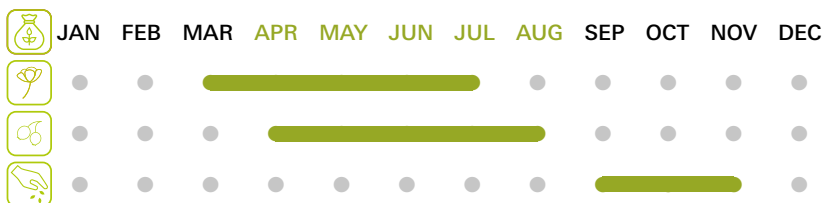
Iridaceae



Flora-On.pt (PPS)



FS



Wastelands, fallows, borders of shrublands, road slopes and trails. Widespread throughout mainland Portugal, preferring acid soils.

Life form: Geophyte/ Perennial.



Promotes small mammals.



Hand collection of the ripe (brownish) capsules, from which the seeds will subsequently be extracted. Although the vegetative propagation is easier – collection of bulbs and their plantation in the target place – it is not advisable, as it implies the impoverishment of the donor populations.



By seed or bulbs. Seeding: no pre-treatment is required. Seeding can be done outdoors into the target place, but the production of plants for subsequent plantation is recommended. This production can be made in small containers, indoors or outdoors, in a mixture of peat and sand (50:50).

Type of infrastructure for which it is recommended: trails and micro-reserves.

Scientific name

Hyacinthoides vicentina (Hoffmanns. & Link) Rothm.

Common name

Bluebell

Family

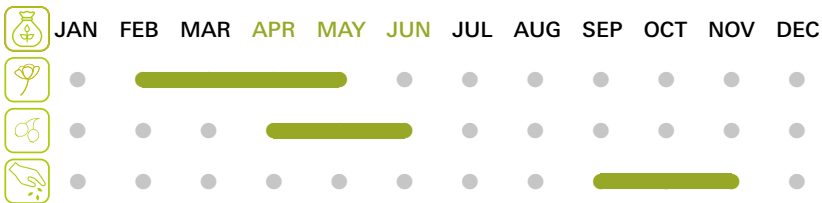
Asparagaceae



EA



FS



Clearings of scrubs or fallows, on sandy or clay soils. Frequent in places temporarily flooded and, sometimes, along water courses. It occurs in the South of mainland Portugal, especially on the south-western coast.

Life form: Geophyte/ Perennial.

Herb



Annexes II and IV of the Habitats Directive. Endemic to mainland Portugal. It promotes small mammals.



Hand collection of the ripe (brownish) capsules, from which the seeds will subsequently be extracted. Although the vegetative propagation is easy – collection of bulbs and their plantation on the target place – it is not advisable, as it implies the impoverishment of the donor populations.



By seeds or bulbs. Seeding: no pre-treatment is required. Seeding can be done outdoors into the target place, but the production of plants for subsequent plantation is recommended. This production can be made in small containers, indoors or outdoors, in a mixture of peat and sand (50:50).

Type of infrastructure for which it is recommended: micro-reserves.

Scientific name

Hypericum perforatum L.

Common name

St. John's-wort

Family

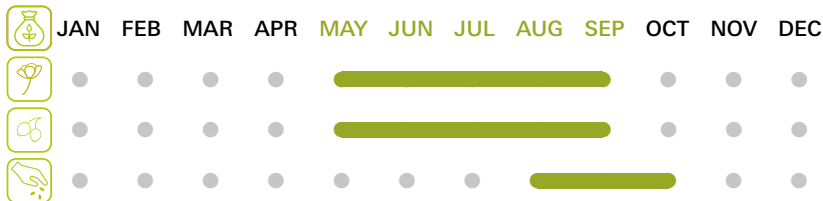
Hypericaceae



FS



Flora-On.pt (AJP)



Borders of woodlands, low scrubs, mesoxerophytic scrubs, roadsides, borders of trails, and fallows. Widespread throughout mainland Portugal, with a wide ecological plasticity.

Life form: Hemicryptophyte/ Perennial.



Promotes the occurrence of pollinators.



Hand collection of the ripe (brownish) capsules and subsequent extraction of the seeds. This can be done by crashing them against a sieve with a mesh size adequate to retain only the fragments of the capsules.



Seeding: no pre-treatment is required, but the application of gibberellin might promote germination. Seeding can be done directly into the target place or to produce plants that will later be planted there. The plants can be produced in small containers, indoors or outdoors, on a substrate of peat and sand (50:50).

Type of infrastructure for which it is recommended: roads and trails

Scientific name

Lamarckia aurea (L.) Moench

Common name

Goldentop grass

Family

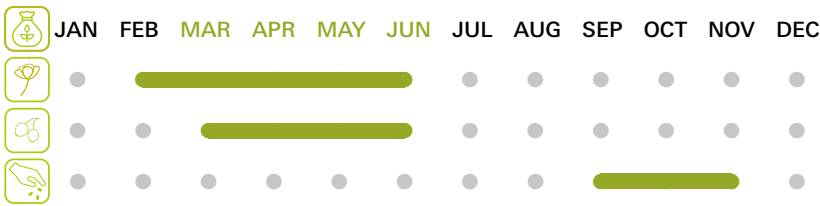
Poaceae



FS

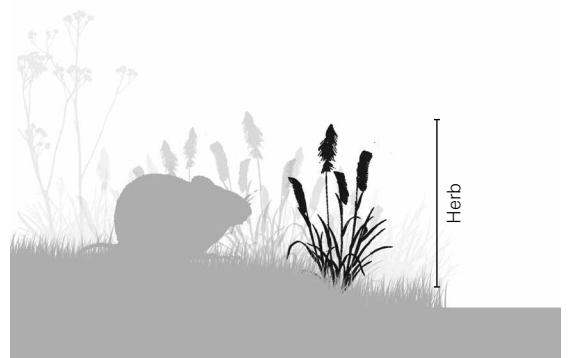


PM



Annual grasslands, clearings of scrubs, walls, slopes, rocky outcrops and pastures. It occurs in small populations throughout mainland Portugal, normally on dry and stony places; somewhat nitrophile.

Life form: Therophyte/ Annual.



Promotes butterflies.



Hand collection of the ripe (brown and dry) spikelets.



Seeding: no pre-treatment is required and the seeds need not be extracted from the spikelets, but the separation of the spikelets is advisable. Seeding should be done outdoors directly into the soil.

Type of infrastructure for which it is recommended: roads, trails and micro-reserves.

Scientific name

Mantiscalca salmantica (L.) Briq. & Cavill.

Common name

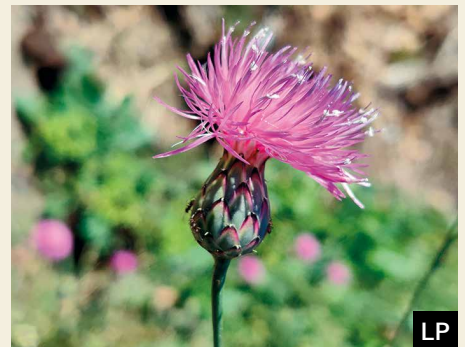
Dagger flower

Family

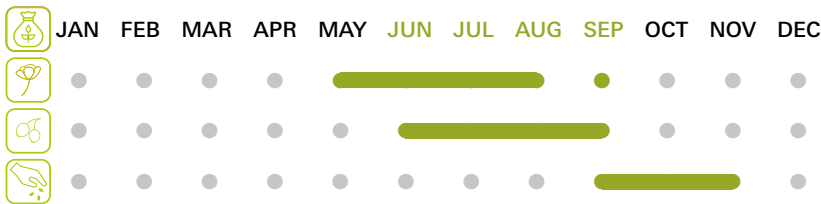
Asteraceae



Flora-On.pt (MP)



LP



Margins of roads, wastelands, fallows, and clearings of degraded scrubs. Widespread throughout mainland Portugal, in dry places, especially on basic soils.

Life form: Hemicryptophyte/ Perennial.



Promotes habitat for butterflies.



Hand collection of the dry inflorescences, with a pair of shears if necessary. The seeds can be manually extracted by picking up the pappi.

Precautions: wear gloves.



Seeding: no pre-treatment is required. It can be sown directly into the target place, or to produce plants for subsequent plantation. The plants can be produced in small containers, indoors or outdoors, on a mixture of peat and sand (50:50).

Type of infrastructure for which it is recommended: roads and trails.

Scientific name

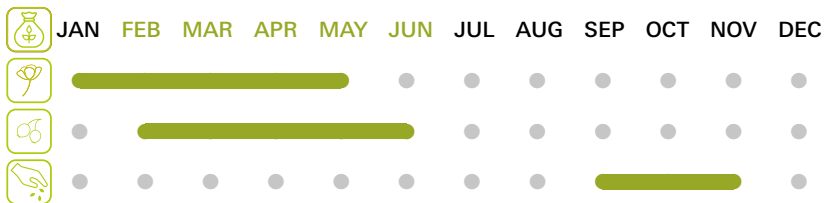
Narcissus bulbocodium L.

Common name

Hoop petticoat

Family

Amaryllidaceae



Humid meadows or temporarily flooded areas, margins of water courses, heaths, clearings of scrubs, open areas in deciduous woodlands, oak woods, and pine woods. It occurs across a wide range of habitats throughout mainland Portugal, preferring sandy or clay substrates.

Life form: Geophyte/ Perennial.



Promotes habitat for small mammals.



Hand collection of the ripe (brownish) capsules, from which the seeds will subsequently be extracted. Although the vegetative propagation is easy, collection of bulbs and their plantation on the target place it is not advisable, as it implies the impoverishment of the donor populations.



By seeds or bulbs. Seeding: no pre-treatment is required. Seeding can be done outdoors into the target place, but the production of plants for subsequent plantation is recommended. This production can be made in small containers, indoors or outdoors, in a mixture of peat and sand (50:50).

Type of infrastructure for which it is recommended: trails and micro-reserves.

Scientific name

Papaver spp. (*P. hybridum* L., *P. pinnatifidum* Moris e *P. rhoeas* L.)

Common name

Poppies

Family

Papaveraceae



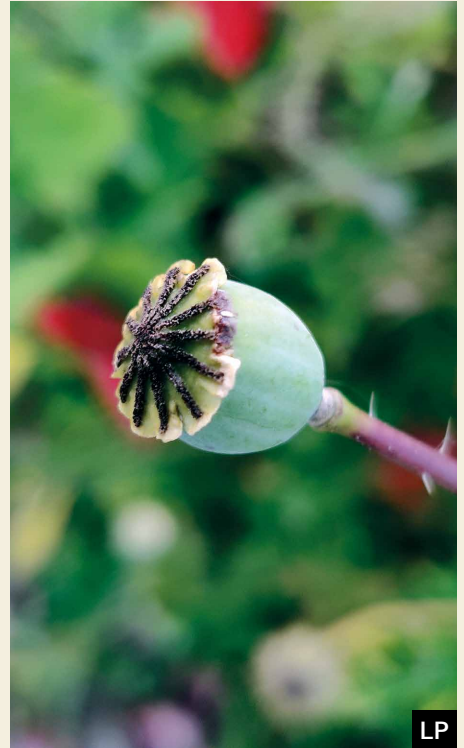
MPF



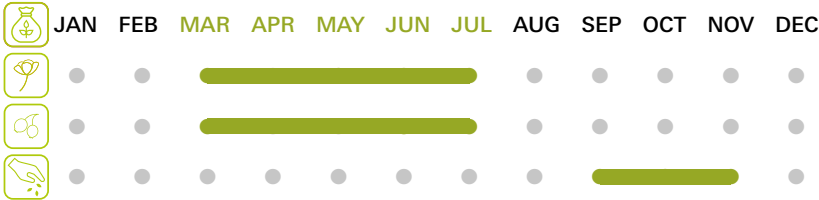
LP



LP



LP



Grain fields, fallows, pastures, grasslands, clearings in shrublands, montados, olive-groves, borders of trails and wastelands. Widespread throughout mainland Portugal, including somewhat nitrified soils associated with extensive sheep grazing. These species are sensitive to herbicides used in nearby areas.

Life form: Therophyte/ Annual.



Promotes pollinators.



Seed collection can be made by shaking the ripe capsules (brownish) into a bag. Alternatively, the capsules can be collected by hand in the field and shaken indoors later, to release the seeds. The seeds being very small, it is not advisable to crash the capsules to release them because it is difficult to separate the capsule residues from the seeds, even with sieves.



Seeding: no pre-treatment is required. Seeding should be done outdoors, throwing the seeds into the target place, after loosening or breaking up the soil surface with a rake.

Type of infrastructure for which it is recommended: roads and trails.

Scientific name

Petrorhagia nanteuilii (Burnat) P.W. Ball & Heywood

Common name

Wild carnation

Family

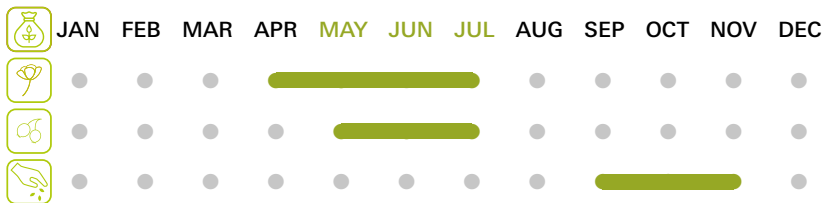
Caryophyllaceae



Flora-On.pt (MP)

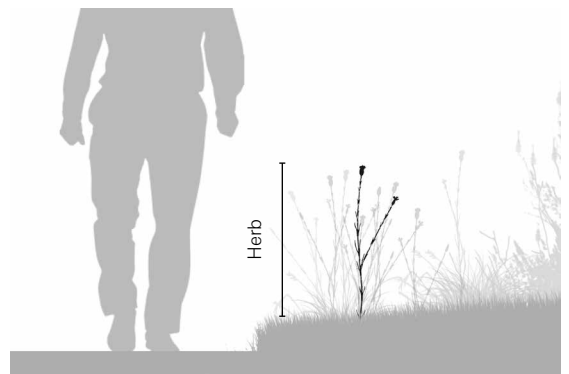


LP



Somewhat disturbed sites such as roadsides. Widespread throughout mainland Portugal, on sandy soils and neutral or basic substrates.

Life form: Therophyte/ Annual.



Promotes pollinators.



Seed collection can be made by shaking the ripe (brownish) capsules into a bag, without cutting the plant, which ensures that only the ripe seeds are released and respects the natural asynchrony of seed maturation of this species. Alternatively, the capsules can be picked by hand when they are all ripe, and the seeds extracted by shaking the capsules or crashing them against a sieve of adequate mesh size.



Seeding: no pre-treatment is required. Seeding should be done directly into the target place.

Type of infrastructure for which it is recommended: roads, trails and micro-reserves.

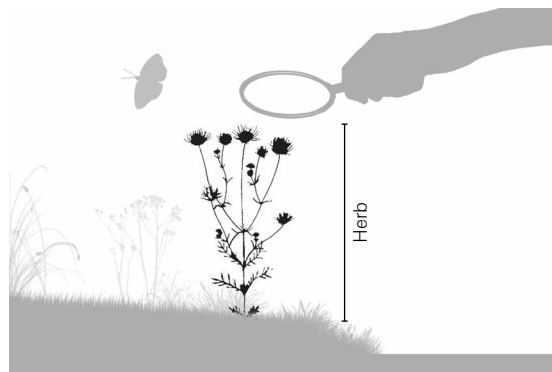
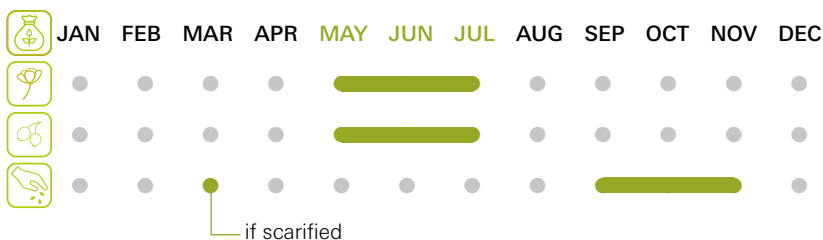
Scientific name

Pterocephalidium diandrum (Lag.) G.López

Common name

Family

Dipsacaceae



Annual grasslands and clearings of xerophytic scrubs. Widespread throughout mainland Portugal, mainly dry places with sandy, schistic or quartzitic soils.

Life form: Therophyte/ Annual.



Endemic to the Iberian Peninsula.



Hand collection of the inflorescences containing ripe (brownish) seeds into a bag. Seed maturation is normally asynchronous between plants of the same population. We know that they are ripe because of the colour but also because they are easily pulled out by the awned calyxes. Cleaning is needed just to remove small dirt and remains of the flowers.



Seeding: no pre-treatment is required and the seeds can be sown with the awned calyxes, but germination might be favoured by a slight scarification of the seed. There is generally a high proportion of empty seeds. Seeding should be done outdoors, into the target place.

Type of infrastructure for which it is recommended: micro-reserves.

Scientific name

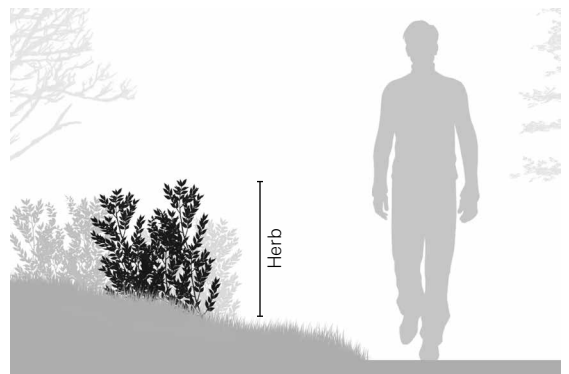
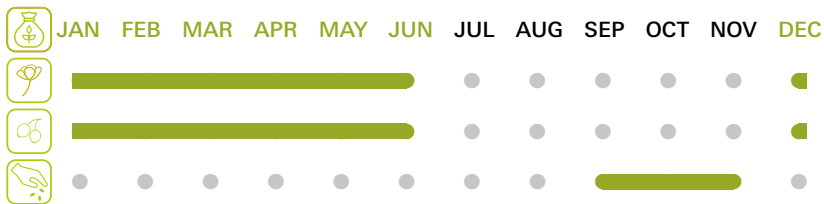
Ruscus aculeatus L.

Common name

Butcher's broom, box holly

Family

Asparagaceae



Borders or undercover of woodlands (oak woods, including evergreen oak woods), and sclerophyllous scrubs. Species with a large ecological plasticity, widespread throughout mainland Portugal, especially in shady, cool and low altitude sites.

Life form: Geophyte/ Perennial.



Listed in Annex V of the Habitats Directive concerning the preservation of natural habitats and of the wild fauna and flora.



Hand collection of the berries when ripe (red).



Seeding: fermentation of the fruits in water at 4-5 °C (in the cooler) for about 15 days or until the pulp is easily removed. Extract the seed upon pulp removal. Plant production can be made in small containers, preferably in a nursery, on a mixture of peat and sand (50:50).

Type of infrastructure for which it is recommended: trails and micro-reserves.

Scientific name

Ruta spp. (*R. angustifolia* Pers. e *R. chalepensis* L.)

Common name

Egyptian rue

Family

Rutaceae



Flora-On.pt (PPS)



Flora-On.pt (AJP)



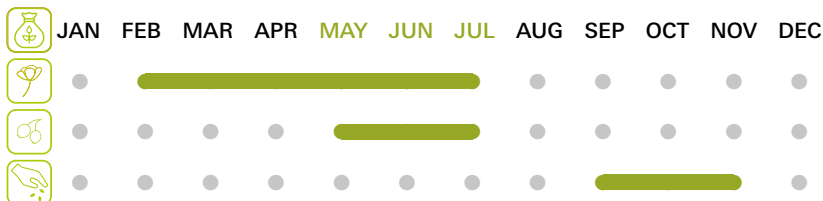
MPF



MC



LP



Open scrubs and borders of scrubs, in sunny, stony and dry places. Widespread throughout mainland Portugal, with a wide ecological range and substrate types (sand, limestone, schist).

Life form: Chamaephyte/ Perennial.



Promotes habitat for butterflies.



Hand collection of the ripe (brownish) capsules. The capsules must be crushed to release the seeds. Precautions: wear gloves and long sleeves, as the plant (including the seeds) cause skin burning.



Seeding: no pre-treatment is required; however, keeping the seeds at 4-5 °C for 7-14 days before sowing might be beneficial. It can be sown outdoors, directly into the target place, or to produce plants for subsequent plantation. Plant production can be done in small containers, indoors or outdoors, on mixture of peat and sand (75:25).

Type of infrastructure for which it is recommended: roads and trails.

Scientific name

Scabiosa atropurpurea L.

Common name

Mournful widow

Family

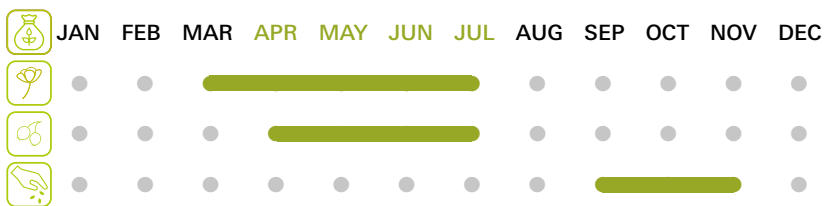
Dipsacaceae



FS



Flora-On.pt (MP)



Pastures, wastelands and open areas, road slopes, and margins of roads and trails. Widespread throughout mainland Portugal, on any type of soil.

Life form: Hemicryptophyte/ Perennial.



Promotes habitat for butterflies.



Hand collection of the dry inflorescences. The ripe achenes detach from each other under a slight pressure.



Seeding: no pre-treatment is required. The achenes should be previously separated from each other but it is not necessary to extract the seeds from them. Seeding should be done into the target place.

Type of infrastructure for which it is recommended: roads and trails.

Scientific name

Scorpiurus vermiculatus L.

Common name

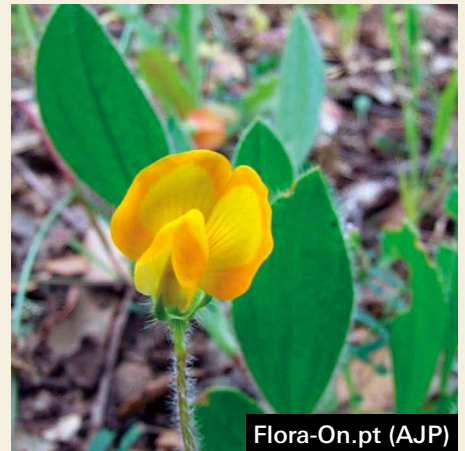
Caterpillar plant

Family

Fabaceae



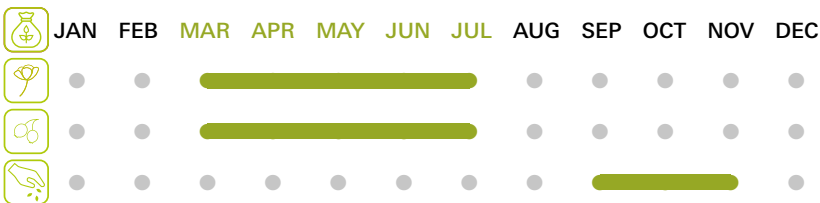
Flora-On.pt (AJP)



Flora-On.pt (AJP)



Flora-On.pt (PPS)



Mountain grasslands, woodlands, perennial crops (groves, olive-groves, vineyards) and, sometimes, borders of trails. Widespread throughout mainland Portugal, but it is more frequent in the South.

Life form: Therophyte/ Annual.



Nitrogen fixer.



Hand collection of the ripe (brownish and somewhat hardened, with yellow seeds) fruits. It might be necessary to pick fruits from the ground. To obtain the seeds it is useful to break the pods, with a coffee grinder, for example, before sieving.



Seeding: no pre-treatment is required. Seeding should be done into the target place.

Type of infrastructure for which it is recommended: roads, trails and micro-reserves.

Scientific name

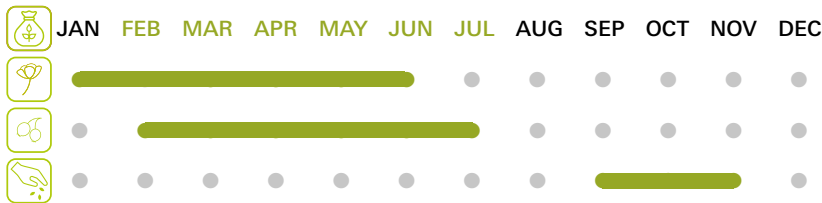
Silene spp. (*S. colorata* Poir., *S. gallica* L. e *S. scabriflora* Brot.)

Common name

Catchfly

Family

Caryophyllaceae



Clearings of pine woods or xerophytic scrubs, agricultural fields, grasslands, pastures, wastelands and margins of roads and trails. Widespread throughout mainland Portugal, on any type of soil, but especially sandy soils.

Life form: Therophyte/ Annual.



Promotes the occurrence of pollinators. *Silene scabriflora* subsp. *scabriflora* is endemic to the Iberian Peninsula and northeast Morocco.



Seed collection can be made by shaking the ripe (brownish) capsules into a bag. Alternatively, the capsules can be collected by hand, with subsequent extraction of the seeds by shaking the capsules or crashing them against a sieve.



Seeding: no pre-treatment is required. Seeding should be done into the target place.

Type of infrastructure for which it is recommended: roads, trails and micro-reserves.

Scientific name

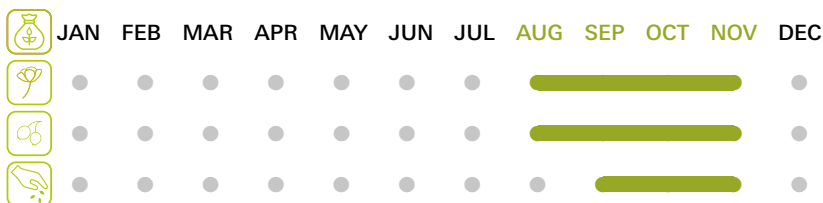
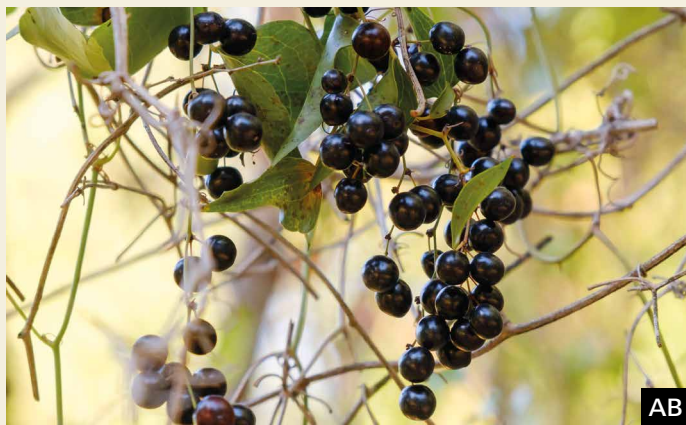
Smilax aspera L.


Common name

Prickly ivy


Family


Smilacaceae




 Riparian or evergreen woodlands (for example, oak woods), pine woods, scrubs and hedges. Widespread throughout mainland Portugal, sometimes forming a liana layer in dense woodlands.

Life form: Climbing phanerophyte/ Perennial.

 Provides food for small birds such as the blue tit, the European robin, the blackbird, the common whitethroat, the Sardinian warbler, the Eurasian blackcap or the garden warbler.

 Hand collection of the berries when ripe (black).

 Seeding: fermentation of the fruits in water at 4-5 °C (in the cooler) for about 15 days or until the pulp is easily removed. Extract the seed upon pulp removal. Plant production should be made in small containers, if possible in a nursery, on a mixture of peat and sand (50:50).

Type of infrastructure for which it is recommended: micro-reserves.

Scientific name

Trifolium spp. (*T. angustifolium* L., *T. arvense* L., *T. campestre* Schreb. e *T. stellatum* L.)

Common name

Clover

Family

Fabaceae



Flora-On.pt (JDA)



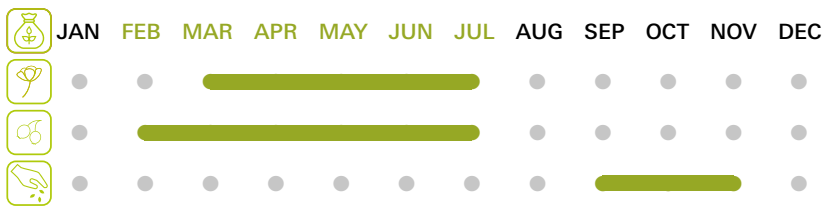
Flora-On.pt (MP)



FS



LP



Annual grasslands, openings in shrublands, pinewoods and montados, sometimes wastelands and trail edges. Widespread throughout mainland Portugal, especially on dry soils.

Life form: Therophyte/ Annual.



Legume species and nitrogen fixers; they promote habitats for butterflies.



Hand collection of fruits when ripe (brown calyx with yellow seed). It might be necessary to pick up the fruits from the ground. To extract the seeds it is useful to break the fruits in a coffee grinder, for example, before sieving.



Seeding: no pre-treatment is required. Seeding should be done outdoors, directly into the target place.

Type of infrastructure for which it is recommended: roads, trails and micro-reserves.

Scientific name

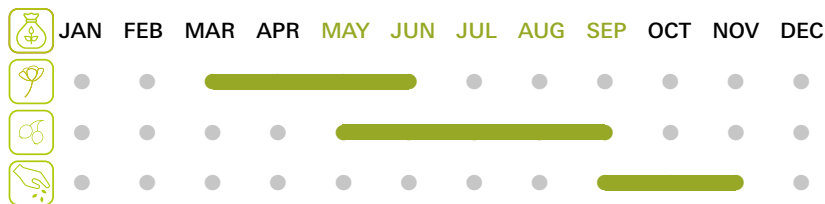
Adenocarpus anisochilus Boiss.


Common name

—


Family


Fabaceae




 Dense shrublands and borders of woodlands, also in wastelands, roadsides and margins of trails, and along water courses. It occurs in the South of Portugal, preferably in deep and acid soils.

Life form: Phanerophyte/ Perennial.

 Endemic to mainland Portugal. Nitrogen fixer.

 Hand collection of the ripe seeds (brown or cream-coloured pods). The pods can open during the process, and project the seeds. The pods have a high oil content, therefore thick paper bags are advised to collect the seeds.

 Seeding: the seeds should be removed from the pods; if the latter are quite ripe they open spontaneously and release the seeds; so, it is recommended to store the pods in a ventilated container covered with a sheet of newspaper or a cloth, for about 7 days, to favour this natural mechanism. No pre-treatment is required, but germination is favoured by mechanical scarification of the seeds, either by small superficial cuts or scratches or by heating (boiling for 5 seconds). The seeding can be made in small containers, on a mixture of peat and sand (50:50) that should be kept moist but not wet.

Type of infrastructure for which it is recommended: roads, trails and micro-reserves.

Scientific name

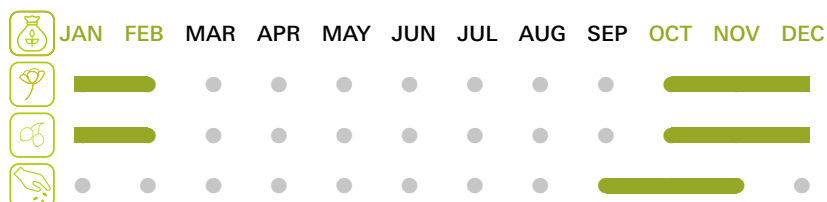
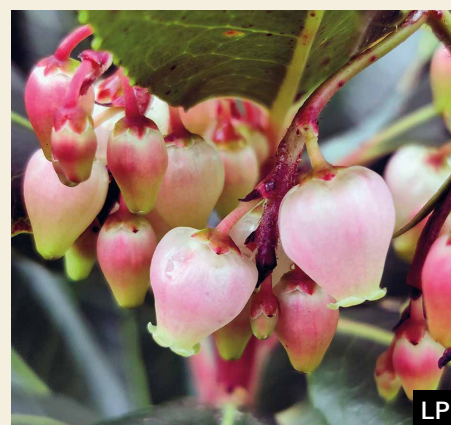
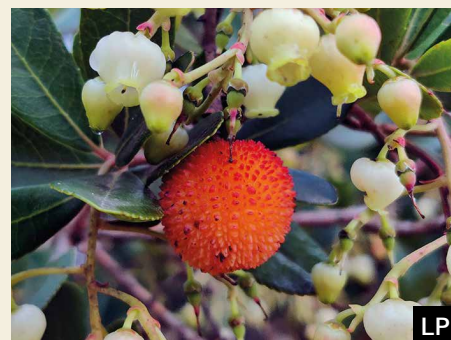
Arbutus unedo L.

Common name

Strawberry tree

Family

Ericaceae



Borders and clearings of woodlands (evergreen oak woods), dense shrublands and ravines. Widespread throughout mainland Portugal, preferably in areas of sub-humid climate. Soil indifferent.

Life form: Phanerophyte/ Perennial.



It promotes habitat for the butterfly *Charaxes jasius* (Linnaeus, 1767); birds and other animals feed on the fruits.



Hand collection of the fruits, when red. Notice that flowering occurs simultaneously with the ripening and shedding of the fruits from the previous year.



Seeding: the fruits should remain in water until they break up; this slurry should ferment for 15 days in the cold, in a closed container. Then, it should be sieved and the seeds washed, because direct seeding of the fermented slurry promotes fungi development or attracts natural predators such as ants. The plants can be produced in small containers, on a mixture of peat and sand (50:50) that should be kept moist but not wet.

Type of infrastructure for which it is recommended: roads, trails and micro-reserves.

Scientific name

Calicotome villosa (Poir.) Link

Common name

Spiny broom

Family

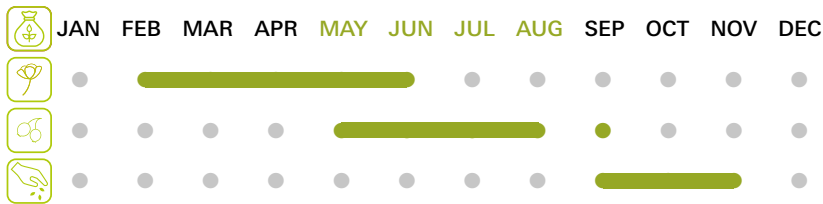
Fabaceae/ Leguminosae



EG



FS



Borders and clearings of open evergreen oak woodlands, also in road slopes and hedges. It occurs in the South of Portugal, mainly in Central Alentejo and especially in dry and stony soils.

Life form: Phanerophyte/ Perennial.



Area of distribution restricted to the Iberian Peninsula and North Africa. Nitrogen fixer.



Hand collection of the dry pods (brownish). Precautions: wear gloves, the plant is thorny.



Seeding: the seeds should be removed from the pods; if these are quite ripe, they open spontaneously and release the seeds; so, it is recommended to store the pods in a ventilated container covered with a sheet of paper, for about 7 days, to favour this mechanism. No pre-treatment is required, but germination is favoured by mechanical scarification of the seeds either by small superficial cuts or scratches or by heating (boiling for 5 seconds). The plants can be produced in small containers, on a mixture of peat and sand (50:50).

Type of infrastructure for which it is recommended: roads, trails (but not too close to them) and micro-reserves.

Scientific name

Cistus albidus L., *C. crispus* L. e *C. populifolius* L.

Common name

Rockrose, cistus

Family

Cistaceae



FS



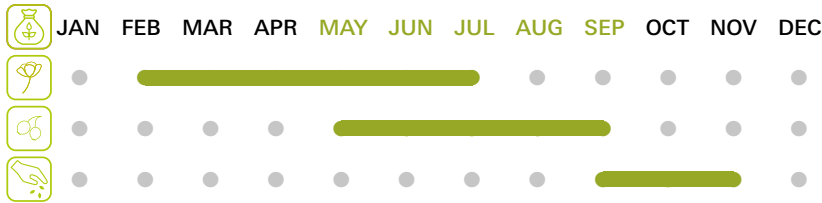
MC



CPC



EF



Low scrubs, clearings and borders of woodlands (evergreen or deciduous oak woods); coast or inland. The three species are widespread throughout mainland Portugal, but *C. albidus* prefers mild climates and limestone substrates, *C. crispus* prefers dry sites and clay soils, and *C. populifolius* needs some surface moisture and acid soils.

Life form: Phanerophyte (*C. albidus* and *C. populifolius*) and Chamaephyte (*C. albidus* and *C. crispus*)/ Perennial.



They promote pollinators.



Hand collection of the ripe fruits (round brownish capsules).



Seeding: the seeds should be extracted from the capsules, by slightly crushing the latter, followed by sieving through different sieves. Scarification of the seeds is needed, immediately before sowing, by putting them in boiling water for 5 minutes. The plants can be produced in small containers, on a mixture of peat and sand (50:50) that should be kept moist but not wet.

Type of infrastructure for which it is recommended: roads, trails and micro-reserves.

Scientific name

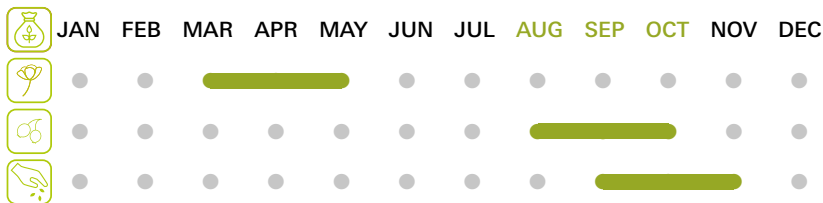
Crataegus monogyna Jacq.


Common name

Hawthorn


Family


Rosaceae




 Borders of humid woodlands and riparian woodlands, dense scrubs and hedges. Widespread throughout mainland Portugal, preferably in shady and cool places, close to water courses.

Life form: Phanerophyte/ Perennial.

 Food source and shelter for many species of animals, namely butterflies. The flowers attract many pollinators, and the fruits attract many bird species, which also like this plant for nesting.

 Hand collection of the fruits, when red (ripe).

 Seeding: No pre-treatment is required, but germination is favoured by cold stratification (keep the fruits at 4 °C for at least 1 month). After this period, let the fruits ferment in water for about 15 days to facilitate the removal of the pulp and seed extraction, as well as to hydrate the seeds. The plants can be produced in small containers, on a mixture of peat and sand (50:50) that should be kept moist but not wet. The germination can take up to 1 year to occur.

Type of infrastructure for which it is recommended: roads, trails and micro-reserves.

Scientific name

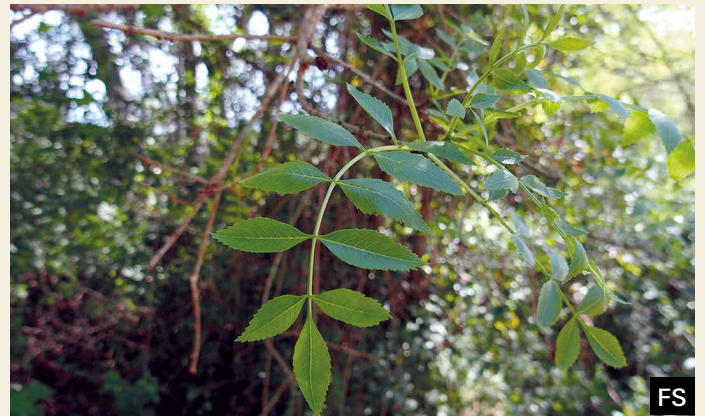
Fraxinus angustifolia Vahl

Common name

Ash

Family

Oleaceae



Riparian woodlands, river banks and by water courses. Widespread throughout mainland Portugal, preferring deep and fresh soils.

Life form: Phanerophyte/ Perennial.



Shelter for several species of fauna. It protects the margins of water courses from erosion, and purifies the water.



Hand collection of the fruits, when brown, or still green if fully developed.



Seeding: No pre-treatment is required, sowing should be done soon after collection. The plants can be produced in small containers, on a mixture of peat and sand (50:50) that should be kept moist so that the seeds are always hydrated.

Type of infrastructure for which it is recommended: margins of railways and trails.

Scientific name

Lavandula pedunculata (Mill.) Cav. e *Lavandula stoechas* L.

Common name

Lavender

Family

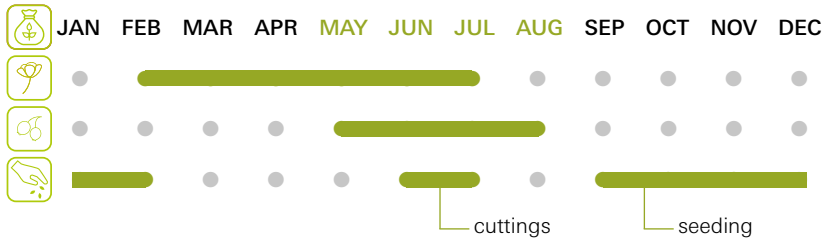
Lamiaceae



EG



FS



Low scrubs, dense shrublands, clearings and understory of woodlands; wide ecological range. Widespread throughout mainland Portugal, preferably in dry and exposed sites.

Life form: Phanerophyte and Chamaephyte/ Perennial.



Shrub
(more frequently,
small - 50-70 cm;
up to 1.5 m)



Important honey plants. *Lavandula stoechas* subsp. *luisieri* is endemic to the Iberian Peninsula.



Collection of semi-woody cuttings, about 10 cm long. Collection of the dry inflorescences.



Cuttings: bury about one third of the cutting (ensuring that at least one node is covered), leaving only a few leaves in the upper part, preferably on a light and well-drained substrate. Keep the substrate moist.

Seeding: the seeds can be extracted by gently crushing the inflorescences, followed by sieving through different sieves. No pre-treatment is needed. The plants can be produced in small containers, on a mixture of peat and sand (50:50) that should be kept moist but not wet.

Type of infrastructure for which it is recommended: roads and trails.

Scientific name

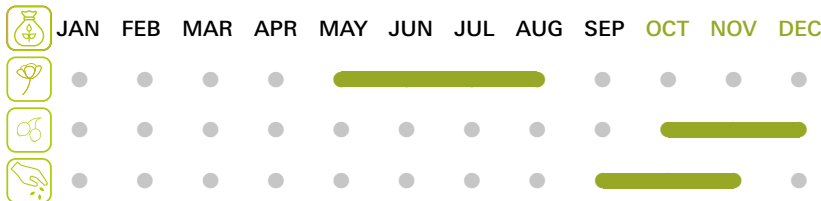
Myrtus communis L.

Common name

Myrtle

Family

Myrtaceae



Scrubs, shrublands, borders and understory of woodlands and open forests. Widespread throughout mainland Portugal, preferring areas with some superficial moisture, such as ravines or nearby temporary water courses.

Life form: Phanerophyte/ Perennial.



Food source for numerous pollinating insects, birds and small mammals.



Hand collection of the ripe (dark-blue) fruits.



Seeding: remove the pulp of the fruits immediately after collection, to extract the seeds. Immerse them in water for 24 h prior to seeding. The plants can be produced in small containers, on a mixture of peat and sand (50:50) that should be kept moist but not wet.

Type of infrastructure for which it is recommended: roads and trails.

Scientific name

Phillyrea angustifolia L.

Common name

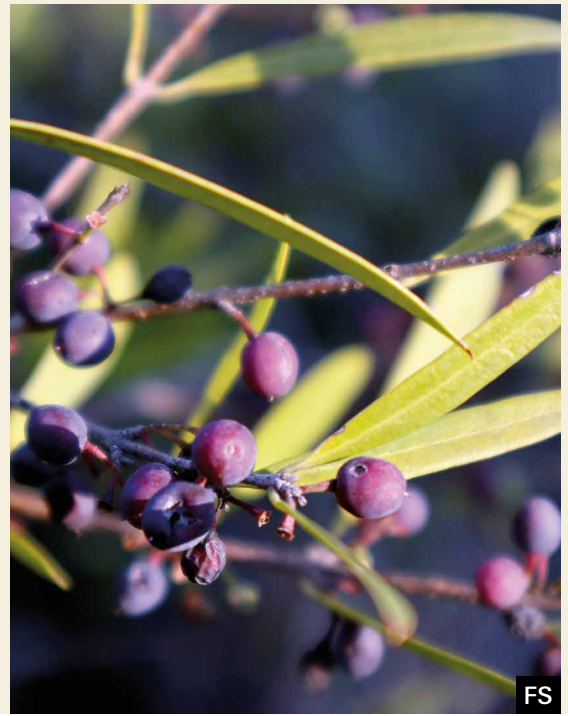
Narrow-leaved mock privet

Family

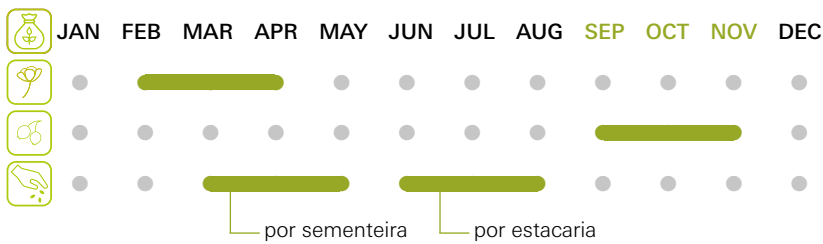
Oleaceae



FS



FS



Scrubs and shrublands, in dry and exposed places. Wide-spread throughout mainland Portugal, and soil-indifferent.

Life form: Phanerophyte/ Perennial.



Food source for numerous species of pollinating insects and birds.



Collect semi-woody apical cuttings (apex from the branches) from vigorous mother-plants. Collect ripe fruits, in December.



Cuttings: Apply a treatment with naphthalene-acetic acid (ANA) at 0.8%. The plants can be produced in small containers, on a mixture of peat and sand (50:50) that should be kept moist but not wet.

Seeding: The seeds must be scarified, either mechanically (small cuts or scratches on the seed surface) or chemically (immersion in sulphuric acid for 30 minutes, followed by rinsing in running water). The seeding can be made soon after collection or on the following spring, in small containers on a mixture of peat and sand (50:50) that should be kept moist but not wet.

Type of infrastructure for which it is recommended: roads and trails.

Scientific name

Pistacia lentiscus L.

Common name

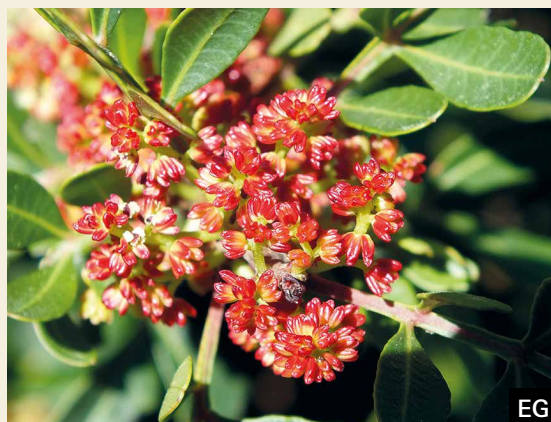
Mastic tree

Family

Anacardiaceae



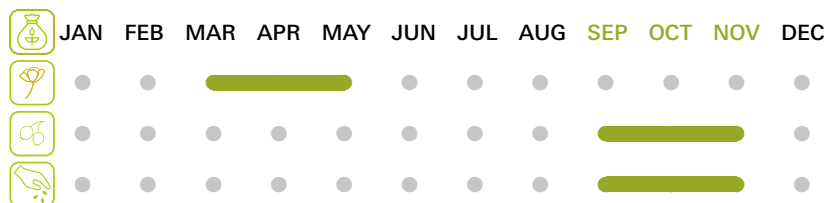
MC



EG

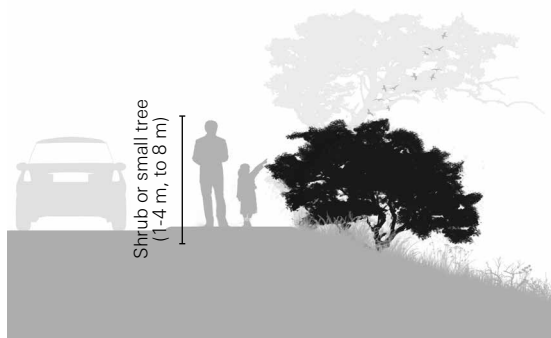


EG



Scrubs and shrublands, coast and hinterland, in drier zones, but also in woodlands and growing as trees. It occurs mainly in the Centre and South of mainland Portugal, with some preference for limestone substrates.

Life form: Phanerophyte/ Perennial.



Food source and shelter for various species of fauna.



Hand collection of the fruits.



Seeding: no pre-treatment is needed, but germination is favoured by the removal of the pulp and by mechanical scarification (small cuts or scratches of the seed surface), followed by immersion in water for 2 or 3 hours. The plants can be produced in small containers, on a mixture of peat and sand (50:50) that should be kept moist but not wet.

Type of infrastructure for which it is recommended: roads and trails.

Scientific name

Pyrus bourgaeana Decne.

Common name

Iberian pear

Family

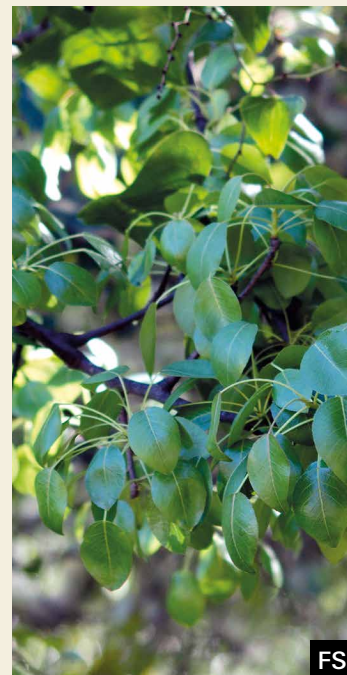
Rosaceae



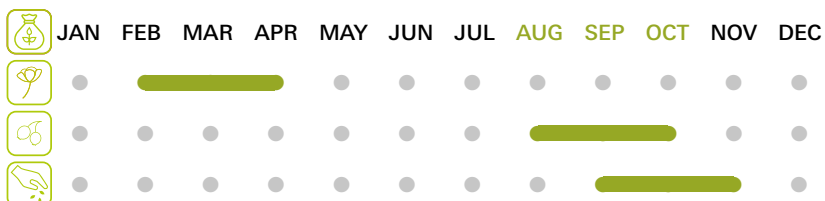
FS



FS



FS



Borders and clearings of woodlands, montados, open shrublands, margins of trails and other wastelands. It occurs mainly in the Centre and South of mainland Portugal, preferring fresh places. Soil-indifferent.

Life form: Phanerophyte/ Perennial.



Tree (up to 6 m)



Food source and shelter for many species of animals.



Hand collection of the ripe fruits (pears).



Seeding: Keep the fruits in the cold for at least 15 days. Then, cut and macerate the fruits (carefully not to damage the seeds) and put them in a closed container with water, to ferment. Afterwards, sieve the pulp and extract the seeds, or directly sow the slurry. The former method is not recommended, because the presence of the pulp increases the risk of fungi infection and natural predators such as ants. The plants can be produced in small containers, on a mixture of peat and sand (50:50) that should be kept moist but not wet.

Type of infrastructure for which it is recommended: roads and trails.

Scientific name

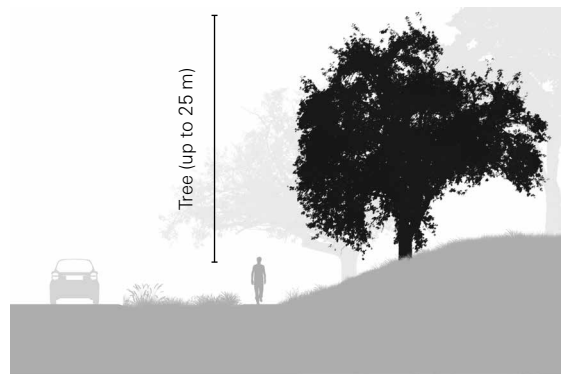
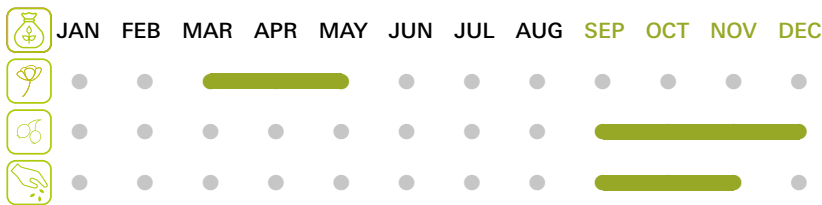
Quercus faginea Lam., *Q. suber* L., *Q. rotundifolia* Lam. e *Q. coccifera* L.

Common name

Portuguese oak, cork oak, holm oak and kermes oak

Family

Fagaceae



In woodlands and montados, dominating in oak and cork-oak woodlands, co-dominant or present in holm-oak woodlands, dense woodlands, and other mixed woodlands. Widespread throughout mainland Portugal. *Quercus suber* and *Q. faginea* seem to prefer fresh places with some humidity (particularly *Q. faginea*), on siliceous soils (*Q. faginea*) or basic soils (*Q. suber*).

Life form: Phanerophyte/ Perennial.



Important structural species in several ecosystems. Food sources and shelter for numerous species of fauna. *Quercus faginea* is worth highlighting as a soil restorer, and its woodlands are ideal habitats for arachnids, insects, amphibians, birds, and mammals, and also for red deers or Iberian lynxes. *Quercus suber* is considered a national tree since 2011 (Resolução da Assembleia da República n.º 15/2012) and, similarly to *Q. rotundifolia*, is protected by law (Decreto-Lei n.º 169/2001, de 25 de maio. D.R. n.º 121, Série I-A, Decreto-Lei n.º 155/2004, de 30 de junho. D.R. n.º 152, Série I-A).



Hand collection of the fruits (acorns) from the tree or from the ground when they are fully or partly dark-brown.



Seeding: no pre-treatment is needed, but germination can be accelerated if the acorns are stratified in humid sand for some weeks, until the root begins to emerge. The plants can be produced in small containers, on a mixture of peat and sand (50:50) that should be kept moist but not wet.

Type of infrastructure for which it is recommended: roads and trails.

Scientific name

Rhamnus alaternus L.

Common name

Evergreen buckthorn

Family

Rhamnaceae



MPS



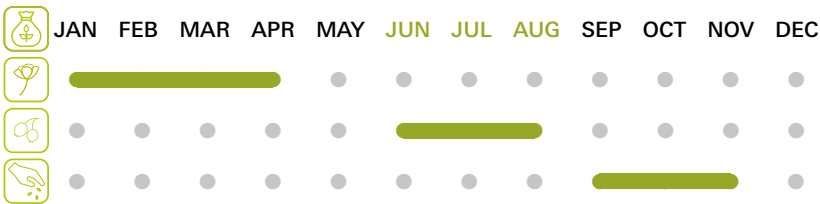
FS



MPF



LP



Shrub (up to 3 m)



Shrublands, hedges and borders of woodlands (oak and evergreen oak woodlands). Widespread throughout mainland Portugal; easily adaptable to different types of soil and humidity levels, but preferring hot and dry places.

Life form: Phanerophyte/ Perennial.



Food source for numerous pollinating insects, birds and small mammals. It promotes the habitat for the butterfly *Gonepteryx cleopatra* (Linnaeus, 1767).



Hand collection of the ripe (black) fruits.



Seeding: separate the pulp manually, and immerse the seeds in water for 24 hours, prior to seeding. The plants can be produced in small containers, on a mixture of peat and sand (50:50) that should be kept moist but not wet.

Type of infrastructure for which it is recommended: roads, trails and micro-reserves.

Scientific name

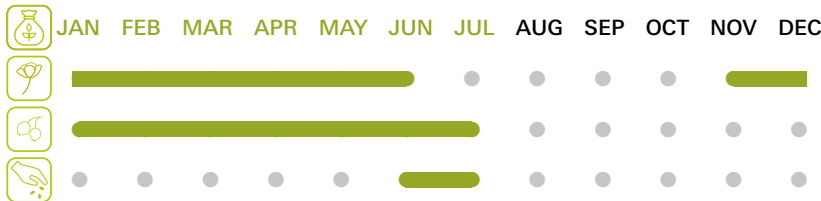
Rosmarinus officinalis L.

Common name

Rosemary

Family

Lamiaceae



Scrubs and open oak woodlands. Soil-indifferent. Widespread throughout mainland Portugal, and planted near apiaries, which enlarged its original distribution area.

Life form: Phanerophyte/ Perennial.



One of the most important honey plants, for its intense, early and durable flowering.



Collection of semi-woody cuttings, about 10-20 cm long.



Cuttings: Bury about one third of the cutting (ensuring that at least one node is covered), leaving only a few leaves in the upper part. The plants can be produced in small containers, on a light and well-drained substrate, with irrigation to ensure the moisture of the substrate. It roots rapidly.

Type of infrastructure for which it is recommended: roads and trails.

Scientific name

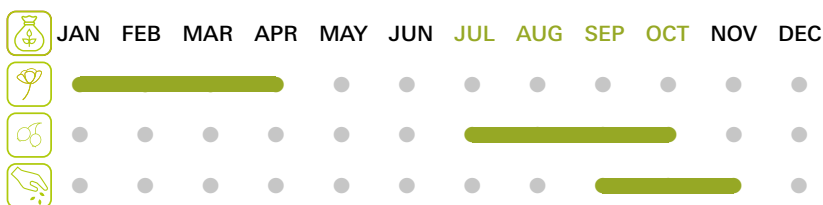
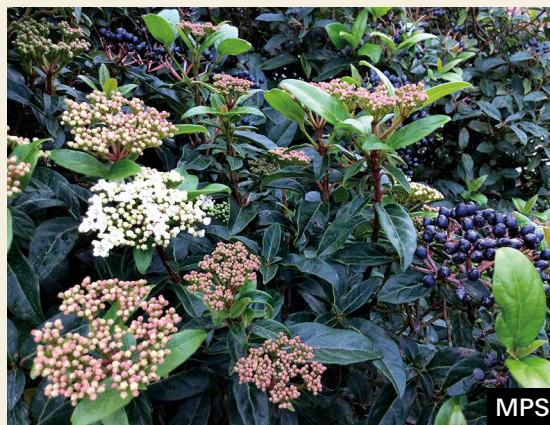
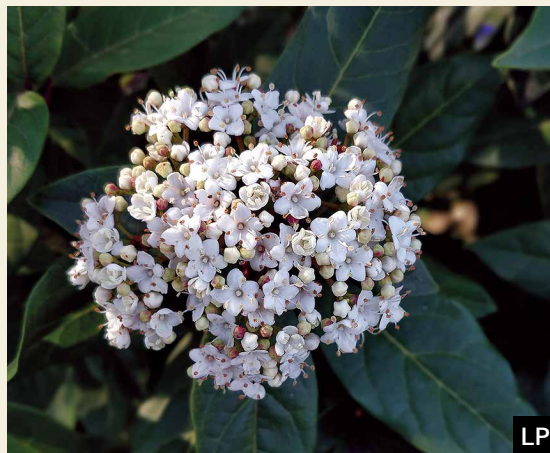
Viburnum tinus L.

Common name

Laurustinus

Family

Caprifoliaceae



Oak woodlands, borders of woodlands, hedges and shrublands. Widespread throughout mainland Portugal, preferably in sheltered places, fresh and shady.

Life form: Phanerophyte/ Perennial.



Honey plant, promoting butterflies, bees and other pollinators.



Hand collection of the ripe fruits (dark-blue/black).



Seeding: should be done soon after collection, to prevent seeds from entering dormancy. Separate the pulp manually, before sowing. The plants can be produced in small containers, on a mixture of peat and sand (50:50) that should be kept moist but not wet. Germination can occur only 2 years later.

Type of infrastructure for which it is recommended: roads and trails.



MPF

Glossary

Native plant: plant species from the region where it occurs, growing there spontaneously, without human intervention.

Biodiversity: the whole variety of life on Earth, including genes, species, communities and ecosystems, as well as the ecological processes where they take part.

Conventional sowing: manual or mechanical distribution of seeds on the ground's surface, followed by their burial. Suitable for small areas.

Ecological corridor: strips with native vegetation that link otherwise separated natural areas. Not all corridors are linear.

Ex situ conservation: conservation of components of biological diversity outside their natural habitats. It is usually carried out in zoological and botanical gardens, wildlife research centres and gene banks.

Exotic plant: any plant species growing outside its natural (native) distribution area.

Felling: cut down of large trees (DBH \geq 20 cm).

Fuel management strip (Roadside fuelbreak): strip of terrain providing both horizontal and vertical discontinuities of fuel load in rural areas; it is created by modification or removal (partial or complete) of plant biomass, namely through grazing, cutting or removal by other means.

Green infrastructure: network of natural and semi-natural areas associated with urban areas and other human-built structures, which provide multiple benefits to citizens who use them and improve ecosystem functions.

Hydroseeding: seeding in which seed is applied to the soil surface in a liquid from a specialized high pressure equipment (hydroseeder). Indicated for large areas and very steep slopes.

In situ conservation: conservation of ecosystems and natural or semi-natural, and maintenance and recovery of viable populations in their natural environments.

Invasive plant: exotic plant species that (1) reproduces autonomously and abundantly; (2) expands beyond the site where it was initially introduced (more than 100 m in less than 59 years for seed-dispersed species; more than 6 m every three years for species propagating vegetatively) without human intervention and regardless of the disturbance level of the environment; (3) attains high densities; and, as a consequence (4) leads to environmental and ecological changes and socioeconomic damages.

Landscape connectivity: ability of the landscape to facilitate or hinder the flow of organisms between habitats. The level of connectivity determines the intensity of dispersal or movement between areas, affecting the genetic flows, local adaptations, risk of extinction, probability of colonization and organisms ability to move.

Linear infrastructure: human-made linear structure also present in natural environments, where they affect soil quality, topography, hydrology and, particularly, biodiversity. They include all kinds of roads, railways, irrigation channels, and gas and power lines.

Marginal zones of the linear infrastructures: semi-natural areas alongside the linear infrastructures that, normally, are not used for any particular purpose. They include the marginal road verges, the bases of power line towers and small plots resulting from adjustments in the infrastructure design.

Mowing: cutting the vegetation present on the road verge bands corresponding to 1.5 – 3 m away from the paved zone. It includes the cutting of plants lacking lands-

cape interest, shrubs and trees with a stem diameter at breast height smaller than 20 cm.

Natura 2000 Network: ecological network established within the European Union space and resulting from the application of the Birds and Habitats Directives (respectively, Directive 79/409/CEE and Directive 92/43/CEE); its purpose is to ensure the long-term conservation of the threatened species and habitats of Europe. It is the primary tool for nature conservation in the European Union.

Noxious plant: native or exotic plant species that is damaging to man-defined purposes such as productivity of agricultural crops.

Rhizome: underground stem with roots.

Riparian area: transition zone between aquatic and terrestrial ecosystems, normally corresponding to a cluster of native species along the edges of river, streams, stream beds or other water bodies.

Sapwood: outer part of the trunk of woody species, corresponding to the lighter part of the wood; tissue responsible for the transport of water and compounds dissolved in it to the whole plant.

Seed lot: a specified quantity of seed from the same species, population and date of collection. To be included in a seed bank, the lot must have, at least, 5 000 seeds.

Selective cutting: cleaning of herbs, shrubs and small trees (diameter at breast height < 20 cm) within 7 m beyond the 3 m-wide strips bordering the road, where mowing, pruning, thinning or control of vegetation growth are necessary. Selective cutting is frequently used in the management of roadside fuelbreaks.

Service or protection strip: protection zone established along the power lines, with a maximum width of 45 m (22.5 m to each side of the line) and where the management of plant material or fuel follows the enforced specific legislation.

Soil-indifferent: plant that grows well in all types of soil.

Stepping stones: small patches or islands of natural or semi-natural habitat that work as bridges between larger and well-preserved areas of habitat.

Tree-shelter: tubular structure, usually made of plastic, used to protect young plants.

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Collaborators

