

Protocol for the management of plant Invasive Alien Species



Restoration and improvement of Priority Habitat 9370*
“Palm groves of *Phoenix*”

LIFE PHOENIX / LIFE22-NAT-ES-LIFE Phoenix

Compiled by: GESPLAN and UoC.

Version: 2.0

Date: 20-09-2024

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1. INTRODUCTION

The overall aim of the LIFE Phoenix project is to improve the conservation status of Habitat 9370* on the islands of Gran Canaria and Crete, by tackling their most important risks and threats. In this sense, competing and invasive vegetation represents one of these major problems, especially in Gran Canaria, where it is currently constraining the development of the natural palm groves.

In particular, dense and impenetrable reedbeds of *Arundo donax* suffocating palm groves are present in some 646 Ha of ravines across Gran Canaria, representing fire hazard severity zones which can function as fire propagation corridors. In some points, reedbed coverage exceeds 90% of the range of Habitat 9370* and displaces other native species. In Crete, competition with *Eucalyptus spp.* must be also addressed.

This protocol has been elaborated to promote exchange of information and expertise on plant IAS management between Gran Canaria and Crete during the first stage of the project, in order to ensure replication and transfer on this topic in both regions. It is also expected to contribute to other projects or initiatives in different regions, with similar problems affecting their natural ecosystems.

2. BACKGROUND

The target plant IAS or competitor species affecting the project palm groves are: *Arundo donax*, *Cenchrus setaceus*, *Agave spp.* and *Opuntia spp.* in Gran Canaria; and *Eucalyptus spp.* in Crete. Their current regulatory context is shown in the following table:

Table 1. Regulatory context of the target plant IAS and competing species.

Species	Europe	Country	Region
<i>Arundo donax</i>		Spanish catalogue of IAS, RD 630/2013	
<i>Cenchrus setaceus</i>	EU Regulation 1143/2014	Spanish catalogue of IAS, RD 630/2013	Order of 13th June 2014, Canary Islands
<i>Agave spp.</i>		Spanish catalogue of IAS, RD 630/2013	
<i>Opuntia spp.</i>		Spanish catalogue of IAS, RD 630/2013	
<i>Eucalyptus spp.</i>			

In relation to these species, LIFE Phoenix aims to contribute to their eradication (where feasible) or control, allowing the progressive recovery of the palm grove habitat towards its climax stage and, especially in Gran Canaria, minimising the risk of fires. In this context, the project's goal is to control competitor and IAS plants in at least 50% of the total target habitat in both islands, which means an estimated surface of around 36 Ha.

In the case of Crete, the elimination of competitor plants (mainly *Eucalyptus spp.*) will be prioritised by mechanical methods. In Gran Canaria, given the remoteness of the project areas, interventions will primarily consist of manual elimination (with the aid of basic tools like scissors,

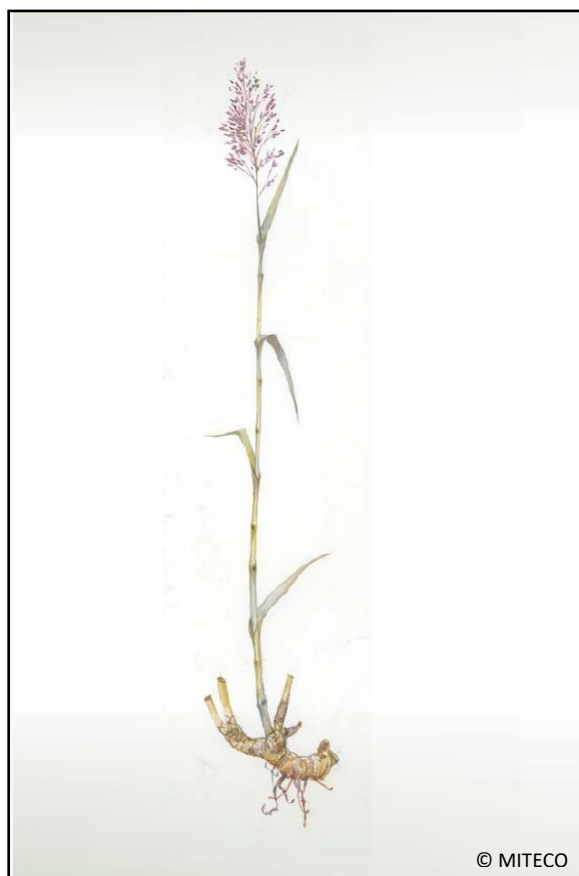
hoe or saw) or mechanical control (with the aid of light machinery like backpack brushcutter or light saw machine).

Regular maintenance works and rapid reforestation with autochthonous species will be carried out in order to avoid re-colonisation by IAS. In most cases, only seeds and reproductive parts of the plants (carefully cut to avoid dispersal) will be properly treated *in situ* (neutralisation, isolation and/or burial) or transported to landfill in sacs. The rest of the plant debris will be grinded on site and reused as a mulch layer, reducing costs and generating ecological benefits for the habitat: minimisation of IAS re-sprout, soil temperature and moisture regulation, source of organic matter, etc.

Whenever possible, roots and rhizomes will be treated on site (through repeated cuts and/or coverage with geotextile or plastic) without uprooting, so that the soil is not damaged. IAS control will be done during the most suitable time periods for each species, according to their reproductive and vegetative phases. Chemical methods with permitted herbicides will be in general discarded in order not to affect groundwater or other autochthonous plants. Their use could only be considered in punctual situations, with a much localised application (through injection or with a brush), to avoid re-sprout of certain species and always as a complementary action to manual or mechanical methods.

3. *Arundo donax*

Common name	Giant reed
Taxonomy	Phylum: <i>Magnoliophyta</i> ; Class: <i>Liliopsida</i> ; Order: <i>Poales</i> ; Family: <i>Poaceae</i> .
Native distribution	East of Asia



DESCRIPTION:

It is an herbaceous, perennial, erect plant with strong and fleshy roots. It has a thick, stout, hollow stem, reaching 2-6 metres in height and up to 4 cm in diameter. It is smooth and glabrous, shiny, simple or somewhat branched at the nodes; the canes are divided by partitions at the nodes (like bamboo). The leaves are long and ribbed (similar to those of maize), blue-green, arranged in two conspicuously opposite rows along the stem, which they 'embrace'; they have tufts of hairs at the base; they grow to about 60 cm long and 6 cm wide. The margins are sharp to the touch and can even cut. The flowers are borne in large apical panicles, 30-65 cm long. The spikelets, compressed laterally, have purplish or yellowish tones, generally with three bisexual flowers. The glumes are subequal and membranous; the lemma is bifid and hairy on the dorsal side, and longer than the palea. The fruit is an oblongate, striated caryopsis, which does not appear to produce viable seeds outside its native range. The embryo occupies about one third of the length.

ECOLOGY AND PROBLEMS ASSOCIATED WITH ITS INTRODUCTION:

It is resistant to desiccation, high temperatures and moderate salinity, but not to heavy frost or intense shading. It reproduces mainly vegetatively from its rhizomes, at a rate of half a metre per year. Below 7°C the rhizome stops producing stems, while above 30°C there is also shoot inhibition. It is a hygrophilous plant, which requires soil moisture, and is therefore found in riparian environments and wetlands, both natural and artificial, irrigation ditches, springs, etc.

Ecological impact: 1) It competes with, reduces, alters and displaces native riparian vegetation, replacing it in its entirety and preventing its regeneration. 2) It reduces the drainage capacity of rivers and canals. 3) It is a risk factor for fires due to the high amount of biomass it produces. 4) It has a high transpiration rate, reducing the water resources of invaded areas.

MAIN ENTRY PATHWAYS: Intentional introduction as an ornamental species and for various other uses (straw, tools, agriculture, etc.).

MAIN VECTORS OF INTRODUCTION: Dispersal by garden waste, machinery, water currents (rhizome fragments), wind (seeds).

CONTROL METHODS:

Manual control: manual and/or mechanical uprooting. Successive cuts must be made until the rhizome reserves are exhausted; this must be repeated before the shoots reach one meter so that it is not necessary to remove them from the area. The backpack brushcutter with articulated arm has proved to be a very useful tool, as the operator is more stable in rough and unstable terrain. Controlled burning could be done to remove the aerial part and then pull up the rhizomes and shoots. These should be grinded to a size similar to sawdust, or they can also be buried more than one meter deep, covered with plastic sheeting.

Combined control: The use of herbicide could be effective after several successive cuts and only in areas away from watercourses due to possible contamination of aquifers.

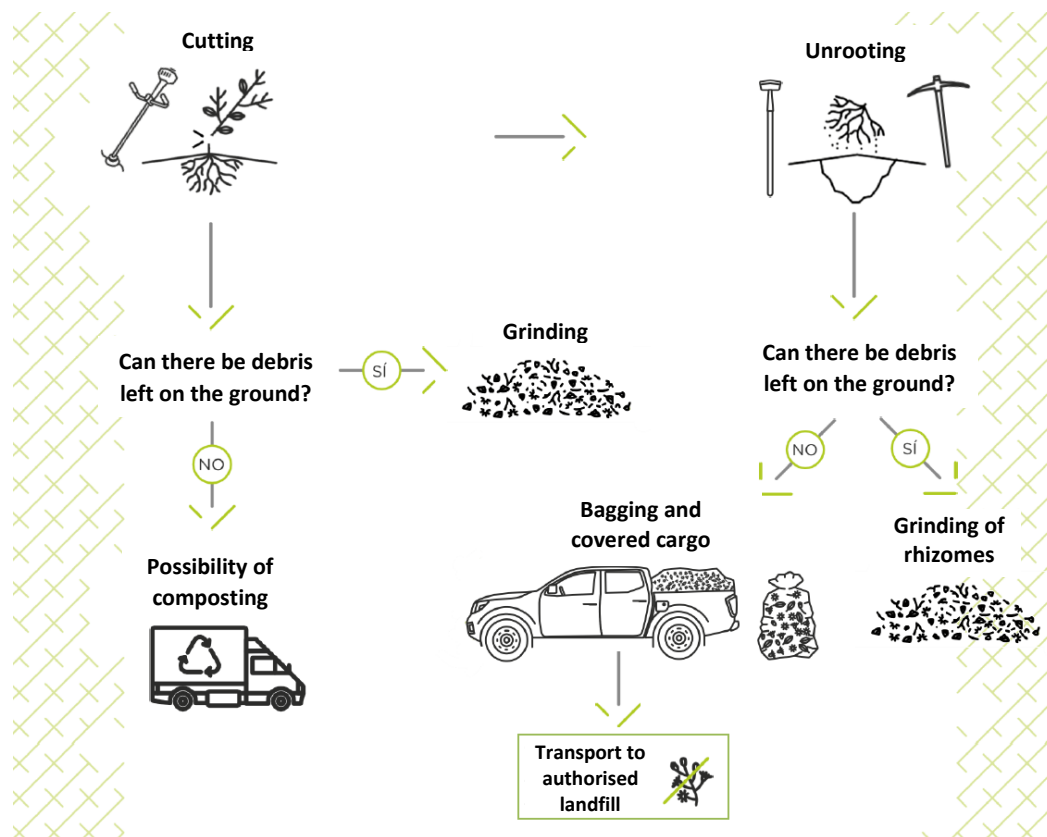
Optimal working period: When the plants are in vegetative rest, in late summer and early autumn.

WASTE MANAGEMENT:

Once cut, the canes can be left on the ground in an orderly manner or chipped. In the case of rhizomes, if neither grinding nor deep burying is possible to leave them in the area, they should be removed in bags or plastic containers to landfill.

MONITORING:

Review after six months to check for re-sprouting. For the restoration of watercourses after the cutting of reedbeds, it is necessary to replant with potential endemic vegetation, which in many cases consists of Canary Island willow.



4. *Cenchrus setaceus*

Common name	Crimson fountaingrass
Taxonomy	Phylum: <i>Magnoliophyta</i> ; Class: <i>Liliopsida</i> ; Order: <i>Poales</i> ; Family: <i>Poaceae</i> .
Native distribution	North East Africa



DESCRIPTION:

It is a perennial herb up to 130 cm tall that grows in dense clumps. The floral stems are erect (or slightly drooping), unbranched or, in any case, very sparsely branched. These stems arise from the base of the plant, together with the leaves. The leaves have a rolled blade, are long, ribbed, rough to the touch, and measure up to 30 cm x 3 mm. They are mostly glabrous, but sometimes have a few hairs towards the base. The ligule between the leaf sheath and the lamina is ciliate. They have a conspicuous rib on the upper side. The seed spikelets are 6-30 cm long, feathery, reddish, pinkish or purple in colour. Each floral spikelet is surrounded by numerous feathery bristles, 12-26 mm long, with one bristle significantly longer than the others (16-40 mm).

ECOLOGY AND PROBLEMS ASSOCIATED WITH ITS INTRODUCTION:

It reproduces by seed, which forms a persistent bank in the soil, viable for up to 6 years, being able to re-sprout from the roots. It is very resistant to fire (which favours its regeneration),

drought and high temperatures. It has a wide tolerance to soil types, growing in acidic, alkaline, sandy and clayey soils. It occurs in thickets, pastures, crops, green areas of anthropic origin, coastal cliffs, etc. It does not tolerate frost or waterlogged soil. It is considered the most problematic invasive species in the Canary Islands.

Ecological impact: 1) It competes with native vegetation, displacing it and forming monospecific stands. 2) It alters hydrological regimes, nutrient dynamics, light availability, changes soil pH and salinity, and modifies the fire regime.

MAIN ENTRY PATHWAYS: Intentional introduction as an ornamental species.

MAIN VECTORS OF INTRODUCTION: Seeds are transported by wind and water, by animals, vehicles, in garden waste, etc.

CONTROL METHODS:

The management of this species in the Canary Islands is regulated in according to: “*ORDER of 13 June 2014, approving the Technical Guidelines for the management, control and elimination of the rabogato (Pennisetum setaceum)*”.

Manual control: First, the flowering parts of the plant are removed, this being the most delicate part. The action should be carried out at a time when flowering is not at its maximum and wind is not excessive, as the main aim of this first step is to avoid seed dispersal at all costs. The best way is to carefully gather the spikelets from the plant, bag them at the top, close the bag at the bottom and then cut off the fascicles. When this is not possible because of the size of the specimen, the spikelets are carefully cut off with scissors and placed in bags to avoid dispersal of the seeds. Attempts will be made to recover any seeds that may have fallen to the ground. This action significantly improves the success and effort of subsequent actions to maintain or eradicate the species. Once the spikes and their seeds have been removed, the plant is dug up by hand or hoe collecting all the root fragments that can be seen, which should also be bagged.

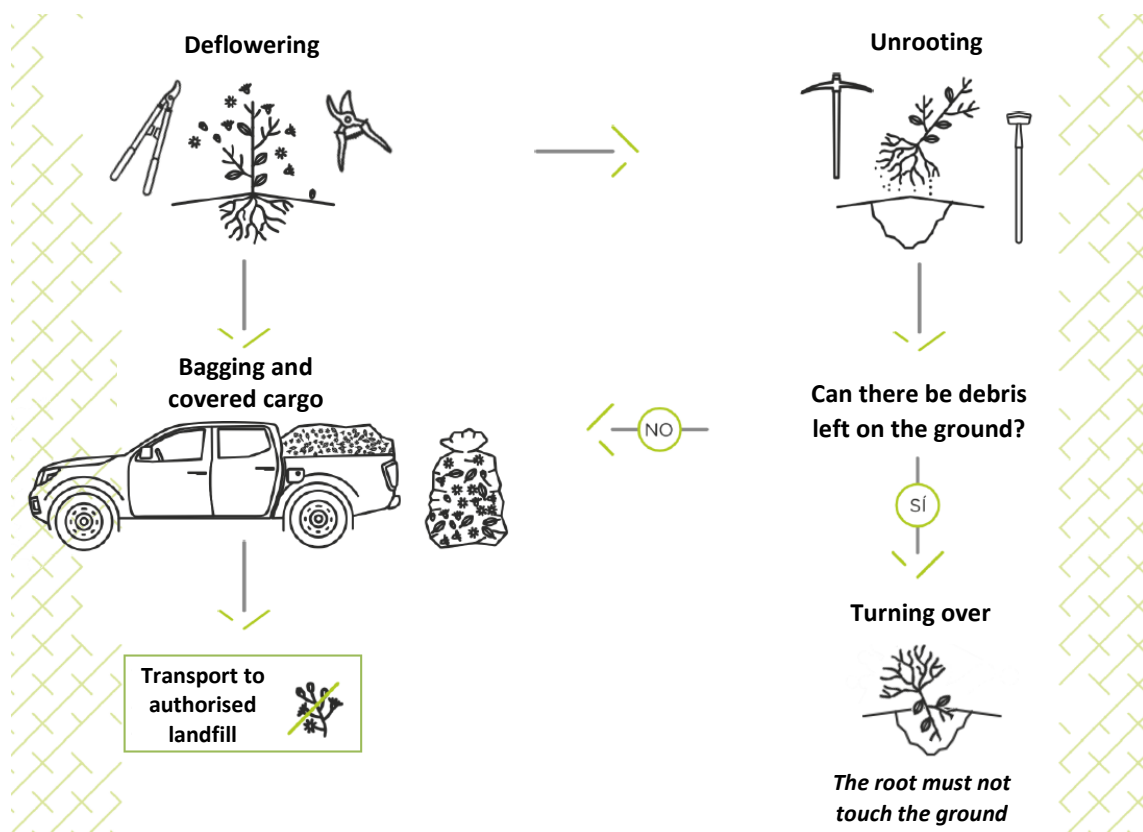
Optimal working period: When the plants are in a vegetative state.

WASTE MANAGEMENT:

All plant debris is collected in plastic bags or containers. The bags should be accumulated on the runway or roadside for transfer to the landfill, taking special care to avoid breakage that could disperse seeds or propagules in the storage area or on the transport route to the landfill. Management at the landfill must be very careful to avoid the spread of seeds through bag breakage in the use of machinery. Burial at sufficient depth is usually a good method of waste disposal. As regards the removal of the plant waste in areas of difficult access, where transport is very difficult, it is left on the ground in such a way that it cannot re-sprout, after prolonged immersion in water tanks. The remains must not be used in the generation of compost.

MONITORING:

Periodic check for root re-sprouting, especially after the first autumn rains.



5. *Agave spp.*

Common name	Century plant, maguey, American aloe (for <i>Agave americana</i>).
Taxonomy	Phylum: <i>Magnoliophyta</i> ; Class: <i>Liliopsida</i> ; Order: <i>Asparagales</i> ; Family: <i>Asparagaceae</i> .
Native distribution	Between eastern Mexico and the southern United States.



DESCRIPTION:

The genus comprises 13 species. They are perennial, robust and rhizomatous plants. The trunk is almost non-existent or absent. The leaves (which can be up to 2 metres long and 25 cm wide) grow from the ground forming large rosettes, arranged upwards and curving towards the ground at the end; they are fleshy, robust, lance-shaped, with spines of almost 2 cm (very sharp and fine, giving the margin a serrated appearance) on the margins and apex (about 5 cm); their colour is bluish-green or bluish-grey. The large flowers (6-10 cm) appear from 10 years of age onwards in a panicle at the end of one of the stems (at 5-8 m high, greenish with alternately arranged bracts) and are pale yellow to greenish in colour; they are made up of 6 'petals' fused at the base to form a short tube. Once the plant has flowered, it dies, being replaced by small shoots that grow around its base. The fruit is an elongated, trigonous capsule (3 compartments), green in colour, changing to brown and blackish over time, with a beaked apex and numerous flattened, shiny black seeds.

ECOLOGY AND PROBLEMS ASSOCIATED WITH ITS INTRODUCTION:

They have a CAM metabolism, sexual and asexual reproduction (by underground rhizomatous stolons). They need well-drained soils and grow in full sun, but do not tolerate shade. They are very resistant to drought and high temperatures, and tolerate light frosts. They grow in sunny places, rocky areas, wadis, sandbanks, ditches and slopes, generally near the sea.

Ecological impact: 1) They displace native vegetation through competition for space, shading, nutrients and alteration of the invaded environment, reducing native biodiversity.

Health impact: 1) The spines can cause harm to humans and native fauna.

MAIN ENTRY PATHWAYS: Intentional introduction as ornamental and textile plants, as well as for boundary demarcation.

MAIN VECTORS OF INTRODUCTION: Once introduced, they expand naturally.

CONTROL METHODS:

Manual control: wherever possible, they shall be extracted at the root with small mechanical winch-type machinery. Before cutting the flowering stems with bulbs, spread netting on the ground, and then collect all the shoots by hand. The flower stalks and leaves are cut into pieces and placed on an insulating surface, stones or plastic to prevent rooting.

Chemical control: Before applying phytocides, the flowering stems of all adult plants must be cut to avoid possible damage to pollinating insects. Several leaves are cut off beforehand and a hole is drilled with a 16 or 18 mm wood drill to inject 50 ml of glyphosate solution 36% with 50% water. The holes are then plugged with cork stoppers and the treated area is marked and signposted for at least 48 hours in accordance with the regulations.

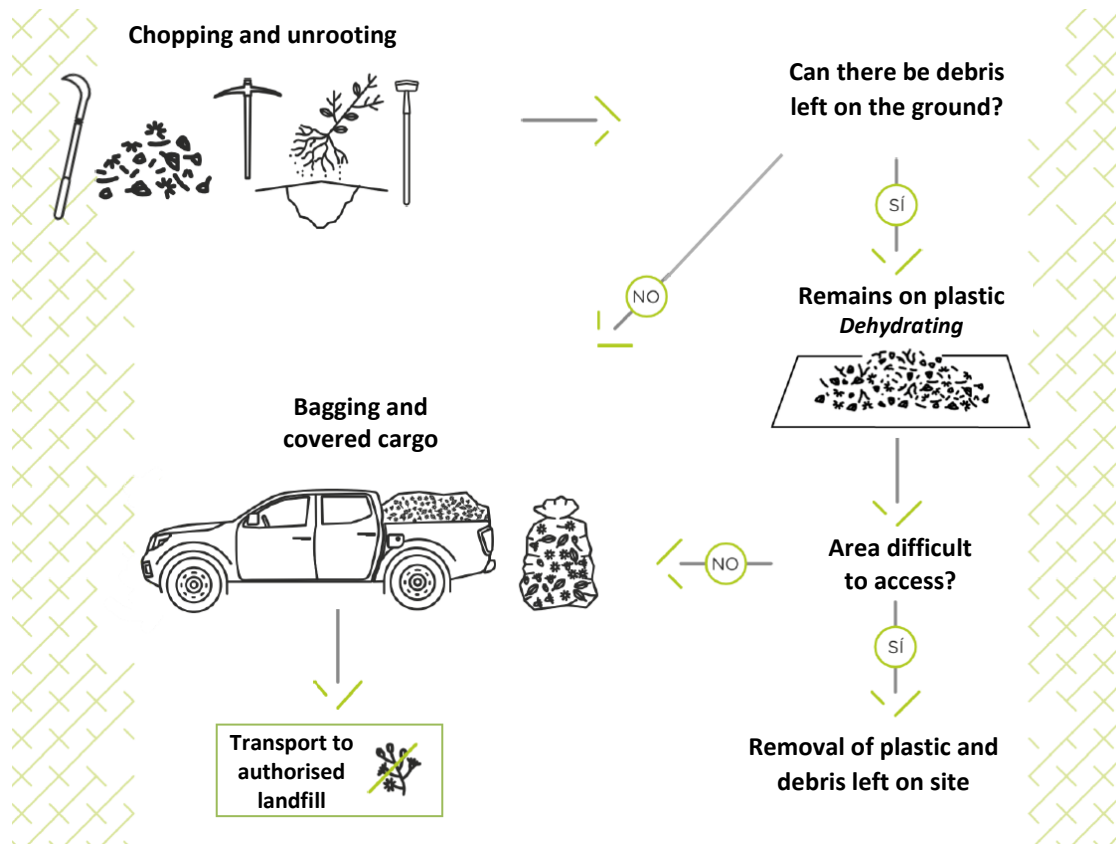
Optimal working period: When the plants are in a vegetative state.

WASTE MANAGEMENT:

Bulblets or propagules should be transported in plastic bags and drums and the rest of the plant in containers to landfill. If it is not possible to remove all the material, the plants can be left on the site with the roots in the sun to encourage drying; the bulblets could be buried 1 meter deep.

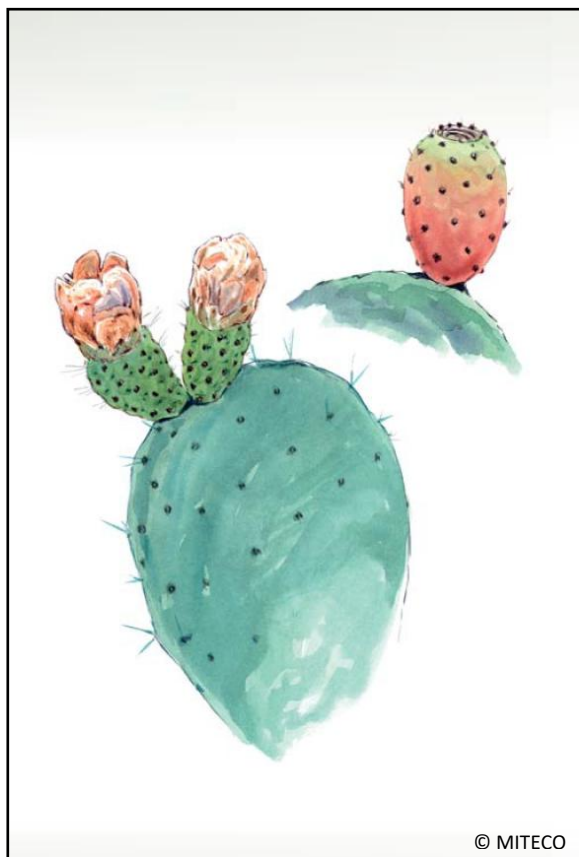
MONITORING:

Check after six months for root re-sprouting. In case of insulation with plastic materials, these should be collected when the remains are dry or decomposed.



6. *Opuntia* spp.

Common name	Prickly pear cactus.
Taxonomy	Phylum: <i>Magnoliophyta</i> ; Class: <i>Magnoliopsida</i> ; Order: <i>Caryophyllales</i> ; Family: <i>Cactaceae</i> .
Native distribution	American continent, from southern Canada to northern Patagonia.



DESCRIPTION:

The genus comprises more than 300 species. They are succulent shrubs with a well-developed trunk, up to 6 m high, with stems transformed into 30-50 cm fleshy, succulent, narrowly obovate or oblong, flattened, greyish-green cladodes (blades). Areoles scattered on the blades, with numerous glochids (small spines with hooked ends) and spines; the spines vary in density (from 0 to 6) and size (from 2 to 40 mm), and are thin, straight and whitish. The flowers are bright yellow or orange, large, 5-10 cm in diameter. The fruits are barrel-shaped pseudo-berries, green, orange or red, with glochids and sometimes thorns, 6-10 cm long, deeply umbilicated at the apex (prickly pears), with edible orange flesh. The seeds are abundant.

ECOLOGY AND PROBLEMS ASSOCIATED WITH ITS INTRODUCTION:

They reproduce both by seed (which can remain dormant) and vegetatively, as the blades are capable of rooting. They have a CAM metabolism and are very resistant to drought, cold and sea

winds. They need intense light and well-drained soils, and prefer slopes and/or abandoned terraces with good sunlight. They occur in semi-arid habitats, cultivated land and wasteland, green areas of anthropogenic origin, or recent volcanic lava flows with sparse vegetation. Germination takes place at slightly high temperatures (approximately 21°C). Seedlings usually develop rapidly during the summer months, showing high viability rates.

Ecological impact: 1) They compete with and displace vegetation native to hot, arid areas, preventing its regeneration. 2) They can alter the hydrological regime of invaded areas, nutrient dynamics, etc.

Health impact: 1) They can cause digestive problems to livestock. 2) The thorns can cause damage to wildlife and humans.

MAIN ENTRY PATHWAYS: Intentional introduction for agricultural cultivation, for ornamental purposes and for hedging.

MAIN VECTORS OF INTRODUCTION: Seed dispersal by endozoochory. Blade debris after pruning is capable of rooting.

CONTROL METHODS:

Manual control: Dismantling of the blades and trunk, chopping of all the material and subsequent uprooting. Both hand tools and brushcutters can be used.

Mechanical control: Using a backhoe, pull up the whole stalks and, where possible, bury them in trenches, tamping the soil with the same machine to facilitate decomposition.

Chemical control: Herbicides are not recommended due to their poor performance.

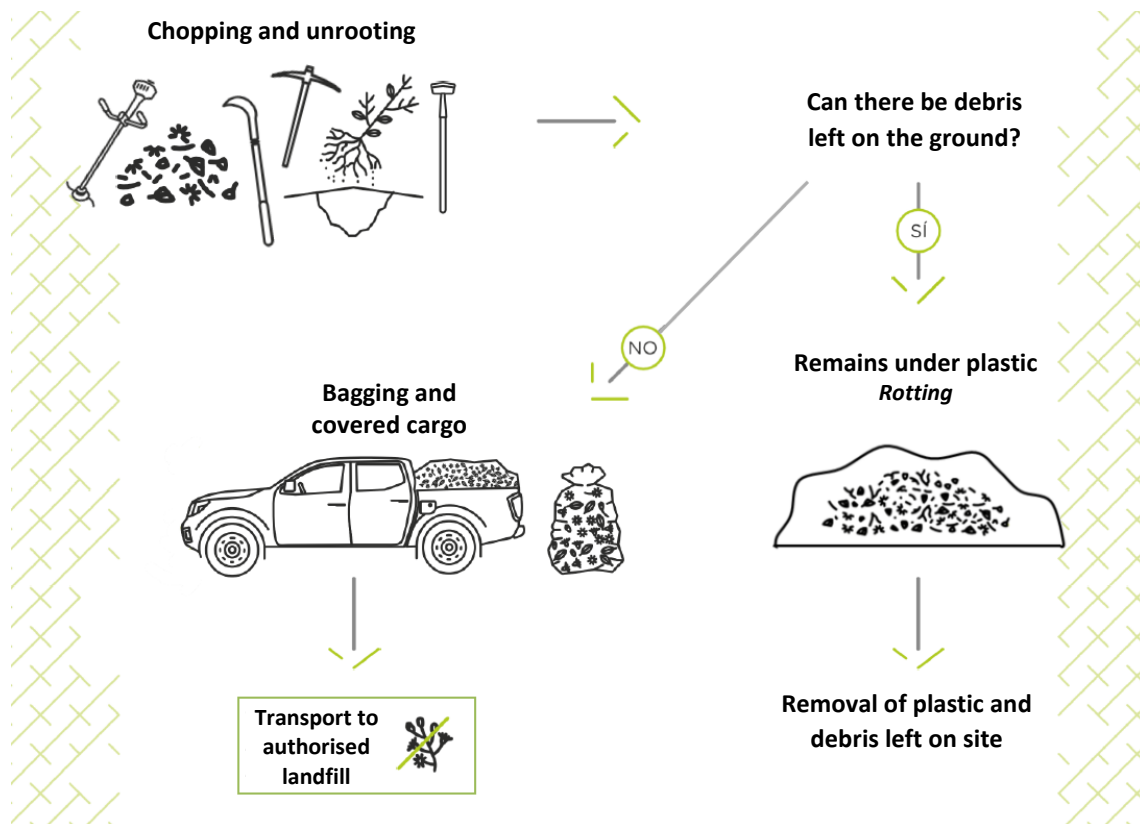
Optimal working period: When the plants are in a vegetative state.

WASTE MANAGEMENT:

Leave the chopped remains on an insulating surface and cover with plastic to facilitate rotting. Roots often penetrate these materials, so they need to be checked frequently. Once this procedure has been completed, remove the plastic material. If they cannot be left on the ground, they must be transported to landfill in double bags or plastic containers.

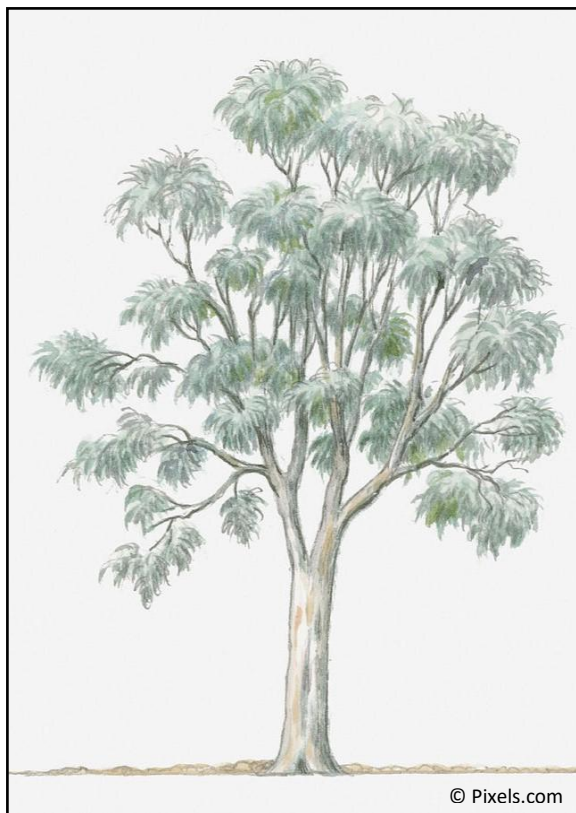
MONITORING:

Review after six months to check for regrowth. In case of insulation with plastic materials, these should be collected when the remains are decomposed.



7. *Eucalyptus* spp.

Common name	Eucalypt, gum tree.
Taxonomy	Phylum: <i>Magnoliophyta</i> ; Class: <i>Magnoliopsida</i> ; Order: <i>Myrtales</i> ; Family: <i>Myrtaceae</i> .
Native distribution	Australia, New Zealand, Philippines and Timor.



DESCRIPTION:

The genus comprises more than 700 species. Evergreen trees that can reach 40-60 m in height, with a wide crown and very thick trunk, smooth bark, white in colour with brown or reddish tones, which flakes off in slabs over the years. Leaves are alternate, hanging, petiolate, greenish-green and somewhat coriaceous. Inflorescences are arranged in umbels of 7-11 cup-shaped flowers with numerous whitish-yellowish stamens. Flowering occurs in April-July. The fruit forms a 5-8 mm long cupuliform capsule with a pointed operculum.

ECOLOGY AND PROBLEMS ASSOCIATED WITH ITS INTRODUCTION:

They are heliophilous species that require full exposure for satisfactory growth. They prefer humid soils, although they resist drought well (in their natural distribution area they are found in areas with rainfall from 200-1,250mm), due to an extraordinary root system. Successful plantations are found worldwide in areas with rainfall of

around 300 mm. They prefer deep soils, mainly alluvial, neutral or acid. They reproduce by seed and can re-sprout from stock. In most species there are no dormancy conditions and the seed can germinate immediately after maturity. Seedlings from seeds do not thrive in shade. They re-sprout vigorously after fires.

Ecological impact: 1) Due to their large size, they require large spaces to develop, almost always taking precedence over native vegetation. 2) They cause alterations in the natural succession patterns due to the allelopathic substances (cineol or eucalyptol) contained in their leaves. 3) They can alter the hydrological regime (desiccants), the soil characteristics (impoverishment) and the fire regime (they are resistant to fire).

MAIN ENTRY PATHWAYS: Intentional introduction for timber plantations and ornamental purposes.

MAIN VECTORS OF INTRODUCTION: Human activity.

CONTROL METHODS:

Manual control: In the case of young saplings, hand-pulling by removing as much of the root as possible may be sufficient.

Mechanical control: It has limited efficacy due to the regrowth capacity of eucalyptus trees. It is only effective if the plants are uprooted, which requires the use of heavy machinery in the case of large specimens. For adult specimens that cannot be uprooted, cutting and curing must be carried out.

Chemical control: When the use of machinery is not possible, a localised treatment with glyphosate (or other common stump and brush removal products) can be carried out on the stumps, in the form of brush strokes on their surface to minimise damage to the rest of the flora.

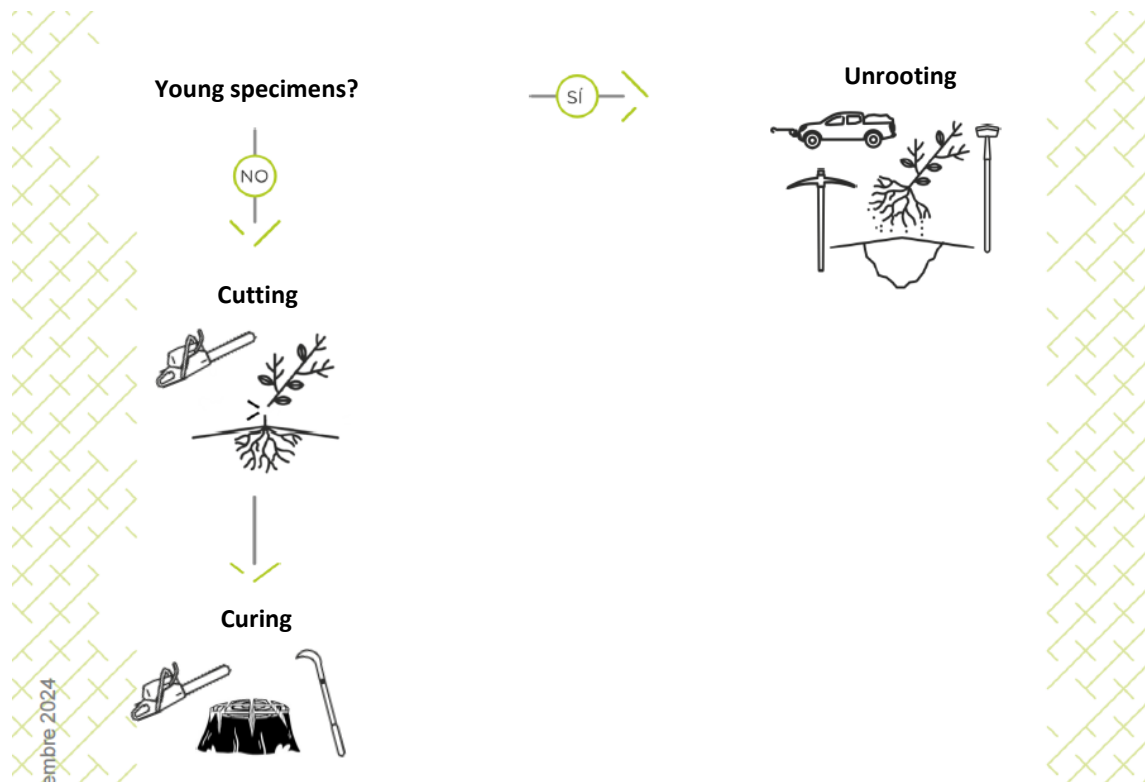
Optimal working period: Felling at the time of greatest vegetative growth (spring and summer) discourages stump regrowth; preferably when the seeds are not yet ripe, around May.

WASTE MANAGEMENT:

Plant debris shall be transported out of the area of operation and care shall be taken to ensure that it is not likely to take root again. Special care shall be taken to avoid dispersal of reproductive parts such as seeds and seedlings.

MONITORING:

Review after six months to check for regrowth.



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Spanish Catalogue of Invasive Alien Species. Ministry for Ecological Transition and the Demographic Challenge (MITECO):
<https://www.miteco.gob.es/es/biodiversidad/temas/conservacion-de-especies/especies-exoticas-invasoras/ce-eei-catalogo.html>

ACKNOWLEDGEMENTS

Special thanks to María Guacimara González Díaz and Cristina Vázquez Montero, for providing specific information generated by the RedEXOS initiative in relation to the target species.

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