Life PollinAction

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With the contribution of the Life Programme of the European Union LIFE19 NAT/IT/000848

Guidelines

CREATION AND MANAGEMENT OF HABITATS FOR POLLINATORS

ROAD INFRASTRUCTURE

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Guidelines

CREATION AND MANAGEMENT OF HABITATS FOR POLLINATORS

ROAD INFRASTRUCTURE

THE LIFE POLLINACTION PROJECT
ACTIONS FOR BOOSTING POLLINATION IN RURAL AND URBAN AREAS
LIFE19 NAT/IT/000848

THE PROJECT

The LIFE project PollinAction aims at the implementation of concrete actions to protect pollinating insects and to address the current 'pollination crisis'.
The causes of this phenomenon are numerous, but the most substantial impact can be attributed to human land use. The processes of urbanisation and the expansion of intensive agricultural areas have resulted in a profound simplification of the landscape and the disappearance of habitats that were once widespread. Meadows, small woods, and hedges, as well as field and road edges, are becoming increasingly rare and reduced in size. Yet, it is precisely in these habitats that pollinators can find the resources they require to survive, including pollen and nectar, as well as areas in which they can nest and withstand the winter. In such simplified landscapes, ensuring the availability of habitats suited to the needs of pollinating insects is the only effective strategy to favour their presence and activity. Small areas in which these animals can find food resources, but also reproductive sites, and which allow them to safely move around the territory: meadows, small, wooded patches, wetlands, hedges, extensive agricultural areas. These interacting components create a network, a Green Infrastructure, capable of providing many benefits to both wild species, plants and pollinators, and humans.

WHO THEY ARE

The project, co-financed by the European Union, is co-ordinated by Ca' Foscari University of Venice and developed in collaboration with the Autonomous Region of Friuli-Venezia Giulia - Central Directorate for Agri-food, Forestry and Fishery Resources, Biodiversity Service; Veneto Region - Agri-environmental, Fish and Wildlife Planning and Management Directorate; Veneto Agency for Innovation in the Primary Sector - Veneto Agricoltura; Municipality of Caldogno; Concessioni Autostradali Venete - CAV S.p.A.; Centro de Investigación y Tecnología Agroalimentaria de Aragón; ALBATROS S.r.l.; EcorNaturaSì S.p.A.; SELC soc. coop..

THE AREAS

Italy (Veneto and Friuli-Venezia Giulia) and Spain (Aragon). Three settings: agricultural areas, urban areas, and road infrastructures.

THE OBJECTIVES

LIFE PollinAction aims to mitigate the pollinator crisis by creating or improving their habitats, primarily by increasing the abundance of wild plants.
Specifically, LIFE PollinAction activities are dedicated to:

- creating approximately 28 hectares of new habitats rich in plant species, including 18 hectares of new meadows, 7 hectares of flowering strips, and 2 hectares of shrub patches;
- creation of 14 kilometres of new hedges;
- improvement of 230 hectares of meadows;
- assessment of ecosystem services provided by habitats and design and implementation of Payments for Ecosystem Services (PES) schemes to inform regional/national agricultural policy;
- designing milk, honey, and hay supply chains based on species-rich meadows to increase farmers' competitiveness.

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PREFACE

WHY A GUIDE?

Road infrastructure plays a pivotal role in the global transport network, facilitating the movement of people and goods on a vast scale.
However, their presence has a marked impact on the surrounding environment, affecting plant and animal biodiversity. Indeed, road construction often results in the fragmentation of existing habitats, creating physical barriers that impede the movement and dispersal of wild species. If not properly managed, these barriers can become inhospitable zones for local fauna.
Nevertheless, the areas situated in close proximity to long-distance transportation routes offer an opportunity for the improvement of the surrounding area. Indeed, with the implementation of targeted and effectively managed interventions, these areas have the potential to be transformed into ecological corridors and stepping stones of high ecological value, providing habitats and vital resources for the conservation of biodiversity. In line with this rationale, road embankments, rest areas and green spaces situated alongside motorways can be enhanced with plant species that are attractive to pollinators, thereby facilitating the creation of an environment that is more conducive to their survival.
The objective is to transform road infrastructure into ecological corridors for pollinators; the benefits of this approach include an overall improvement in ecological connectivity, support for the genetic diversity of pollinator populations, and a tangible contribution to the stability of the ecosystem. Furthermore, these improvement actions can directly and positively influence the landscape in proximity to infrastructure, thus reducing soil erosion and consequently enhancing the resilience of infrastructure to climate change.
The indications provided in these Guidelines are a synthesis of the experience gained during the LIFE PollinAction project, with the aim of providing technical and practical information for environmental restoration projects in urban and peri-urban areas. In particular, the guide supports the European Union Pollinator Initiative[1], adopted by the Commission in 2018, by outlining the steps needed to plan, create, and maintain optimal natural and semi-natural habitats for pollinators along major road infrastructure.

This guide, which is dedicated to road infrastructure, forms part of a series that also includes a guide dedicated to the agricultural setting and another on urban areas.

[1] *https://environment.ec.europa.eu/topics/nature-and-biodiversity/pollinators_en*

WHO IS THIS GUIDE FOR?

This guide has been developed for managers of major road infrastructures who are interested in implementing actions to preserve or create habitats for pollinators along the infrastructures they manage.

Road infrastructure managers play a pivotal role in this endeavour. They are in a position to leverage their influence and managerial authority to advance the sustainable utilisation of green spaces adjacent to roads. Furthermore, they can adopt strategic plans for the disposal of areas to facilitate the expansion or creation of new habitats for pollinating insects, while also encouraging the involvement of landowners in these initiatives.

Technicians and professionals have the potential to play an instrumental role in the enhancement of these areas. Their acquired expertise enables them to provide invaluable support in the planning, implementation, and management of these domains in accordance with the principles of sustainability and biodiversity conservation.

Furthermore, **landowners adjacent to road infrastructure** may also play a significant role. The provision of underutilised plots of land for the creation or conservation of pollinator habitats along road infrastructure, in conjunction with the initiatives of infrastructure managers, represents a valuable opportunity to enhance the green corridor logic of these infrastructures.

Associations may act as an additional driving force behind such initiatives. Firstly, the involvement of **citizens** can encourage the adoption of good practices, as well as the subsequent phases of care, maintenance and promotion. Secondly, **professional associations** may enhance the scope of restoration projects, especially through the proactive involvement of owners of land bordering the infrastructure.

HOW TO USE THESE GUIDELINES

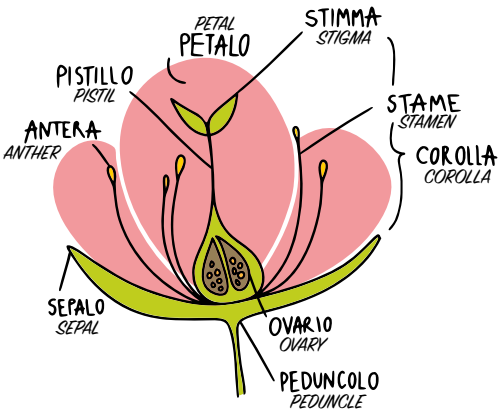
Section 1 introduces the topic of pollinators and pollination.
Section 2 explains key strategies to support pollinators along road infrastructure.
Section 3 provides concrete indications for the improvement of habitats for pollinators.

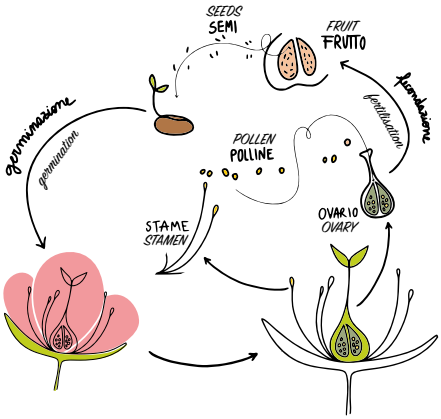
SECTION 1

WHAT IS POLLINATION?

Pollination can be defined as the transfer of pollen between flowers of different plants of the same species. It represents an essential phase of the reproductive cycle of the majority of flowering plants, including numerous species that provide us with food and materials. This process is facilitated by the movement of insects or other animals from one plant to another. In the absence of pollinators, many plants would be unable to produce seeds and reproduce, which would result in a decline in plant diversity and, subsequently, the loss of resources for insects.

POLLINATION





WHO ARE POLLINATORS?

It is perhaps unnecessary to provide an introduction to pollinators, as many are well-known. The honeybee is undoubtedly the most renowned pollinator, and its decline has attracted considerable attention from the general public. However, it is a common misconception that the honeybee is the most significant pollinator. In fact, the majority of pollination is performed by wild pollinators. It is estimated that there are at least 20,000 species of wild bees, in addition to bumblebees, butterflies, wasps and ants. These species are of vital importance for the preservation of the environment, both natural and cultivated. The principal pollinators can be classified into four main groups.

WHO ARE POLLINATORS

HYMENOPTERA

Bumblebees and bees, both social and solitary, wasps

Bees are among the most efficient pollinating insects in handling flowers, and many plants, both wild and cultivated, form obligate relationships with them. Wasps also contribute to the pollination of many plant species and, like bees, require pollen and nectar for their survival. In some cases, ants can also make an important contribution to pollination.

A specimen of Bombus pascuorum (Common Carder Bee)

LEPIDOPTERA

Butterflies and moths

They visit a wide variety of wild plants in search of nectar. They are less effective than bees in transporting pollen. Characterised by elongated, slender legs and a specialised tubular proboscis-shaped mouthpart, called spirotrumpet, they are not able to manage to intercept much pollen with their bodies nor do they have special structures to collect it.

A specimen of Macroglossum stellatarum (Hummingbird Hawkmoth) on Scabiosa sp.

DIPTERA

Flies, including hoverflies

They are an important yet often underestimated group of pollinators. Diptera are distinguished from other insects by their two membranous forewings and two reduced hindwings, which serve as balancing organs during flight. They are an ancient group and were probably among the first groups of pollinators. Diptera visit flowers to obtain nectar, which provides energy, and pollen, necessary for egg production.

A specimen of Ectophasia crassipennis (Thick-legged Ectophasia) on Pimpinella saxifraga (Burnet-saxifrage)

COLEOPTERA

Beetles and many others

They are a very ancient and incredibly diverse group of pollinators. More than 300,000 species have been described worldwide, representing approximately 40% of known insects. Beetles have contributed to shaping the earliest pollination relationships between plants and insects.

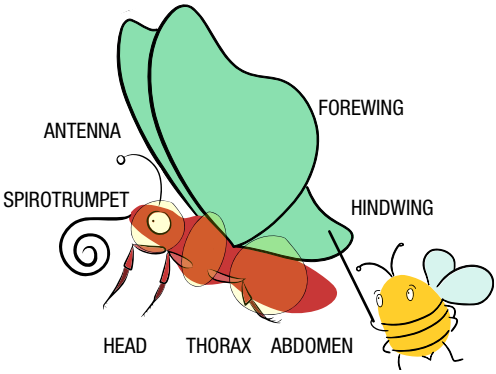
A specimen of Cetonia aurata (Rose chafer) on Prunus mahaleb (Mahaleb cherry)

BOX: WHAT THEY LOOK LIKE AND HOW THEY LIVE

Some insects do not have wings and flies have only one pair of functioning wings. However, in Coleoptera, the first pair of wings is modified to form a protective covering for the second pair of wings

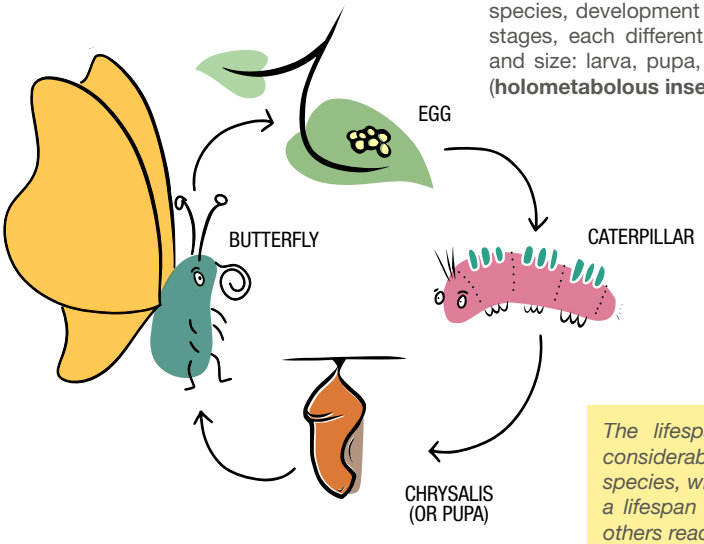
The **insect body** consists of three parts:
> the **head** on which are the eyes and antennae,
> the **thorax** to which are articulated 3 pairs of legs and, in most cases, 2 pairs of wings,
> the **abdomen**.

While we have bones inside our bodies, insects have an external skeleton (**exoskeleton**) that surrounds their bodies like a kind of shell.



Antennae represent vital organs that facilitate sensory perception and environmental interaction in insects.

Insects are oviparous, emerging from eggs. In some species the young insects are morphologically similar to adults (**heterometabolous insects**). In many other species, development occurs through several stages, each different in appearance, shape and size: larva, pupa, perfect insect or adult (**holometabolous insects**).



The lifespan of insects exhibits considerable variation between species, with some species having a lifespan of just a few days and others reaching several years.

WHY ARE POLLINATORS IMPORTANT?

Pollinators are of critical importance in maintaining healthy ecosystems and ensuring food production, as they facilitate the reproduction of flowering plants. The role of pollinators in the functioning of our agricultural system is of fundamental importance. It is estimated that approximately 90% of flowering plants and 75% of food crops worldwide are dependent on pollinators.

It is possible to consider the use of artificial pollination or the purchase of bees and bumblebees as potential solutions to the problem. But without wild plants? Pollinators are crucial for the reproduction of wild plants. Without them, plant populations would decline, even if other essential elements, such as soil, air, and nutrients, were available.

PLANTS AND POLLINATORS

Insect pollination represents one of the most remarkable examples of co-evolution, whereby two distinct species, a plant and an insect, engage in a symbiotic relationship that is mutually beneficial, resulting in evolutionary changes for both parties. The relationships established between these two groups of organisms give rise to the high degree of complexity and diversity observed in nature.

Flowering plants adapt to their pollinators by developing structures and strategies to attract specific pollinators. Insect-pollinated flowers often exhibit bright colours and patterns, which are often invisible to the human eye, that guide insects towards pollen and nectar. And it is a two-way street! Insects adapt to plants by evolving body parts and behaviour to favour the pollination of specific plants. Bees, for example, have developed special sucking mouthparts to absorb nectar, and in some species, they even have small baskets on their hind legs to collect pollen.

About 90% of plants require the help of other organisms, such as insects, birds, or bats, to transfer pollen from one plant to another. Thanks to the pollination process, seed plants can produce seeds and fruit; likewise, plants provide insects with the resources, pollen and nectar, as well as reproductive and overwintering sites necessary to complete the life cycle.

WHY ARE POLLINATORS DISAPPEARING?

The decline of pollinators is the result of a multitude of interrelated factors, including the use of pesticides, the spread of diseases and pests, climate change, and the introduction of alien species. However, the most significant impact can be attributed to human land use practices. The expansion of urbanisation and the intensification of agricultural management have contributed to the simplification of the landscape and the reduction, and in some cases, the loss of natural and semi-natural habitats that are vital for pollinators.

Road infrastructure has a profound and enduring impact on the biodiversity of plant and animal species. This is largely due to the reduction of green spaces, which, when present, represent small hospitable islands within an otherwise inhospitable urban matrix

SECTION 2

WHAT IS THE GOAL?

Pollinators are adversely impacted by a multitude of factors, with the loss of natural and semi-natural habitats, such as meadows, hedges, and woodlands, representing a significant concern. The loss of habitat is accompanied by a decline in the diversity and abundance of plant species that provide essential resources for pollinators, including food (pollen and nectar) and shelter.
The recommendations set forth in these Guidelines are intended to **address the decline in biodiversity and enhance the ecological integrity of areas adjacent to road infrastructure**. This is achieved by creating or enhancing habitats that are rich in entomophilous flowering species[2], which can provide nutritional resources (pollen and nectar) and ensure the availability of reproductive sites for pollinating insect populations. The presence of these elements along road infrastructure can lead to a significant increase in the richness and abundance of insects.

NOT JUST POLLINATING INSECTS!

The establishment of hedges, meadows and wildflower strips, along road embankments and green spaces situated alongside motorways provides an effective refuge for a multitude of plant species and a variety of animal species, including birds and other wildlife.
The creation and maintenance of habitats and the flora that inhabit them offers the opportunity to achieve a variety of benefits through a single action. These include the regulation of temperature and the mitigation of the heat island phenomenon in urban centres, the reduction of surface water runoff in the event of increasingly frequent intense precipitation, thereby contributing to the reduction of soil erosion. Furthermore, the incorporation of green spaces can positively impact the psychological well-being of individuals using these routes, thanks to the enhancement of the landscape surrounding the infrastructure, which facilitates a more profound connection between humans and the natural environment.

[2] *Plants pollinated by insects, especially bees, butterflies, moths, dipterans and beetles*

BRINGING NATURE BACK ALONG ROAD INFRASTRUCTURE PROVIDES US WITH MANY BENEFITS

Health and psycho-physical well-being
Green spaces along road infrastructure provide travellers with opportunities for recreational activities and the pursuit of wellness

Scenic quality
Urban green spaces enhance aesthetic quality of road infrastructure

Pollination
Habitats and resources for pollinating insects

Biodiversity
Species, habitats

Heat wave mitigation
Green spaces along road infrastructure have a significant impact on temperature regulation, with the capacity to both cool and mitigate rising temperatures

Runoff control
Control of surface runoff by green spaces can prevent flooding, reducing damage to population and infrastructure

The main benefits provided by natural and semi-natural habitats in the urban environment. Yellow boxes indicate services directly related to the overall functioning of ecosystems; purple boxes indicate services related to society and the environment.

HOW MUCH SPACE DO I NEED?

Areas along road infrastructure, such as embankments, adjacent green areas, roundabouts, roadsides, traffic islands and parks created on marginal areas, all have the potential to meet the minimum needs of pollinators. This means that they can provide the resources (pollen and nectar) that are essential for the insects to survive, as well as the opportunity for them to nest and survive the bad season.

Size is not always important. The variety and quality of the habitats created or improved are more important than quantity! Planting a wide variety of flowers, with different colours, flower sizes and flowering times (spring to autumn), will attract a wide range of pollinators and ensure a continuous supply of resources for both adults and larvae.

It is possible to situate plants in a variety of green spaces, both large and small, in proximity to the infrastructure. Indeed, all road infrastructures typically encompass a variety of underutilised marginal green spaces, including side slopes, traffic islands, roundabouts and drainage ditches, that can serve as potential sites for the implementation of green infrastructure solutions. Even small bare patches are crucial for all those insects that nest in the soil.
Despite the vast diversity of pollinator species, they all require three types of habitats to survive and complete their life cycle:

- **foraging habitat:** areas characterized by the presence of floral resources (pollen and nectar), within a reasonable flying distance, spanning from spring to late autumn. The greatest number of pollinators and, consequently, the greatest demand for resources occurs in early summer. However, the availability of floral resources must also be ensured in spring, when overwintering pollinators emerge from hibernation and require sustenance, and in late summer, when pollinators need to feed in preparation for hibernation;
- **breeding habitat:** breeding habitats are species-specific. For example, some bee species (both solitary and social) construct their nests in bare soil, either by digging or by utilising abandoned nests and burrows. Other bee species utilise leaves, while others employ cavities in plant stems or walls. Butterflies require specific native plants, both herbaceous and shrubby species, which serve as a food source for their caterpillars;
- **overwintering habitat:** areas with vegetation that remain undisturbed from late summer until late spring, such as permanent meadows, road or ditch margins, shrub patches, hedges, groves, and isolated trees, as well as timber piles and litter.

Pontia edusa on Sanguisorba

WILD POLLINATORS: FOOD REQUIREMENTS AND HABITAT

POLLINATORS	DIETARY REQUIREMENTS	BREEDING HABITAT	OVERWINTERING HABITAT
Solitary bees (*Hymenoptera*)	Pollen and nectar	Most of the species nest in bare or partially vegetated, well-drained soil. Others nest in narrow tunnels in the trunks of dead trees. Some species build their nests by folding leaves over themselves.	Stems of dead plants, bark, reeds, foliage, and especially undisturbed soil are the winter homes of solitary bees.
Bumblebees (*Hymenoptera*)	Pollen and nectar	The majority nest in small cavities, often underground, in abandoned rodent nests, or in tree hollows, at the base of tufts of grass, or in wall crevices.	The queens overwinter underground in shaded areas, usually near trees, on embankments, and on north-facing slopes, to avoid emerging too early on a warm or sunny day in winter.
Wasps (*Hymenoptera*)	Pollen and nectar	Most wasp nests are made of paper. Wasps utilise saliva and chewed wood pulp to create their nests. The appearance of the nests varies depending on the species that built them. They are typically located in sheltered areas with easy access to the outside, such as hollow trees, tall grass, or buildings. Other species build their nests of mud in sheltered locations.	Some adult wasps overwinter in protected and undisturbed locations, such as under tree bark or in building cavities.
Butterflies (*Lepidoptera*)	Nectar	Butterflies construct their nests in proximity to plants that are utilised by caterpillars as a source of nourishment.	Most butterflies survive the winter as a chrysalis or larva (caterpillar) in vegetation or litter; others overwinter as adults in sheltered cavities or tree trunks; still others migrate over long distances.
Hoverflies (*Diptera*)	Nectar and pollen	The females lay eggs in suitable places where the larvae can find food. Species that feed on aphids lay eggs near aphid colonies, species with larvae that feed on plants lay eggs on host plants, while other species lay eggs in stagnant water.	Hoverflies have two strategies to survive the winter. They either burrow into the ground as larvae or enter a state of hibernation as adults in sheltered places within the trunks of old trees or in building crevices.
Beetles (*Coleoptera*)	Pollen	Some species lay eggs among decomposing leaves, others in decaying wood, or in animal feces.	Adults survive the winter in tree cavities, among decomposing leaves, under logs, and in the soil.

BOX: FLOWERS FOR FREE

One of the most effective strategies for the conservation of pollinators is the maintenance and enhancement of existing habitats. Some species of plants that are important for pollinators are very common along road infrastructure, as embankments, adjacent green areas, roundabouts, roadsides, traffic islands.

SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Achillea millefolium												
Buphthalmum salicifolium												
Calystegia sepium subsp. *sepium*												
Centaurea nigrescens												
Cichorium intybus												
Cirsium vulgare												
Crepis biennis												
Daucus carota subsp. *carota*												
Geranium molle												
Glechoma hederacea												
Helminthotheca echioides												
Lamium purpureum												
Leontodon hispidus												
Iris pseudacorus												
Lotus corniculatus												
Lythrum salicaria												
Ranunculus acris												
Ranunculus bulbosus												
Salvia pratensis												
Taraxacum officinale												
Torilis arvensis												
Trifolium pratense												
Trifolium repens												
Veronica arvensis												
Vicia sativa												

LEGEND: The coloured squares represent the colour of the flowers and the flowering period.
Plants to the left of the vertical dotted line are of particular importance in providing floral resources for insects during the early stages of the season.

WHAT SHOULD I PAY ATTENTION TO?

MATERIAL SELECTION

The selection of the appropriate material, the plants, to be used is of paramount importance to ensure the success of the intervention, reduce the cost of cultivation treatments, and at the same time maintain the integrity and stability of natural ecosystems. It is imperative that the plants be of '**local provenance**', whereby the seed used for plant production must have been collected in the same 'region of provenance' (ROP) as that of the plants' destination. In the event of unavailability, it may be accepted that the material sourced from other ROPs may be used, provided that it is sourced from locations as close as possible to the site of intervention.

In the case where interventions entail the utilisation of **seedlings in soil blocks**, at the time of delivery, these must be provided with soil firmly attached to the roots and free from weed plants; they must be free from obvious pathologies, with sufficient development of the above-ground part to facilitate effective handling by operators. Woody plants, trees and shrubs, must be well lignified, preferably

BOX: DEFINITION OF REGION OF PROVENANCE

For plant species, the region of provenance is defined as 'the territory or set of territories subject to sufficiently uniform ecological conditions and on which there are topsoil or seed sources that are sufficiently homogeneous from a phenotypic and, if evaluated, genotypic point of view, taking into account altitudinal limits where appropriate' (Directive 1999/105/EC on the marketing of forest reproductive material). For forest species, regions of provenance are defined nationally by Ministerial Decree No. 9403879 of 30/12/2020 'Establishment of the National Register of Basic Materials' and subsequent amendments and integrations, and possibly detailed by regional regulations. The recent Ministerial Decree No. 269708 of 11/06/2021 'Division of the Italian territory into Regions of Provenance' includes a cartographic representation of the aforementioned regions of provenance. This tool, available online[3], can also be adopted as a precautionary measure for herbaceous species, marketed in various forms (seedlings, seeds, brush-harvested seed, bulbs, etc.) and for which no analogous legislation exists. An additional classification[4] is also available online, comparable to the previous one (although based on different criteria) and equally suitable when adopting a precautionary approach in the handling of plants and seeds. The provenance of plant material is typically guaranteed by public nursery facilities that, for institutional purposes, produce only locally sourced plants. In any case, the costumer is required to verify the information regarding the origin of the plants, requesting documentation from the supplying nursery (which may or may not coincide with the producing nursery), as suggested below:

- if the plant nursery producing the plants is certified according to UNI EN ISO 22005 (traceability), it is sufficient for the nursery to declare, before delivery, the denomination (location and municipality) of the stand from which the batches supplied were collected;
- if the producing nursery is not certified according to traceability, the costumer is expected to request the following information: the source population (location, municipality) of the seed used, the year of collection of the same, the quantity used for the production of that batch of plants, and the corresponding number of plants obtained.

[3] *https://www.politicheagricole.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/17155*
[4] *Classification and mapping of the ecoregions of Italy. https://www.tandfonline.com/doi/full/10.1080/ 11263504.2014.985756*

of an age less than or equal to two years (with a maximum age of three years), with a maximum height of 80–90 cm and a minimum height of 20 cm. In instances where the root system has become excessively twisted and compact due to prolonged nursery cultivation, it may be beneficial to sever the root ball at the end prior to planting. This can assist in the disentanglement of the roots and facilitate the establishment of a robust root system, thereby enhancing the speed of seedling establishment.

If the top of the root system appears twisted, before planting, it may be useful to sever the end of the soil block to facilitate the disarticulation of the roots and accelerate the establishment of the young seedlings

BOX: WHY NATIVE PLANTS

The term 'native plants' (also referred to as 'autochthonous') denotes species that have originated and evolved within the geographical area in which they are found. Consequently, they have a long history of natural presence within the natural ecosystems of a given region. Non-native plants, also referred to as allochthonous, alien, or exotic plants (*for further information, please see the BOX Exotic Species on page 24*), are naturally widespread in other parts of the world, or even in other areas of the country (for example, they are typical of Mediterranean climate areas). However, they can also grow well in other areas as ornamental or garden plants. The use of native plants, which are adapted to the local climate and conditions, is a more effective method of ensuring the success of the intervention and its long-term duration. It is of the utmost importance to note that, although exotic plants may offer pollinators some nutritional value, native plants, due to their long history of co-evolution, attract and support a greater diversity of native pollinators and are crucial for the survival of numerous species.

LIFE PollinAction's Public Reference Nurseries

The plants used for the creation and/or improvement of habitats in the LIFE PollinAction Project were produced and supplied by public nurseries, project partners.

- Centro Biodiversità Vegetale e fuori Foresta di Veneto Agricoltura a Montecchio Precalcino (VI): Via Bonin Longare, 6, 36030 - tel. +39 0445 864445;
- Regional nursery centres of Friuli-Venezia Giulia:
  - > Azienda Volpares a Palazzolo dello Stella (UD): Casali Volpares, near Palazzolo dello Stella (UD);
  - > Vivaio forestale Pascul di Tarcento (UD): Via Pradandons, 15 - tel. +39 0432 785029

Cultivation of seedlings in soil blocks at Volpares Nursery (Palazzolo dello Stella)

Seeds of native species of hay meadows stored at Veneto Agricoltura Nurseries (Montecchio Precalcino)

Plots for intensive production of local seed for hay meadows at Veneto Agricoltura Nurseries (Crespano del Grappa)

BOX: EXOTIC SPECIES

A significant proportion of the plant species utilised in agricultural, horticultural and forestry contexts are not native to our country. Rather, they have been introduced from other regions of the globe. Such species are designated as 'exotic' or 'alien'. The majority of these introductions have resulted in benefits, as evidenced by the significant role of exotic species in the agri-food sector. However, some of these species have become naturalised in the regions of introduction and subsequently spread uncontrollably, invading both natural ecosystems and agricultural and urban environments. This has resulted in a range of negative impacts. A typical example of an invasive species along roadsides is Johnson grass (*Sorghum halepense*). These particular exotic species are defined as invasive alien species because they have the capacity to alter, and in some cases, irreversibly disrupt the structure and functioning of ecosystems, with adverse ecological and economic consequences. In some instances, these species have also been shown to have detrimental effects on human health.

Invasive species exhibit a number of characteristics: the alarm bells!

- ability to colonise disturbed environments and bare ground
- very rapid growth
- short life cycle with early flowering and dissemination, often different from that of native species
- production of large quantities of seeds and/or fruits
- effective propagation through vegetative means

It is these very characteristics that render these species so popular for use as ornamental greenery.
However, the introduction of invasive exotic species represents a significant threat to biodiversity. It is therefore imperative to adopt responsible practices, including the avoidance of invasive plant species, to prevent further disruption to natural ecosystems.

The phenomenon of invasions is experiencing a marked increase, with a considerable number of new species being introduced on a voluntary or accidental basis each year. In view of this situation, the European Commission has adopted a list of invasive alien species of EU relevance, which is updated on a periodic basis in accordance with EU Regulation 1143/2014[5]. This list identifies those invasive species whose negative effects are so significant that they require coordinated and uniform action at the EU level.

[5] *https://eur-lex.europa.eu/legal-content/IT/TXT/?uri=celex%3A32014R1143*

SPECIES TO AVOID

TREES
Box elder Maple (*Acer negundo*)
Tree of Heaven (*Ailanthus altissima*)
Cigartree (*Catalpa bignonioides*)
Chinese windmill palm (*Trachycarpus fortunei*)
Black Locust (*Robinia pseudoacacia*)
SHRUBS
Butterfly Bush (*Buddleja davidii)*
False Indigo bush (*Amorpha fruticosa*)
Cherry Laurel (*Prunus laurocerasus*)
Oval-leaved Privet (*Ligustrum ovalifolium*)
Chinese Privet (*Ligustrum sinense*)
Glossy Privet (*Ligustrum lucidum*)
Oregon Grape (*Mahonia aquifolium*)
Japanese Rose (*Rosa rugosa*)
Japanese Spirea (*Spiraea japonica*)
HERBACEOUS PLANTS
Panicled Aster (*Symphyotrichum lanceolatum*)
Balsam (*Impatiens* spp., various species)
Japanese Honeysuckle (*Lonicera japonica*)
Evening Primrose (*Oenothera* spp., various species)
Phacelia (*Phacelia tanacetifolia*)
Tawny Daylily (*Hemerocallis fulva*)
Buckwheat (*Fagopyrum esculentum*)
Canada Goldenrod (*Solidago canadensis*)
Giant Goldenrod (*Solidago gigantea*)
Japanese Knotweed (*Fallopia japonica*)
Kudzu (*Pueraria lobata*)
American Pokeweed (*Phytolacca americana*)

The main introduction pathway of alien plant species into regions beyond their native range is through trade and use as ornamental plants. Indeed, approximately 80% of the invasive species currently present in Europe have been introduced voluntarily as ornamental plants. These are the plants we often find in private gardens or public green spaces.

One of the primary factors motivating managers or private citizens to select an ornamental plant is its aesthetic appeal, regardless of its provenance. The aesthetic appeal of a plant can be quantified through a series of morphological measurements, including the size of the plant, the dimensions of its flowers, and the hue of their colour. Once these parameters have been collated, a comparison can be made between two plant species in order to ascertain their aesthetic similarity. This method may prove useful in suggesting local (native) plant species in place of invasive alien species that better meet the aesthetic requirements of the green project to be realised.

A comparable analysis was undertaken to evaluate the similarity between the local flora and the ornamental species most commonly sold by nurseries and florists in the province of Venice. Of the 75 alien ornamental plant species analysed, nine were found to have at least one local species that was 100% aesthetically similar according to the chosen parameters. In addition, 42 other plants exhibited at least one local species with a similarity rating of 83%.

The utilisation of plant species native to the local flora in public and private green projects offers a multitude of advantages:

- reinforces the gene pool of the local flora by reducing the risk of hybridisation;
- increases the abundance and diversity of pollinating insects;
- facilitates the creation of more suitable habitats for the support of local bird populations;
- enhances the sense of belonging and reinforces the connection between individuals and the territory;
- can represent a novel market opportunity for local companies;
- particularly, termophilous plant species are well adapted to urban environments, in which they find characteristics similar to the Mediterranean environment: limited water availability, high temperatures and brightness.

ALIEN ORNAMENTAL SPECIES	NATIVE SPECIES	ALIEN ORNAMENTAL SPECIES	NATIVE SPECIE
 *Camellia japonica*	 *Cistus creticus*	 *Primula japonica*	 *Primula farinosa*
 *Dimorphoteca pluvialis*	 *Tragopogon porrifolius*	 *Rosa gr. 'Pink-Favorite'*	 *Rosa gallica*

Code of conduct: replacing ornamental plants with native species

In 2018, the LIFE ASAP project produced a Code of Conduct for Nurseries and Invasive Alien Species. The Code of Conduct comprises 12 fundamental principles, one of which encourages nurseries and garden centres to make available replacement species to invasive alien species, possibly belonging to the local flora.

To learn more:
www.minambiente.it/pagina/specie-esotiche-invasive
www.specieinvasive.it
www.lifeasap.eu

METHOD SELECTION

As will be seen in Section 3, there are several techniques that can be employed for the creation or enhancement of habitats. The selection of the optimal method is contingent upon a number of variables, including the surface area to be treated, the practitioner's experience and technical preparation, and the availability of specific equipment. However, the methods are not mutually exclusive, and often, the best result is achieved by integrating various techniques. In all cases, it is essential to consider the **availability of materials**. It is important to note that not all species are part of the typical nursery production, and thus it is essential to plan the intervention well in advance.

SITE CONDITIONS

The growth of plants is subject to several environmental factors, which exert a significant influence on their development. Each plant species has a defined tolerance range in relation to the various ecological factors (light, temperature, humidity and soil characteristics) within which it is able to perform its essential functions and complete its life cycle. To ensure the success of interventions, it is of the utmost importance to pay particular attention to the plant mix, which must be designed in such a way so as to utilise species that are appropriate to the intervention site.

HOW MANY DIFFERENT SPECIES?

More is better! The richer and more diversified a habitat is, the more able it is to withstand a wide variety of environmental conditions. More importantly, the richer a habitat is in terms of plant species, the greater the number of pollinators it will attract. A diversified habitat ensures the presence of species with different floral traits, capable of satisfying pollinator insects with diverse feeding requirements and capabilities to manipulate flowers. Differences in floral traits such as flower shape, accessibility of resources, colour, etc., make different plant species suitable for different pollinator insects. For example, open flowers, with exposed pollen and nectar, such as those of the buttercup (*Ranunculus* spp.), are easily accessible to numerous different groups of pollinators, while flowers with more complex corollas, such as those of the common sage (*Salvia pratensis*), with pollen and nectar difficult to access, can be pollinated only by a narrower group of insects.

A high species richness allows for staggered flowering, i.e., different flowering periods that ensure the supply of resources throughout the season. Finally, increasing the number of different species ensures the presence of plants with different vegetative characteristics (leaves and stem), thus providing resources and breeding and overwintering habitats for different species of insects, including beneficial insects.

MAIN FLOWER TRAITS OF THE SPECIES VISITED BY DIFFERENT GROUPS OF POLLINATORS

POLLINATORS	COROLLA SHAPE	COLOUR	FRAGRANCE	MAIN FLORAL RESOURCE	EASE OF ACCESS TO FLORAL RESOURCES	EXAMPLES	
HYMENOPTERA	Bilabiate	Blue and yellow	Sweet	Nectar	Limited	*Ajuga reptans, Salvia pratensis*	 1
LEPIDOPTERA	Tubular	Red and purple	Sweet	Nectar	Limited	*Scabiosa triandra, Succisa pratensis*	 2
DIPTERA	Disc	Yellow and white	Soft	Pollen	Good	*Achillea millefolium, Pastinaca sativa*	 3
COLEOPTERA	Disc	White and cream	Unpleasant	Pollen	High	*Crataegus monogyna, Viburnum lantana*	 4

1. Flowers with bilabiate morphology of Lamium orvala (Balm-leaved Red Deadnettle) - 2. Flowers with tubular morphology of Lythrum salicaria (Purple loosestrife) with pollinator (Pieris rapae - Small white butterfly) - 3. Head of Knautia arvensis (Common ambretta) with pollinator (Eristalis tenax - Drone fly) - 4. Inflorescence of disk flowers of Filipendula ulmaria (Common Meadowsweet)

BOX: EVEN THE EYE WANTS ITS PART!

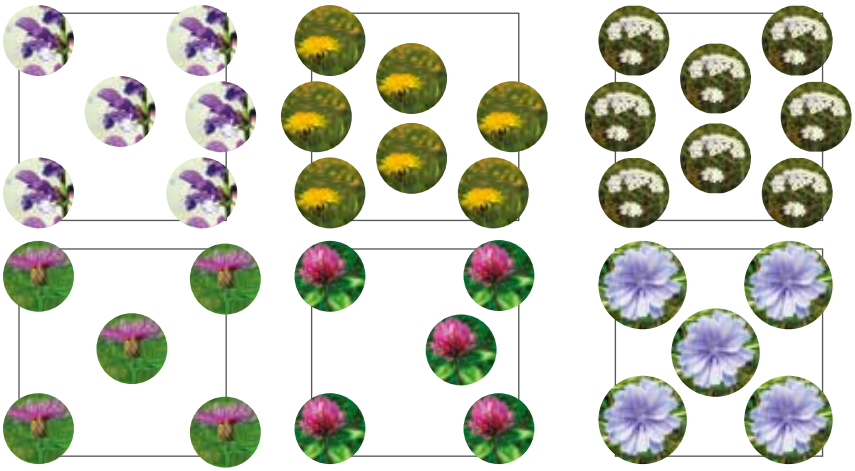
Pollinators do not only use size as a guide. They also use scents and colours. When using seedlings in soil blocks, it is recommended to implement a planting scheme that involves the formation of **small, mono-specific groups**, defined as small groups of plants of the same species. This method ensures that the plants are more visible and therefore more attractive to insects during the flowering period. Furthermore, since pollinators tend to visit neighbouring flowers, mono-specific groups facilitate the transfer of pollen between individuals of the same species. A useful tip is to alternate mono-specific groups of species with different flower structures.

Explanatory scheme of small mono-specific groups for the construction of wildflower strips

The specifics of planting schemes can vary depending on the needs.
In **wildflower strips**, mono-specific groups may comprise a variable number of plants, ranging from 4 to 10 plants. It is recommended that plants be spaced approximately 30-40 cm apart, but the distance should be assessed considering the final size of the plants and their propensity for vegetative propagation. For instance, for hygrophilous species like Water flag (*Iris pseudacorus*), which spread rapidly thanks to underground rhizomes, lower densities should be considered, such as 3 plants/m linear of the bank.
In the case of **meadows**, it is recommended to identify areas (plots) of about 2 sqm within which to carry out close planting of seedlings. The number of individuals per plot varies from 24 to 40, depending on the requirements and the size of the species at maturity. The minimum density of planting plots is 20 per 1,000 sqm, also variable depending on the needs.

Geometric layout for the construction of a flower strip

The arrangement of the plots may be random within the meadow or follow a straight line (transect), with a distance of approximately 3 m between each plot. In cases where the intervention involves rare or threatened species, lower densities than those indicated may be employed, yet still ensuring the creation of small populations capable of flowering, ripening and producing seed.



Explanatory scheme for the planting of species in plots to enrich species-poor meadows

Explanatory scheme for planting species in plots to enrich species-poor meadows

Detail of the plots. The actual number of individuals should be assessed taking into account the final size of the plants and their propensity for vegetative propagation

DESIGN HABITATS TO COVER THE ENTIRE FLOWERING PERIOD

Ideally, a habitat should comprise a mix of species so as to ensure the provision of resources throughout the entire growing season, from April/May to September/October. Nevertheless, this is not always straightforward to accomplish.

The best strategy is to combine different habitats. For instance, many very common shrub species such as the Blackthorn (*Prunus spinosa*) and the Common hawthorn (*Crataegus monogyna*), exhibit very early flowering, thereby providing resources when herbaceous plants are not yet in bloom. The combination of different habitats enables the completion of the life cycle of different species. For example, many butterflies utilise meadows as a foraging habitat, while they require shrubs for egg-laying and nutrition during the larval stage. A typical combination can therefore be a hedge or a patch of shrubs, which provide resources in early spring and nesting and overwintering sites, and meadows and wildflower strips, which provide resources at the peak of the season, in summer and autumn.

MANAGEMENT

Proper habitat management is essential for their long-term maintenance. All habitats require some form of regular maintenance, both to ensure their initial establishment and to maintain them over time.

For **woody habitats** such as hedges and shrub patches, maintenance is required particularly during the **stages**, and especially the first year, to control invasive herbaceous species, which can otherwise have a detrimental impact on the growth and survival of young woody seedlings.

Conversely, **herbaceous habitats**, such as meadows and wildflower strips, need **regular annual maintenance** through mowing. The absence of periodic mowing gives rise to spontaneous dynamics processes within the habitat. Initially, the accumulation of dead plant matter results in a reduction in species diversity, particularly those that are entomophilous. Subsequently, the areas are colonised by brambles and shrubs, which are then succeeded by tree species. The practice of mowing serves to control the growth of weeds, maintain the diversity of plant species, and prevent the invasion of woody plants.

However, in urban environments, the primary challenges originate from intensive management practices, with regard to both the frequency of mowing and the height at which the grass is cut.

In fact, frequent and close to the ground mowing results in a reduction in species richness. This is due to the fact that such mowing practices favour species that, due to their growth form, are

particularly well adapted to the disturbance caused by mowing, namely tufted grasses and annuals, as well as all plants that grow close to the ground, such as the common dandelion or clovers. In contrast, all species with an erect habit, such as daisies, bluebells and cornflowers, are progressively reduced. The change in plant species composition also has a cascading effect on the insect community, resulting in the loss of the benefits associated with high insect diversity, including pollination, biological pest control, and the decomposition of organic matter. In summary, although it may appear counterintuitive, **the practice of frequent mowing, undertaken primarily for aesthetic purposes, can give rise to other aesthetic issues as a consequence of its role in facilitating increased invasion of weeds and pests**.

It is equally important to consider the height of the cut. A meadow that is maintained at a higher height is more resistant to pests, weeds, and drought events. The optimal maintenance strategy is to limit mowing to a maximum of two or three times per year, with a minimum cutting height of approximately 20 cm. This should be conducted after the entomophilous species have flowered and dispersed, as this ensures their long-term persistence.

Reasonably, a reduction in the number of mowing interventions and an increase in the height at which the grass is cut would result in a reduction in costs compared to the costs associated with traditional intervention logic. However, in this context, it is essential to consider the need for adequate maintenance to ensure the decorum of the specific area. Additionally, different management methods, such as a higher cut in some areas and traditional very low cutting in others, may present potential management challenges that could negatively impact intervention times and, subsequently, related costs.

Nevertheless, if all areas are to be enhanced with high polliniferous species and subsequently managed in accordance with the aforementioned logic, it is probable that the impact, both visual and chromatic, of an environmentally enriched area may offset any potential perception of reduced care, particularly if linked to a reduction in intervention costs over the medium to long term.

BOX: BEST PRACTICES FOR MOWING HABITATS FOR POLLINATORS

Mow no more than 2(3) times a year
An increase in the frequency of mowing can result in a reduction in species richness and diversity, with a notable decline in the number of species that are beneficial to pollinating insects

In case the area is subject to high levels of visitation, resulting in the necessity for more frequent mowing, it is recommended that no more than 50% of the area is mowed at any one time, or that uncut strips are maintained
This approach will facilitate the recolonisation of the mowed site by both plants and insects

Schedule mowing over time
Mowing should be scheduled after the entomophilous species have reached flowering and disseminated

In the event of colonisation by weed species, it is recommended that mowing be scheduled prior to the maturation of the seeds
The most cost-effective and successful method to eradicate weeds is to prevent them from producing and dispersing seeds

Use a minimum cutting height of 20-25 cm
Mowing at this height effectively controls invasive plants while minimizing the impact on native plants and many insects

Avoid the use of fertilisers
The application of fertilisers tends to favour a few highly competitive species, which in turn reduces the floristic richness of the meadow

SECTION 3

MEADOW IMPROVEMENT

The objective of this sheet is to provide a set of guidelines for the **enhancement of existing meadows that have undergone a decline in species diversity**.
The management of **meadows situated in proximity to road infrastructure** is frequently inadequate as a consequence of a dearth of consideration for environmental diversity. This is due to the predominant focus on the administrative and practical maintenance of the areas, which can ultimately result in the impoverishment of the meadows.

MEADOW IMPROVEMENT: HOW TO DO IT

1. Recovery by re-establishing management

As evidenced in Section 2, in the chapter on Management on page 32, inadequate management practices result in a decline in species diversity, particularly entomophilous species, and the introduction of synanthropic-ruderal[7] or exotic species that can be detrimental to the ecosystem. In such instances, the enhancement of meadow habitats can be achieved through the implementation of **well-designed management strategies**.
If meadow degradation is due to intensive management, the recovery of species richness can be achieved by decreasing the number of cuts and the cessation of any fertilisation practice (*see BOX BEST PRACTICES for mowing habitats for pollinators on page 34*).

[7] *Synanthropic-ruderal species are typically small-sized plants that spread in habitats altered and disturbed by humans, such as roadside, urban areas, or abandoned cultivated fields*

Conversely, if the impoverishment of the meadow is caused by a slowdown in management practices, the restoration of species richness can be achieved by implementing appropriate management strategies, which involves 2(3) cuts during each growing season, with removal of mowed material.

The first mowing should be undertaken prior to seed dispersal by ruderal and exotic species, while simultaneously allowing for the maturation and seed drop of spring-summer native species, thus in the first fortnight of June. The second mowing, which is typically conducted from mid-August onwards, is undertaken with the objective of containing the proliferation of late-summer weed species (e.g., Johnson grass, *Sorghum halepense*). The aim of double mowing and hay removal is to deplete the soil of excess biomass and plant residues, in order to avoid new inputs of organic matter and accelerate settlement and balance over time. The objective is to bring the soil and meadow back to their original conditions, which are those most complex and rich in plant and animal biodiversity.

In case the slowdown in management practices has resulted in the establishment of woody species, it is imperative to implement a programme of mechanical clearing, using a field shredder or brush cutter. The optimal timeframe for the initial mechanical shredding is late autumn or winter, when the plants are dormant and to avoid disturbing wildlife populations.

If the areas are colonised by **brambles** or other **invasive exotic species** (e.g., *Ailanthus altissima* or *Amorpha fruticosa*), it is necessary to bear in mind that, due to their great capacity for propagation, the complete eradication of these species may require several passes, at each vegetative regrowth, to remove young shoots.

2. Recovery through species enrichment

If the improper management has been in place for an extended period of time, or in instances where the meadow is experiencing a notable decline in biodiversity, it may be feasible to pursue species enrichment through the implementation of diverse methodologies.

2a. Enrichment through overseeding

Overseeding is a technique used to regenerate and improve meadows. It involves the sowing of seeds on existing grassland characterised by low species diversity, particularly of entomophilous species.

It is of the utmost importance to ensure that the seed reaches the ground below the existing turf. Therefore, prior to sowing, the grass must be mowed with a very low cut with subsequent removal of the mowing.

Overall, methods are contingent upon the size of the area to be overseeded and the available equipment. For **large surfaces**, there are specific seed drills with a large seed hopper, coupled with a harrow to prepare the soil; a corrugated roller is employed to enhance seed penetration. Alternatively, the deployment of scarifiers/aerators can be considered. For **smaller areas**, a variety of small equipment is available on the market, including items such as aerators, rollers and manual seeders. At the hobbyist level, even a simple preliminary work with a rake and broadcasting seeding can be effective. However, it is essential that the seeds reach the soil and do not remain on the grass. In the case of overseeding, the quantity indicated in the literature as sufficient is 0.5-1 g/sqm.

2b. Enrichment through planting of native seedlings in soil blocks

This type of intervention involves the use of seedlings in soil blocks, i.e., pre-grown plant material.

The seedlings serve as 'seed carriers': once established, they can produce their own blooms and viable seeds for the spontaneous spread of species in the surrounding areas. This type of intervention enhances the quality of the habitat and its suitability for pollinators. The same approach can also be used to accelerate meadow enrichment with species of conservation interest, as they may be rare or threatened.

Native seedlings in soil blocks

BOX: WHY USE SEEDLINGS IN SOIL BLOCKS?

Compared to seeds, seedlings in soil blocks have the advantage of faster development, enabling them to rapidly compete with existing species, thus avoiding strong competition during the initial growth phases, which are particularly difficult and delicate for plants, occurring in open field conditions.

The **optimum time for planting is autumn**, as for all other operations involving plant material. Seedlings in soil blocks should be planted in the soil after making a hole suitable for the size of the underground part (root ball or soil block). The plant should be immersed in the soil up to the level of the collar; the roots should not be exposed, and the stem should not be excessively buried in the soil. Various types of tools can be used for planting, including:

- motorised augers with a small diameter tip;
- manual augers, when working on existing vegetation, with the precaution of loosening the soil slightly more than necessary to contain the soil block.

In small areas, such as private gardens, normal gardening tools can also be used; even in this case, it is a good practice to loosen the soil a little more than is necessary to hold the underground part of the seedling (root ball or soil block).

Planting schemes may vary according to requirements and soil conditions. In all cases, **seedling must be planted in small, mono-specific groups** (*see BOX Even the eye wants its part! at page 30*).

The planting of seedlings in soil blocks is a particularly resource- and energy-intensive process, especially when large areas are to be covered, thereby requiring a significant number of seedlings. Furthermore, the establishment of young plants does not always yield the expected results. The success of this process is dependent on a number of factors that are not always predictable, including:

- the type of species and ecotype;
- the ability of the plant to adapt from the 'protected' conditions of the nursery to those encountered in the wild;
- the impact of unpredictable and potentially adverse climatic conditions after planting (such as prolonged drought or significant temperature fluctuations);
- trophic activity and uprooting by wild animals attracted to the young plants (especially crows, hares, and wild boars).

For the reasons mentioned above, if the goal is simply to enrich the composition of a 'hay-type' meadow, overseeding is suggested.

Please refer to Table 1 on page 65 for a list of the main species to be used.

Summary Sheet	
Characteristics	perennial; prolonged and abundant flowering; high landscape value
Location	sunny areas; soils ranging from light to heavy, from well-drained to moist
Required skills	medium
Preliminary work	if work entails overseeding or planting seedlings in soil blocks, it is necessary to provide a short cut with the removal of the mowed material
Period of intervention	mid-October
Technique	restoration of abandoned meadows: a. recovery through mowing: implementation of appropriate management strategies, including 2(3) cuts during each growing season, with removal of mowed material b. recovery through species enrichment restoration of intensive meadows: a. recovery of regular mowing b. cessation of fertilisation c. species enrichment
Flowering period	April-October
Management	• regular periodic mowing (2(3) cuts/year). Plan the first mowing in late spring/early summer, coinciding with the conclusion of the main grasses' maturation period (June) • plan more summer cuts in case of presence of invasive species
Remarks	• use seeds or plants of native species sourced from certified nurseries and/or retailers

BOX: DO YOU HAVE A FIELD THAT HAS BEEN DORMANT FOR A WHILE? MAYBE IT WAS ONCE A PRODUCTIVE CROP LAND? WHY NOT TURN IT INTO A COLOURFUL FLOWERING MEADOW?

The objective of these interventions is the creation of meadows that are rich in species, with a particular focus on entomophilous species, and that are capable of supporting a diversified living community, with a specific emphasis on pollinating insects.
The techniques employed necessitate a more substantial input in terms of locating the requisite plant material. In certain instances, the availability of particular equipment for its collection is also a prerequisite. Furthermore, these techniques necessitate a certain degree of experience and technical preparation.

Characteristics	perennial; prolonged and abundant flowering; high landscape value
Location	sunny areas; soils ranging from light to heavy, from well-drained to moist
Required skills	the establishment of a species-rich meadow requires a certain degree of expertise and technical proficiency in the sourcing and harvesting of plant material, as well as in the preliminary soil preparation work
Preliminary work	harrowing, false sowing, harrowing (or weeding)
Period of intervention	mid-October
Technique	three techniques: • by sowing a mixture of seeds of native species • by the use of species-rich hay • by brush-harvested seed
Flowering period	April-October
Management	• regular periodic mowing (2(3) mowings/year). Plan the first mowing in late spring/early summer, coinciding with the conclusion of the main grasses' maturation period (June) • consider additional summer mowing if invasive species are present

Remarks	• identification of suitable donor meadows by qualified experts
	• if you decide to use hay or brush-harvested seed
	  - carefully assess the quality of the donor meadow and the degree of seed maturity
	  - bear in mind that the material should be harvested around mid to late June, dried and stored until use
	• if you opt to sow seed mixes
	  - use seeds of guaranteed local origin for entomophilous species
	  - use a low seeding density for grasses (max 10 g/sqm) and add 1-4 g/sqm of entomophilous species
	• in the case of mesophilous or meso-hygrophilous meadows, provide a light fertilisation with well-rotted manure, excluding chemical fertilisation
	• avoid fertilisation in the case of xeric, meso-xeric and wet meadows

If you want to learn more, you can consult the first volume of the series 'Guidelines for the creation and management of habitats for pollinator. I. AGRICULTURAL AREAS', which can be found at the following link: https://www.lifepollinaction.eu/?page_id=3806&lang=en

CREATION AND MANAGEMENT OF WILDFLOWER STRIPS

This sheet explains how to create and manage wildflower strips.
Flower strips are defined as strips of entomophilous herbaceous plants of varying width and linear shape created at the edge of a road infrastructure, along a road embankments and other marginal or small areas.

Although they may vary, flower strips are generally modest in size, varying in length and ranging from 2-3 to 10 meters in width. They comprise a mixture of different native herbaceous plants: the general rule is that **wildflower strips should be rich in plant species that differ in size, height, floral morphology and flowering period**.

CREATION OF PERENNIAL FLOWER STRIPS: HOW TO DO IT

Perennial strips are **flower strips composed of plant species with a multi-year life cycle**. In many cases, the above-ground part of the plant dries up during the winter, but the root system continues to live, producing new shoots the following spring. The species composition varies in accordance with the environmental conditions of the site. In mesophilous conditions, the composition is analogous to that of meadows. Conversely, if the objective is to create a strip on a ditch or canal, hygrophilous species must be selected, that is, species adapted to living in environments with permanently water-rich soil.
Perennial strips remain in place for several years, flowering annually. However, their maintenance necessitates the implementation of an appropriate management strategy.

1. Preliminary work

Preparatory work is limited and consists of mowing the existing grass to a height of between 3 and 5 cm. This is done with the aim of reducing competition between the existing species and those to be planted, thus creating a more favourable environment for their establishment.

2. The realisation

The creation of a strip involves the exclusive use of **seedlings in soil blocks**, i.e., plant material that has already developed. It is essential that the seedlings are planted after a hole has been drilled in the soil to a depth appropriate to the size of the underground part (root ball or soil block). The seedlings should be submerged in the soil up to the level of the collar, making sure that the roots are not exposed and that the stem is not

Seedlings in soil blocks produced in the nursery of Volpares (Palazzolo dello Stella) from seeds of native species

excessively submerged. It is essential to use suitably developed seedlings (around the second year of life) with a soil block firmly attached to the roots and free of weeds. There are various types of tools that can be used for planting, but it is important to loosen the soil by a little more than is necessary to hold the soil block.
The planting scheme can vary depending on the requirements, but it is important that **the planting of seedlings occurs in small mono-specific groups** (*see BOX Even the eye wants its part! on page 30*). In the case of hygrophilous strips, it is also necessary to pay particular attention to the water fluctuation zone, which is defined as the area between the minimum and maximum water levels. In the sections of the bank in closer proximity to the water level, it is recommended that species capable of tolerating periods of submergence be situated.
In order to facilitate the management of the strip, it is recommended that late summer-flowering species be localised in designated areas, which should only be mowed at the end of summer (see below, Management and maintenance of wildflower strips).
In mesophilous flower strips, the transplanting of seedlings can be combined with the **sowing of a seed mixture** to increase species diversity and speed up the formation of the strip. To increase ground cover, the seed mix may also include seeds of less competitive grasses such as *Anthoxanthum odoratum*, *Briza media* and *Trisetaria flavescens*. It is recommended that the seeds are scattered between the seedlings at a target density of 4 g/sqm. The seed mixture should be no more than one third grass seed.
The **optimal period** for transplantation and potential sowing is **autumn**.
In the case of hygrophilous strips, if the outer edge of the strip facing the ditch or canal is colonised by tall weed species, it would be beneficial to prepare a seedbed and establish a permanent cover by sowing a mixture of commercial grasses that are suitable for wet soils. This approach would help to avoid the excessive proliferation, growth, and shading of the newly planted seedlings by the more vigorous weed species.
With regard to the principal species to be utilised, one may refer to the lists provided in Table 1 on page 65.

MANAGEMENT AND MAINTENANCE OF WILDFLOWER STRIPS

The **maintenance of perennial wildflower strips requires regular mowing**. In general, two cuts per year will maintain both species composition and richness. The first mowing should not take place before mid-June to allow species to flower and complete their vegetative cycle. The second mowing should take place between the end of August and the first half of September. In the case of the spread of invasive species such as Johnson grass (*Sorghum halepense*), the frequency and method of mowing may need to be changed, with an increase in the number of cuts if necessary. Mowing, especially in summer is particularly important in the first year/ two years and should be repeated several times if the invasion is massive. It is also advisable to take precautions with regard to summer-flowering species. These should be confined to a limited number of clearly defined areas within the border, as they will only require mowing on the second occasion, thus allowing them to complete their cycle.

The sequence of operations required to create a flower strip is illustrated below. The example concerns the creation of a flower strip at the edge of a municipal road, however, the sequence of operations is also applicable to strips created along or adjacent to a fast-flowing road infrastructure.

1. The preliminary operations for the establishment of a mesophilous strip on a roadside location entail the preparation of two planting rows;

2. The planting holes are then created along the rows. In the absence of an auger, or in the case of small areas, conventional gardening tools may also be employed as an alternative;

3. Transport and positioning of mesophilous herbaceous seedlings in soil blocks;

4. The seedlings are arranged in a regular, alternating pattern along the two planting rows at regular distances;

5. The planting of seedlings should be undertaken with due care and attention, ensuring that the collar of the seedlings is positioned at ground level.

Summary Sheet	
Characteristics	perennial; moderate to abundant flowering; high landscape value
Location	sunny and sheltered areas; soils ranging from light to heavy, from well-drained to moist
Required skills	medium (in the case of mesophilous strips, the preparation of the soil and/or existing turf is necessary)
Preliminary work	cutting of the turf
Period of intervention	mid-October
Technique	manual transplantation in small mono-specific groups
Flowering period	May-September
Management	• periodic mowing; schedule two mowings per year, with the first mowing after the first half of June • plan for multiple summer cuts in case of invasive species presence
Remarks	• use plants of native species from certified nurseries and/or retailers • limit the first mowing to specific areas to allow summer-flowering species to complete their life cycle, subjecting them only to the second cut • plan the creation of wildflower strips well in advance, as native plants used for this purpose may not always be available from nurseries

CREATION AND MANAGEMENT OF SHRUB PATCHES AND HEDGES

This sheet illustrates the methods for the establishment and maintenance of shrub patches and hedges, in proximity to road infrastructure, including embankments and marginal areas.

Shrub patches are formations that exhibit an areal (non-linear) shape, recreated on small marginal areas (typically between 50 and 100 sqm) and consist exclusively of shrub species. In contrast, **hedges** are linear formations, typically established along the edges of canals and ditches or within parks. In addition to shrubs, they may also comprise a tree component, with varying degrees of coverage. Shrub patches and hedges are important habitats for many animal and plant species providing essential resources and shelter. Many species also use them to move and spread within a hostile territory such as urbanised areas. A considerable number of native shrub species are highly attractive to numerous species of pollinating insects. Furthermore, the flowering of shrub species often occurs between late winter and late spring, thereby providing a source of sustenance for pollinating insects when the flowering resources provided by grassland species are not yet available.

BOX: EARLY FLOWERING SHRUB SPECIES

SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Cornus mas												
Cornus sanguinea												
Crataegus monogyna												
Ligustrum vulgare												
Prunus spinosa												
Rosa canina												
Viburnum lantana												
Viburnum opulus												

LEGEND: The coloured squares represent the colour of the flowers and the flowering period.

In addition to providing suitable habitats for many wildlife species, these habitats offer numerous other services: hedges mitigate wind, improve the local microclimate, regulate run-off water and clean it of nutrient loads, stabilise canal banks, provide a trophic source for beekeeping (melliferous hedges), and produce small fruits (e.g., *Corylus avellana*, *Prunus* spp., *Sambucus nigra*, etc.).

Extensive early flowering ensures nutrient resources for pollinating insects when the flower resources provided by grassland species are not yet available

In addition to providing resources and shelter for many wildlife species, hedges improve the local microclimate, purify water from nutrient loads, stabilise canal banks, provide a trophic source for beekeeping (melliferous hedges) and produce small fruits

ESTABLISHMENT OF HEDGES AND SHRUB PATCHES: HOW TO DO IT

The methods of intervention for the creation of hedges and shrub patches are similar; however, the species composition must be selected with consideration of the local soil characteristics[8], in particular, moisture levels.

1. Soil preparation

The objective of preliminary soil preparation is to enhance soil functionality and quality while simultaneously reducing the incidence of spontaneous weed vegetation. Operations, to be carried out shortly before planting, should only affect the surface layers, with light milling limited to the planting strip. This can be achieved through the utilisation of manual equipment, such as a rotary tiller.

2. Establishment of the hedge and shrub patch

This intervention employs exclusively **young seedlings, aged between one and three years, in soil blocks**. The planting operations are conducted manually or with the assistance of manual equipment, including transplanters.

Prior to planting, a small hole should be excavated (with an average diameter of 10 cm and a length of 10 cm, dependent upon the dimensions of the soil block) into which the seedlings are placed. It is of the utmost importance to ensure that the plant's collar is positioned at ground level; the roots should never be exposed, nor should the stem be sunk too deep into the soil. The planting hole should then be filled with excavated soil, with slight pressure applied to the soil block to encourage root growth outside of the soil block itself.

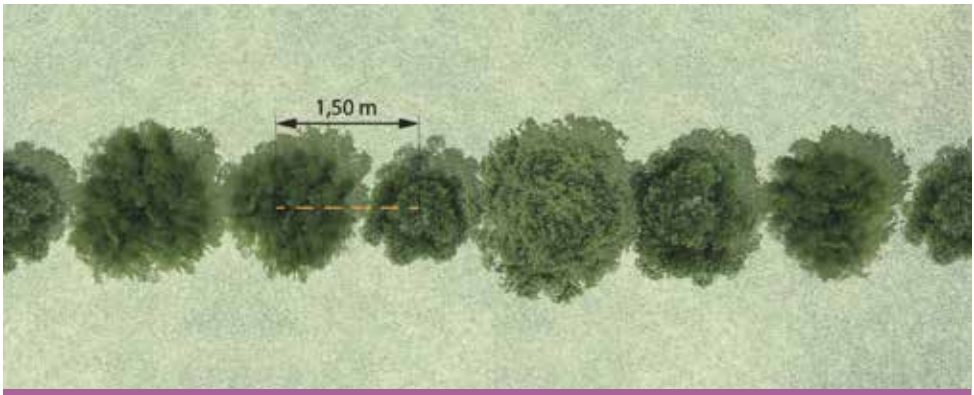
For the establishment of a **shrub patch**, the plants should be planted according to a **checkerboard grid pattern**, with the shrubs staggered between rows. The planting density varies depending on the size and shape that the plant will assume when mature. In the case of regular-shaped surfaces, typically square or circular, exceeding 250-300 sqm, it is recommended to plant **one plant every 2 m** along each row, with **rows spaced 3-3.5 m apart**. This results in a **density** of **one plant every 7 sqm**. In the case of regular-shaped areas of less than 250-300 sqm, or for larger but narrow and elongated surfaces, it is possible to reduce the distance between rows to 2 m, thus reaching a planting **density** of **one plant every 4 sqm**.

In order to establish a **hedge**, it is essential to apply **mulch** after soil preparation.

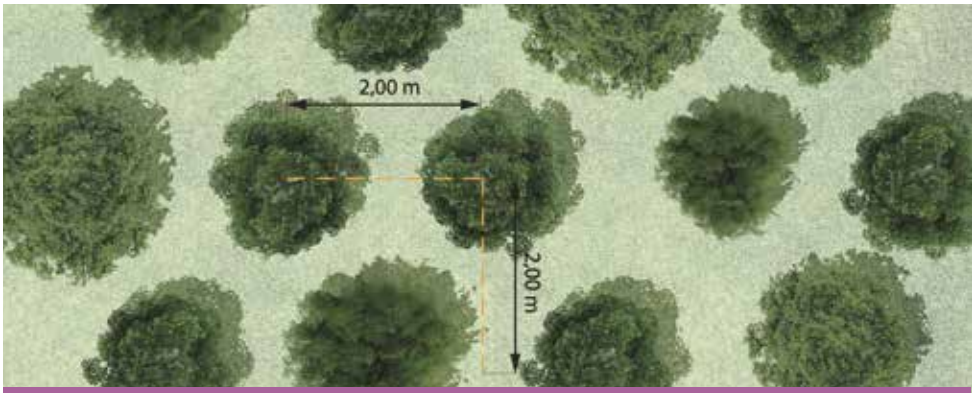
This limits competition from spontaneous vegetation on the young plants during the initial years following the intervention. The procedure entails the utilisation of **biodegradable materials, such as jute or coconut fibre sheets**, over the tilled soil prior to the planting of the seedlings. These materials must be firmly secured at the sides and heads of each continuous stretch of hedge. The seedlings are then planted at intervals corresponding to the incisions made in the sheets at the desired distances. The distance typically used between seedlings is **1.5 m**. In cases where the tree component is also included, it is advised that a distance of **9 m** be maintained between each tree.

[8] *Del Favero R., 1999. Biodiversità e indicatori nei tipi forestali del Veneto, Regione del Veneto – Direzione regionale delle foreste e dell'economia montana e Accademia italiana di scienze forestali, pp 335.*

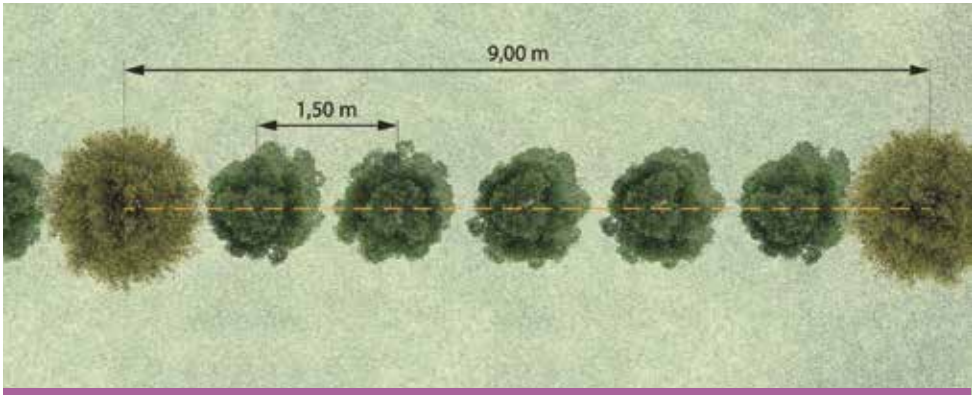
The species employed in the establishment of hedges and shrub patches are typically sourced from standard nursery production, thereby mitigating potential issues associated with procurement. In the case of a hedge that incorporates a tree component, it is recommended that both the species selected and their position be considered with regard to the potential constraints and shading that they may exert once they have reached maturity.
Please refer to Table 1 on page 65 for the main species to be used.



Planting schemes for hedges consisting exclusively of shrubs



Planting schemes for shrub patches



Planting schemes for mixed tree-shrub hedges

The images below illustrate the sequence of operations required to create a hedge or a shrub patch. The creation of shrub patches or hedges necessitates a certain degree of expertise, predominantly in the context of preliminary soil preparation. It is also crucial to adhere to the procedures depicted in Figures 3 and 4. Following soil preparation, mulching is essential to prevent competition from spontaneous vegetation and ensure the survival of young plants during their initial years after the intervention.

1. *Surface preparation of the soil using a rotary tiller*

2. *Excavation of the hole using manual mechanical equipment or a motorised auger*

3. *Mulching of a circular area with a radius of at least 50 cm around the planting hole using biodegradable material such as coconut fibre or jute*

4. Planting of seedlings inside the planting holes through an X-shaped slit in the mulch cover

5. Manual filling of the planting holes and soil compaction

6. Placement of the supporting pole

7. Localised fertilisation using organic-mineral fertilizer

MANAGEMENT AND MAINTENANCE OF HEDGES AND SHRUB PATCHES

In comparison to herbaceous habitats, shrub patches and hedges present **fewer management and maintenance challenges**. During the initial years following planting, it is crucial to ensure regular **mowing** to minimise competition from invasive herbaceous species. Once the seedlings have become established, the intensity and frequency of mowing can be reduced, and will only serve to ensure better development for the shrubs or trees. After the third year from planting, mowing of the invasive species may no longer be necessary.

Summary sheet	
Characteristics	perennial; abundant spring flowering; high landscape value
Location	sunny areas; soils ranging from light to heavy, from well-drained to moist
Required skills	medium (preparation of soil and/or existing turf required)
Preliminary work	soil preparation through light milling; operations should only affect the surface layers
Period of intervention	mid-October to mid-December
Technique	manual staggered planting for shrub patches and linear planting for hedges
Flowering period	January to July
Management	mowing of invasive herbaceous species during the first two years after planting
Remarks	• use plants of native species from certified nurseries and/or retailers • for the creation of a hedge, apply mulch to limit competition from spontaneous vegetation using biodegradable jute or coconut fibre sheets

APPENDIX 1

THE ENHANCEMENT OF ROAD INFRASTRUCTURE AS ECOLOGICAL CORRIDORS: AN ANALYSIS OF THE INTERVENTION ALONG THE 'PASSANTE DI MESTRE'

As outlined in previous Sections, one of the strategies for improving road infrastructure as ecological corridors is to establish habitats with native species that are crucial for pollinating insects. This approach aims to reconnect fragmented habitats and support the vital role of these keystone species in maintaining ecosystem function.
In the contest of Action C.3 of the LIFE PollinAction Project (*Creation of habitats for pollinators along road infrastructures on a regional scale*), the 'Passante di Mestre' motorway bypass was the subject of a series of interventions in plots of land situated along the infrastructure. These interventions were designed to enhance the green areas with **native herbaceous species that are attractive to pollinating insects**.

Nursery material

The nursery material used for the interventions comprised **nine different native, perennial and hardy species**, capable of providing high quantities of resources to a wide variety of pollinators. This resulted in the planting of about **50,000 seedlings** across an area of approximately **5 ha**.
In particular, the following list details the species used to implement the first activities in two of the intervention areas:

- *Salvia pratensis*
- *Leucanthemum vulgare*
- *Leontodon hispidus*
- *Centaurea nigrescens*
- *Cichorium intybus*
- *Scabiosa triandra*
- *Achillea roseo-alba*
- *Tragopogon pratensis*
- *Ranunculus acris*

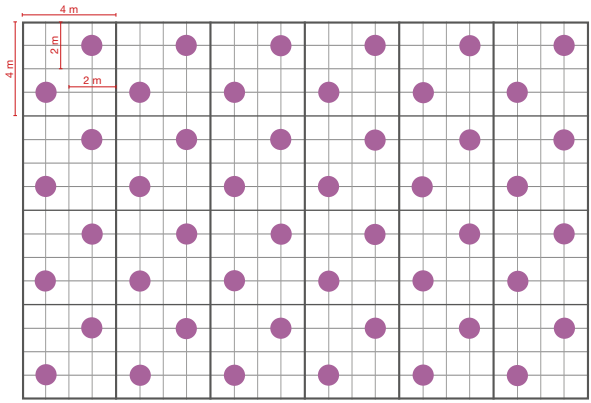
The distribution of species was characterised by a **strong prevalence of *Salvia* and *Leucanthemum*** (84%), a relatively minor presence of *Cichorium* (10%), and the remaining 6% variability consisting of six species. This variability necessitated **design choices that sought to achieve a balanced distribution**, particularly in relation to the available space.

Planting scheme

Given the presence of a turf, the intervention **entailed the enrichment of the area through the planting of seedlings in soil blocks. The seedlings served as 'seed carriers'**, facilitating the spontaneous spread of the species in the surrounding areas. Once established, the seedlings can produce their own blooms and viable seeds, enhancing the quality of the habitat and its suitability for pollinators.
To this end and with the aim of ensuring homogeneity and a good planting density, rectangular-shaped plots have been identified in the intervention areas so that they could be adapted to environmental requirements.

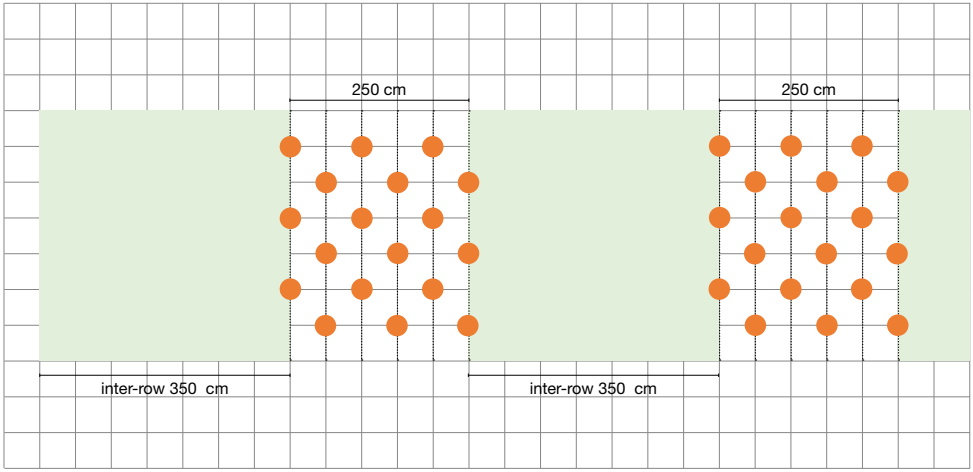
As a result, each intervention area was composed of alternating strips of entomophilous perennial species (enrichment) and strips in their original state. This approach allowed for a planting density of **2 plants per sqm**, thereby increasing the overall density of the plot and reducing the contrast with the herbaceous species already present.
The plots had been arranged **in a configuration that ensured a distance of at least 2 m between them**, which is the minimum width necessary for facilitating maintenance and enabling unimpeded passage. Furthermore, the plot width had been established **at 4 m**, although this can be adjusted in accordance with the specific technical requirements.
Within each plot, seedlings had been **arranged according to the quincunx pattern**, that is, creating parallel but staggered rows, which allows for enhanced interception of solar radiation and reduced root competition. **The arrangement of the plants is offset** to create isosceles triangles with the two adjacent rows, with each plant situated at the vertex of the triangle.
Each 4 m wide plot comprises four rows, with a distance of 1 metre between them. The rows are staggered by 50 cm both within the row and between rows, as illustrated in the following diagrammatic representation of the planting pattern.

Planting scheme



The planting scheme entailed the formation of **small**, **monospecific groups**, with the objective of optimising planting operations and minimising the potential for errors associated with species swapping. Additionally, at the time of flowering, the plants are more visible, thereby enhancing their appeal to insects. Subsequent to the end-of-season trimming and natural dissemination, the plots will undergo a process of evolution, leading to the establishment of a self-sustaining equilibrium.

However, following the selection of the planting site and the initial trials, some **technical aspects that had not been considered** (such as the presence of stones and debris) emerged, necessitating a **revision of the planting scheme**. The quantity of plants per hectare remained unchanged, as did the area covered. Instead, the distribution of material within the area was modified to facilitate the use of suitable mechanisation and enhance future maintenance.
The revised system scheme, which was ultimately adopted, is presented herewith.



The final spatial layout exhibited a **wider inter-row** spacing of 350 cm and a **plot width of 250 cm**, comprising **six rows** (each 50 cm apart). The transplanting distance within a row was 100 cm, but staggered between rows to maintain a quincunx planting pattern.
This modification did not entail any changes in quantity; however, it was necessary in order to optimise the execution phase by taking advantage of the mechanisation available in the area.

The intervention phases

The interventions were carried out in several phases, adapted to the specific characteristics of the areas concerned. In the **preparatory phase**, the existing **turf was cut** to reduce competition from existing species and to facilitate the establishment of new seedlings. The site was then **delimited**, and, in some areas, **strip-tillage** was used to loosen the soil without completely breaking it up, thus creating an optimal **seedbed**.
In the **planting phase**, seedlings were transplanted manually, with a **coring machine** or mechanically, depending on the size of the plots. To aid their rooting, **organic fertiliser** was distributed and applied to the planting hole to enrich the soil.

Maintenance and Contingency management

Post-transplant maintenance played a crucial role in the success of the interventions. During the summer season, at least two **sprinkler irrigations** were made during the hottest months, such as July and August, using a tanker truck with a deflector. This method provided a **minimal but sufficient water supply** to stabilise seedling establishment, while keeping operating costs low compared to irrigating each individual plant.

Localised **manual mowing** within the plots was necessary to ensure uniform development of the young plants. This mowing was carried out at least twice during the summer season to reduce competition from existing herbaceous species. In addition to manual mowing, **mechanised mowing** was carried out in areas outside the plots to further reduce competition.

The **entire intervention area**, including the plots that had been enriched, was mowed **only at the end of the summer** in order to ensure natural seed dispersal and to allow herbaceous species to spread throughout the area.

In conclusion, the maintenance procedures to be undertaken following the transplantation of the species are as follows:

LOCALISED MANUAL MOWING IN THE PLOTS

1 mowing per year, in May, on half the area

MECHANISED MOWING BETWEEN THE PLOTS (INTER-ROW)

4 mowings, to be carried out at the beginning of May-June-July-August (with the exact timing to be evaluated on a case-by-case basis)

MECHANISED MOWING OF THE ENTIRE AREA OF INTERVENTION

2 mowings, to be carried out at the end of June and end at the end of September

With regard to **contingency management**, competition from pre-existing herbaceous species represented a significant challenge. To address this issue, seedlings were planted in **plots with a high density**, capitalising on natural dissemination to gradually colonise untreated areas. Additional **manual mowing** was undertaken to mitigate competition during the initial year, a crucial period for young seedling establishment.
Furthermore, supplementary irrigation was implemented to alleviate the impacts of **drought conditions**. Seedlings with a **well-established root system**, cultivated in a substrate analogous to that of the intended planting areas, were utilized to minimize transplant stress.
Finally, the episode of **herd passage** resulted in damage to some plants, thereby underscoring the necessity of implementing temporary protective measures to safeguard planted areas during the initial stages.

Maintenance costs

As previously mentioned, the **upkeep** of green spaces adjacent to transportation infrastructure represents a significant financial burden for the operating company and must be considered when planning operational costs. In particular, mowing represents a significant expense for the concessionaire on an annual basis, with the objective of maintaining the aesthetic appeal and functionality of the areas that are easily visible from the infrastructure and, in many cases, accessible to the general public (e.g., cyclists, pedestrians, etc.). In this regard, frequent mowing ensures the usability of the area according to a semi-industrial approach (repeated and very low cuts); however, this does not allow the growth of polliniferous species.
The hypothesis proposed and tested within the framework of the LIFE PollinAction project posits the potential for reducing the number of mowing operations in order to facilitate the adequate development of herbaceous species and the completion of their life cycle up to dissemination. However, it is important to consider that a reduction in mowing frequency may be perceived by users as a lack of care on the part of the concession holder.
Furthermore, a reduction in the number of maintenance operations in accordance with the logic proposed by the LIFE PollinAction project, while directly associated with a potential reduction in maintenance costs, could potentially result in additional costs due to the necessity for operators to exercise heightened caution when mowing planted plots, differentiating the type of intervention within the same area.
It should be noted, however, that this is particularly applicable to the initial phases (1-2 years) of maintenance. Once the consolidation of the enrichment intervention has been achieved, the management may realise a reduction in costs due to maintenance being conducted uniformly across all areas. This would entail a reduction in the number of mowings (to 2-3 per year) at a higher height, with the height being consistent across all areas.

APPENDIX 2

TABLE 1: SUPERFOOD & HOST PLANTS

NATIVE WILDFLOWERS

Scientific name	Common name	Flowering period	Habitat	Type
Achillea millefolium L.	Common yarrow	May-Oct	Ge	
Ajuga reptans L.	Bugleweed	Dec-Jun	Ge	
Allium angulosum L.	Mouse garlic	May-Aug	H	
Althaea officinalis L.	Common marshmallow	Apr-Aug	H	
Caltha palustris L.	Marsh marigold	Feb-Jun	H	
Campanula glomerata L.	Clustered bellflower	May-Sep	Ge	
Centaurea nigrescens Willd.	Short fringed Knapweed	May-Dec	Ge	
Cirsium arvense (L.) Scop	Creeping thistle	Apr-Nov	Ge	
Cirsium oleraceum (L.) Scop.	Cabbage thistle	May-Sep	H	
Cirsium palustre (L.) Scop.	Marsh thistle	May-Sep	H	
Daucus carota L. subsp. *carota*	Wild carrot	Apr-Oct	X	
Echium vulgare L.	Blue viper's-bugloss	Mar-Sep	X	
Eupatorium cannabinum L. subsp. *cannabinum*	Hemp-agrimony	Jul-Oct	H	
Genista tinctoria L.	Dyer's Greenweed	Apr-Jul	H	

SUPERFOOD & HOST PLANTS

NATIVE WILDFLOWERS

Scientific name	Common name	Flowering period	Habitat	Type
Gratiola officinalis L.	Hedge hyssop	May-Aug	H	
Hypericum perforatum L.	St. John's wort	Apr-Aug	Ge	
Inula britannica L.	British yellowhead	Jun-Sep	H	
Iris pseudacorus L.	Water flag	Mar-Jun	H	
Knautia arvensis (L.) Coult.	Common ambretta	Apr-Sep	Ge	
Leontodon hispidus L.	Bristly hawkbit	May-Oct	Ge	
Leucanthemum vulgare Lam. subsp. *vulgare*	Ox-eye daisy	Feb-Oct	Ge	
Lysimachia vulgaris L.	Yellow loosestrife	May-Aug	H	
Lythrum salicaria L.	Purple loosestrife	May-Sep	H	
Malva alcea L.	Greater musk-mallow	May-Sep	Ge	
Mentha longifolia (L.) Huds.	Horsemint	May-Oct	H	
Onobrychis arenaria (Kit.) DC.	Sand esparcet	Apr-Aug	X	
Onobrychis viciifolia Scop.	Sainfoin	Apr-Aug	Ge	
Pastinaca sativa L.	Wild parsnip	Jun-Aug	Ge	

SUPERFOOD & HOST PLANTS

NATIVE WILDFLOWERS

Scientific name	Common name	Flowering period	Habitat	Type
Salvia pratensis L.	Meadow sage	Apr-Aug	X	
Scabiosa triandra L.	Narrowleaf scabious	May-Sep	X	
Scrophularia umbrosa Dumort. subsp. *umbrosa*	Green figwort	May-Sep	H	
Scutellaria galericulata L.	Marsh Skullcap	May-Aug	H	
Senecio paludosus L. subsp. *angustifolius* Holub	Fen Ragwort	May-Sep	H	
Silene flos-cuculi (L.) Clairv.	Ragged-robin	Apr-Aug	H	
Stachys palustris L.	Marsh Woundwort	May-Aug	H	
Symphytum officinale L.	Comfrey	Apr-Nov	Ge	
Thalictrum lucidum L.	Shining meadow-rue	May-Aug	H	
Tragopogon pratensis L. subsp. *orientalis* (L.) Celak.	Oriental goat's beard	May-Aug	Ge	
Trifolium pratense L.	Red Clover	Jan-Dec	Ge	
Valeriana dioica L.	Marsh Valerian	Apr-Jul	H	
Veronica anagallis-aquatica L. subsp. *anagallis-aquatica*	Water Speedwell	May-Oct	H	

SUPERFOOD & HOST PLANTS

NATIVE SHRUBS AND TREES

Scientific name	Common name	Flowering period	Habitat	Type
Acer campestre L.	Hedge maple	Mar-May	Ge	
Carpinus betulus L.	European hornbeam	Apr-Jun	Ge	
Cornus mas L.	Cornel cherry	Jan-Apr	Ge	
Cornus sanguinea L.	European dogwood	Apr-Jun	Ge	
Corylus avellana L.	Hazelnut	Feb-Apr	Ge	
Crataegus laevigata (Poir.) DC.	Midland hawthorn	Mar-Jun	Ge	
Crataegus monogyna Jacq.	Common hawthorn	Mar-May	Ge	
Euonymus europeus L.	Common spindle	Mar-Jun	Ge	
Frangula alnus Mill. subsp. *alnus*	Alder buckthorn	Apr-Jun	H	
Fraxinus ornus L. subsp. *ornus*	Flowering ash	Mar-May	Ge/X	
Ligustrum vulgare L.	Common privet	Mar-May	Ge	
Lonicera caprifolium L.	Perfoliate honeysuckle	Apr-Jul	Ge	
Lonicera xylosteum L.	European fly honeysuckle	Apr-Jul	Ge	

SUPERFOOD & HOST PLANTS

NATIVE SHRUBS AND TREES

Scientific name	Common name	Flowering period	Habitat	Type
Malus sylvestris (L.) Mill.	Wild apple	Apr-May	Ge	
Prunus mahaleb L.	Mahaleb cherry	Apr-May	Ge	
Prunus spinosa L.	Blackthorn	Jan-Apr	Ge	
Pyrus communis L. subsp. *pyraster* (L.) Ehrh.	Wild pear	Mar-May	Ge	
Rhamnus cathartica L.	Common buckthorn	Mar-Jun	X	
Rosa canina L.	Dog rose	Mar-Jul	Ge	
Salix cinerea L.	Grey willow	Feb-Apr	H	
Salix purpurea L.	Purple willow	Feb-Apr	H	
Sorbus torminalis (L.) Crantz	Wild Service-tree	Mar-May	Ge	
Ulmus minor Mill.	Field Elm	Feb-Mar	Ge	
Viburnum lantana L.	Wayfaring Tree	Mar-May	H	
Viburnum opulus L.	Guelder-rose	Apr-Jun	Ge	

SUPERFOOD & HOST PLANT					
	Scientific name	**Common name**	**Flowering period**	**Habitat**	**Type**
GRASSES	*Anthoxanthum odoratum* L.	Sweet vernal grass	Mar-Aug	Ge	
	Briza media L.	Quaking-grass	Apr-Aug	Ge	
	Trisetaria flavescens (L.) Baumg.	Yellow oatgrass	May-Aug	Ge	

Habitat: ***Ge*** *= generalist;* ***H*** *= hygrophilous;* ***X*** *= drought tolerant (dry soil, dry grassland);*

 = *'SUPERFOOD' PLANTS - Some native plant species offer a substantial resource base for a diverse range of pollinators;*

 = *PLANTS FOR SPECIALIST INSECTS - Some insects are 'specialists', collecting pollen and nectar only on specific plants;*

 = *PLANTS FOR BUTTERFLIES - The caterpillars of many butterfly species are very specialised and only feed on specific plants.*

APPENDIX 3

INTERVENTION TIMELINE

	JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEP		OCT		NOV		DEC	
	I-II	III-IV	I-II	III-IV	I-II	III-IV	I-II	III-IV	I-II	III-IV	I-II	III-IV	I-II	III-IV	I-II	III-IV	I-II	III-IV	I-II	III-IV	I-II	III-IV	I-II	III-IV
Meadow Improvement																								
Restoration of abandoned meadows																								
Option A. Recovery through mowing																								
1. Shrub clearing (if necessary)																								
2. Mowing with removal of clippings																								
Option B. Recovery through species enrichment																								
1. Mowing the existing turf to a height of between 3 and 5 cm																								
2a. Overseeding																								
2b. Enrichment through planting of native seedlings in soil blocks																								
Restoration of intensive meadows																								
1. Cessation of fertilisation practices																								
2. Mowing with removal of clippings																								
3. Species enrichment (see Option B)																								
Management and maintenance of the meadow																								
Mowing with removal of clippings																								

	JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEP		OCT		NOV		DEC	
	I-II	III-IV	I-II	III-IV	I-II	III-IV	I-II	III-IV	I-II	III-IV	I-II	III-IV	I-II	III-IV	I-II	III-IV	I-II	III-IV	I-II	III-IV	I-II	III-IV	I-II	III-IV
Establishment and Management of wildflower Strips																								
Preliminary work																								
1. mowing the existing turf to a height of between 3 and 5 cm																								
Realisation of the strip																								
Planting of native seedlings in soil blocks																								
ONLY for mesophilous strips: seeding to support the planting																								
Management and Maintenance of the Strip																								
Mowing with removal of clippings																								
Establishment and Management of Shrub Patches and Hedges																								
Preliminary work																								
Soil preparation through light milling																								
Realisation of the hedge and shrub patch																								
Planting of seedlings and mulching																								
Management and Maintenance of hedges and shrub patches																								
Mowing of weed species in the first years																								

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