# Bees and the Environment

Guidelines for Thoughtful Placement of Beehives
in Luxembourg

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Ministry of the Environment,
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Dear Readers,

Beekeeping is not only a fascinating craft but also plays a crucial role in protecting our environment and pollinating numerous crops and wild plants. In light of the growing challenges faced by our ecosystems, responsible action in harmony with nature is more important than ever.

The publication “Bees and the Environment – Guidelines for Thoughtful Placement of Beehives in Luxembourg” offers valuable insights into beekeeping, from the basics of the craft to specific recommendations for supporting our wild pollinators. As a tangible implementation of the National Action Plan for the Preservation of Pollinating Insects, this guide aims to provide both the necessary knowledge and inspiration for sustainable and successful beekeeping.

Promoting the diversity and health of our pollinators is a shared responsibility. The measures taken by beekeepers contribute not only to honey production but also to the preservation of biodiversity and the resilience of our ecosystems.

I extend my heartfelt thanks to everyone for their commitment and awareness of the importance of beekeeping and nature conservation.

Best regards,

**Serge Wilmes**
Minister for the Environment, Climate and Biodiversity


With this publication, Luxembourg presents for the first time a comprehensive guide to the thoughtful placement of beehives. At a time when beekeeping is gaining increasing popularity as a leisure activity, it is crucial to recognise the responsibilities that come with keeping bees.

Beekeeping not only allows us to explore the fascinating world of honeybees but also offers an opportunity to experience nature up close. This connection to nature is invaluable and fosters a deeper understanding of the environment that surrounds us.

It is essential for aspiring beekeepers to acquire a solid foundation of knowledge. Only then can they understand the needs of their bees and act responsibly. A well-informed beekeeper can avoid setbacks and support the development of healthy hives. Bees are not just honey producers; they are indispensable pollinators in our ecosystem. Protecting them is of great importance, and we hope to inspire active efforts to improve their living conditions.

This guide also aims to spark interest in endangered wild pollinators. The vital role that beekeepers play in this endeavour is undeniable. Open dialogue and collaborative actions are key to raising awareness of the challenges faced by wild pollinators and finding solutions together.

We encourage all readers to engage deeply with the contents of this guide and to actively participate in Luxembourg's beekeeping community. Sharing experiences and knowledge is vital for the continued development of beekeeping in our country. Through collective learning and action, we can enrich not only the practice of beekeeping but also foster a greater sense of responsibility for our bees, our communities, and biodiversity as a whole.

Let us work together to ensure that beehives in Luxembourg are not just places of production but also spaces for learning, respect, and collaboration. May this guide help raise awareness of the importance of beekeeping and spread the joy of this practice across Luxembourg.

**Alexandra Arendt**
President
Fédération des Unions d'Apiculteurs du Grand-Duché de Luxembourg - FUAL

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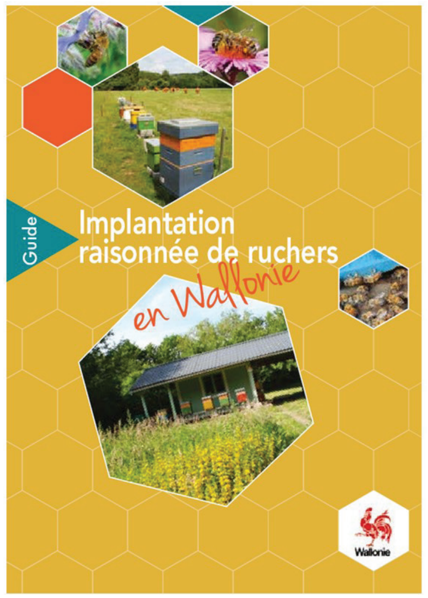
# Introduction

## Introduction to the Walloon Guide

This document is largely based on the publication "Implantation raisonnée des ruchers en Wallonie" (Thoughtful Placement of Beehives in Wallonia), written by Etienne Bruneau and published in 2020 by the Public Service of Wallonia – Agriculture, Natural Resources, and Environment (SPW ANRE). The document is available on the website www.cari.be.

The Walloon guide aims to inform beekeepers about best practices for establishing new beehives, with a particular focus on efforts to protect wild pollinators, foster good relations with neighbours, and ensure the well-being of honeybees. The author addresses modern beekeeping practices and provides a range of practical information on apiculture, applicable laws, as well as honeybees, wild pollinators, and their environment.




## Status of Wild Pollinators and Beekeeping in Luxembourg

Insects constitute a significant portion of the biomass and biodiversity in our regions. At times, they seem omnipresent and abundant, especially when it comes to so-called "harmful" insects. However, insects are particularly affected by the biodiversity crisis, often referred to as the 6th mass extinction or Holocene extinction (Sánchez-Bayo & Wyckhuys, 2019). The decline in insect populations impacts all food chains, including our own, as insects are the primary contributors to pollination. Pollinating insects are especially vulnerable in the current crisis. The findings of scientific studies across Europe and beyond are clear (IPBES, 2016).

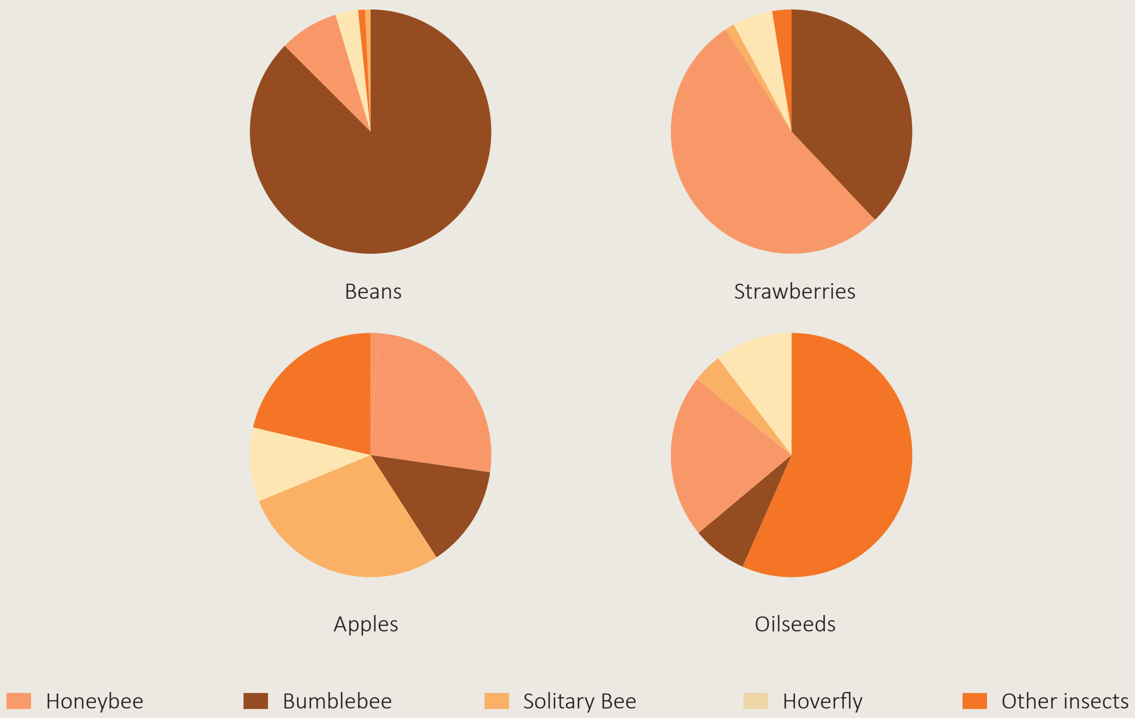
For instance, studies conducted in sixteen European countries since 1990 indicate a 39% decline in grassland butterfly populations (Warren *et al.*, 2020), while similar declines in forest insects have been observed in Germany (Seibold *et al.*, 2019). This alarming trend is also reflected in the number of pollinators listed as threatened on Red Lists. In Belgium, for example, one-third of wild bee species are endangered, and 12% of historically documented species are believed to have disappeared from the country (Drossart *et al.*, 2019). The situation in Luxembourg is similarly dire, although precise data is still being gathered through projects by the Luxembourg Institute of Science and Technology (LIST) and the National Museum of Natural History (MNHN). Key threats to wild pollinators include habitat alteration and fragmentation, the use of chemical agents such as pesticides, invasive species, emerging diseases, and climate change (Sánchez-Bayo & Wyckhuys, 2019).

These threats also affect honeybees, whose colonies can be devastated by diseases or poisoning. However, thanks to the diligent care of beekeepers who closely monitor the health of their bees, honeybee populations remain stable, and the number of beehives in Luxembourg has been steadily increasing over the past decade.

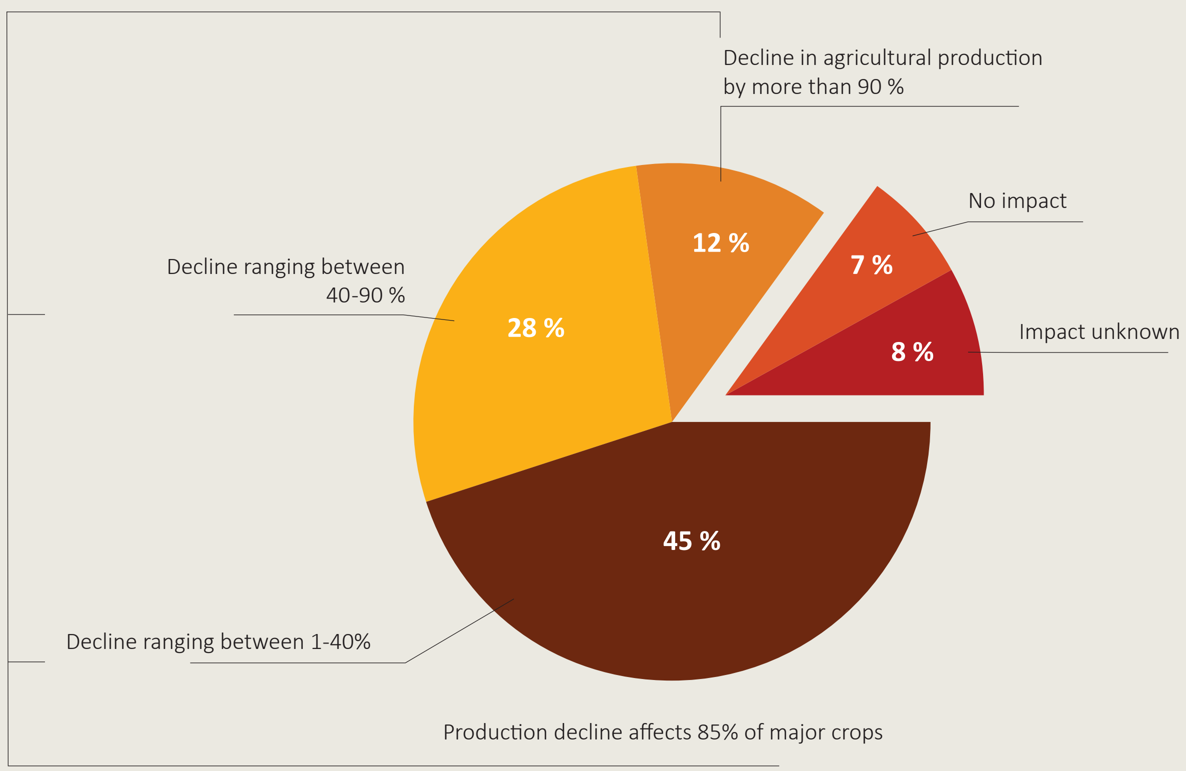
Ecosystem Services: Preserving the populations of wild pollinators and honeybees is a priority, as these species are vital to society. Globally, around 90% of all flowering plants, including many crops, rely on pollinators. It is estimated that 35% of global biomass production—representing a market value of several hundred billion euros—depends on pollinators (IPBES, 2016). This encompasses the vast majority of fruits and vegetables consumed.

Beyond food production, pollinators also contribute to the diversity, functionality, and beauty of landscapes. They play a role in producing plant materials, medicines, and even serve as a source of inspiration for innovation.

Relative Importance of Different Pollinators for the Yield of Various Crops
Garratt *et al.*, 2014 in Bruneau, 2020




Impact of the Loss of Animal Pollination on Major Entomophilous Crops Worldwide
Adapted from the IPBES report (2016) on pollination by Klein *et al.*, 2007






## What can we do?

In today's world, it often feels as though we are powerless in the face of disruptions to the natural balance. However, this is not the case. Each of us has a role to play, and everyone can contribute – whether through their behaviour or actions. How can we care for and support bees in the context of a weakened environment? How can we ensure that our efforts to support the environment and beekeeping also meet the needs of wild pollinators? This guide provides key recommendations for the thoughtful placement of beehives. Achieving this requires actions that involve all stakeholders and take into account the social, economic, and ecological specifics of the local context. Municipalities play a vital role, as they enable concrete and effective measures for meaningful action. Your municipality is likely already working in collaboration with a Biological Station or contributing to biodiversity efforts through the Nature Pact. Additionally, the National Action Plan for the Preservation of Pollinators (Plan national d'action pour la préservation des pollinisateurs) is a valuable resource for initiatives. It is therefore the responsibility of each individual to promote a bee-friendly environment and protect wild pollinators.

## Presentation of the Luxembourg Guidelines

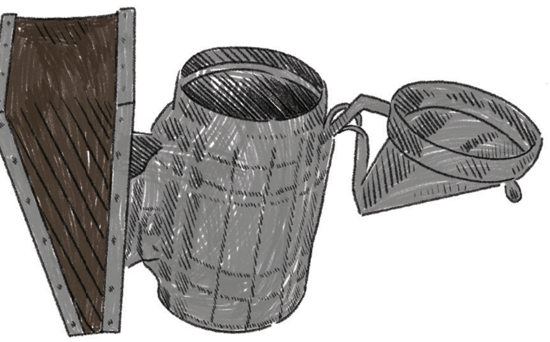
This guide aims to provide a concise introduction to beekeeping while emphasizing the importance of environmentally conscious hive placement that meets the needs of both honeybees and wild pollinators. Following this introduction, the document is divided into three chapters:

1. "Life as a Beekeeper": This chapter addresses the fundamental aspects of beekeeping, including motivations, necessary training, equipment, key responsibilities, bee products, civil liability, and relevant regulations.

2. "Bees, Pollinators, and their Environment": The second chapter introduces the honeybee, covering its life cycle, needs, diseases, and predators. It also delves into the world of wild pollinators, providing information about their natural needs, ecological significance, and the interactions between beekeeping and other pollinators. Additionally, the chapter discusses the pollinators' environment and offers practical advice on selecting a suitable location for beekeeping.

3. "Commitment to Beehives and their Environment": The final chapter explores ways to improve the environment for bees and highlights the socio-ecological importance of beekeeping, including community involvement and public awareness initiatives.

The creation of this guide is the result of collaboration and consultation between the Ministry for the Environment, Climate and Biodiversity, the Luxembourg Beekeeping Association, Biotope environnement Luxembourg, and various Luxembourg administrations, research institutions, and conservation organisations.





# 1 Life as a Beekeeper

## Motivations of a Beekeeper

Honeybees have always been a part of our environment. At the beginning of the last century, many farms maintained a few beehives in their backyards. Today, our relationship with bees has shifted significantly, as the agricultural landscape of the past bears little resemblance to that of today. Very few farms still manage beehives, as farmers no longer have the time to tend to them. As time went on, these farmers were gradually replaced by new beekeepers. These individuals, often nature enthusiasts, typically found themselves with professional downtime, and beekeeping offered them an additional source of income. Bees were also incorporated into educational programs by teachers. Over the past two decades, efforts to preserve biodiversity have taken centre stage, giving rise to a new category of beekeepers. Unlike their predecessors, these individuals are not primarily motivated by honey production or other bee products but rather by the desire to contribute to nature. This new group now constitutes the majority of participants in beekeeping courses.

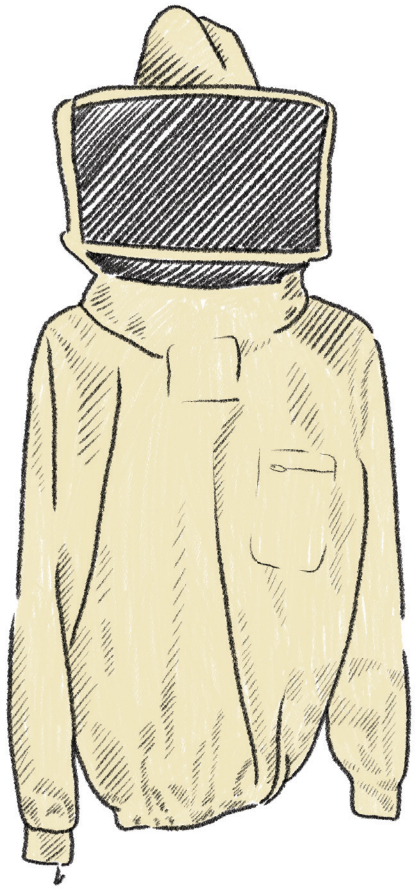
## Expertise

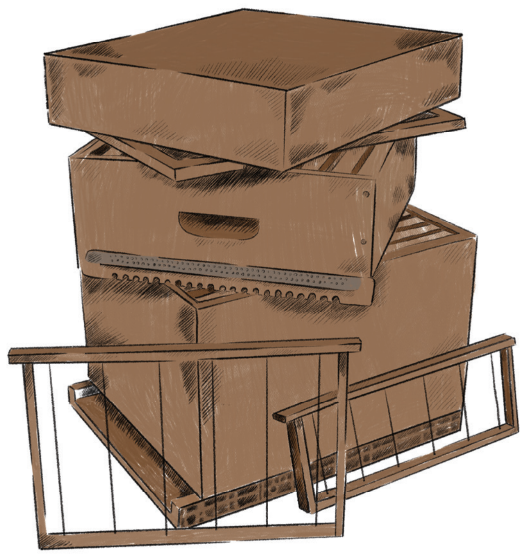
**Training**

In the Grand Duchy of Luxembourg, the *Fédération des Unions d'Apiculteurs du Grand-Duché de Luxembourg* and the various cantonal beekeeping associations are the primary points of contact for aspiring beekeepers. Training programs are conducted by a beekeeping advisor and the cantonal associations. The training includes approximately fifteen hours of theoretical lessons during the winter months (January to March) and several practical sessions throughout the seasons, tailored to the development stages of the bee colonies. Given the continuously evolving knowledge in this field, the cantonal associations' practical sessions are attended not only by beginners but also by experienced beekeepers year-round. The Ministry of Agriculture, Food and Viticulture finances the beekeeping advisory services. This collaboration between the beekeeping federation and the ministry has contributed to an increase in both the number of beekeepers and beehives in the country.

**Basic Equipment**

As a beginner, it is essential to acquire the basic equipment necessary for every beekeeper. This includes a high-quality protective veil, ideally integrated into a full suit, which ensures good visibility in both sunlight and shade. A pair of gloves with long cuffs, which should not be attached to the suit, is also required, along with a hive tool suitable for the type of frames being used, small cleaning tools, and a smoker. It is strongly recommended that beginners avoid purchasing old equipment or materials from unknown sources. Instead, it is better to seek professional advice and invest in new, standardised equipment from specialised stores to ensure it meets current needs and standards. Several models of beehives are available on the market. In Luxembourg, the most commonly used types are the Dadant and Deutsch Normal hives. Both are easy to handle. The Dadant hive, particularly the 12-frame version, is well-suited for rapidly growing bee colonies due to its large capacity. In contrast, the Deutsch Normal hive is smaller but easier to handle. For guidance on selecting and maintaining beehives, it is best to consult a beekeeping advisor during your training or seek advice from experienced beekeepers in your cantonal association.







**Key Tasks for Beekeepers by Season**

The workload per hive varies significantly depending on the progression of the blooming season, which directly influences the development of bee colonies. A few weeks after the winter solstice, the queen bee begins laying eggs again, starting with a few each day and increasing to around 100 eggs daily by February. The temperature in the brood nest must then be maintained at 32–36°C. With the first rays of sunshine and slightly milder temperatures (above 11–12°C), the bees perform their cleansing flights, and foragers start visiting the earliest blooming flowers. Some beekeepers take advantage of the first warm days to clean their hives. The flowering of the goat willow marks the true start of spring.

The pollen from willows, followed later by dandelions and fruit trees, is highly nutritious and stimulates the queen to lay more eggs, enabling the rearing of young larvae. Soon, the first drone eggs are laid. As temperatures rise, beekeepers often use a sunny day to inspect their colonies, performing what is known as the spring check. During this time, they replace used frames with new ones, assess food reserves, evaluate the brood's expansion... The older winter bees gradually make way for younger bees.

Later, often at the start of the fruit tree bloom and depending on colony development (with populations reaching 30,000–40,000 bees), beekeepers add an extra box to well-developed hives. These boxes, which hold frames, are where bees store nectar, which they carefully dry and convert into honey.

The colony continues to grow weekly, reaching its peak size in June. At this point, the colony focuses on swarming to propagate. Since a swarming colony cannot achieve a good summer harvest, beekeepers aim to prevent swarming using various techniques. This process demands significant attention and effort. The swarming period often coincides with the honeycomb harvest and honey extraction, making it the most critical time of the year.

After the summer solstice, the queen's egg-laying activity decreases. During the summer nectar flow, beekeepers monitor colonies by adding empty brood boxes and removing full ones. Once all the combs are harvested, the extracted honey must be replaced with sugar syrup. Simultaneously, beekeepers perform an integrated summer treatment for Varroa mites, which can require considerable effort from mid-July to mid-August.

Feeding may continue until the end of September, depending on the year. Afterward, colonies are prepared for overwintering. During the off-season, beekeepers engage in tasks such as crafting accessories, melting down old wax (for producing pre-formed wax sheets or candles, depending on the quality), and preparing frames for the next season. They also use this time

for further training and selling honey. By this stage, hives mostly contain adult bees forming a winter cluster.

The workload in hives increases gradually over the season, peaking during the swarming period. Beekeepers can expect the busiest months to be April through July. Outside this period, tasks can be scheduled more flexibly. Each hive visit requires approximately 30 minutes of preparation, with inspections lasting 5 to 15 minutes per colony, depending on the tasks.

During the peak season (April, May, and June), weekly visits are essential, leaving little room for prolonged absences. Managing two or three hives is not overly labour-intensive. Beginners typically spend around ten hours per year per hive, including honey processing. As skills develop, this time commitment may decrease. However, during the initial learning phase, more frequent visits are necessary, doubling the estimated ten-hour time commitment. Additional activities, such as harvesting other products, queen rearing, or pollination services, can significantly extend the workload.

**Bee Products**

Honey is the primary product harvested from beehives. This natural substance, created by honeybees, is collected in spring and summer. Most of the honey harvested by beekeepers comes from floral nectar, which bees enrich with their saliva and dehydrate until it has a water content below 18%, preventing fermentation. Depending on the year, bees may also collect honeydew from plants such as maple trees, conifers, and others. Honeydew gives the honey a darker colour and caramel-like aromas, often referred to as forest or honeydew honey. The main types of honey harvested are floral honeys, which vary depending on the year's yield. On average, a single bee colony produces between 20 and 30 kilograms of honey annually, although this can fluctuate from year to year. In Luxembourg, more than 100 tons of honey are produced annually (Beekeeping Program 2020–2022).

Bees collect pollen as a source of proteins, fats, and minerals, which they use to feed their larvae (future bees). They gather this highly nutritious substance from flower stamens and pack it onto their hind legs, adding a bit of nectar or honey to bind it. Upon returning to the hive, forager bees deposit their pollen harvest into empty cells near the brood area. Certain yeasts trigger a lactic acid fermentation process, making the pollen easier for bees to digest and giving it the name "bee bread". While pollen can be harvested by beekeepers, only a minority choose to process this product.

Royal jelly is a glandular secretion produced by young nurse bees to feed larvae under three days old and the queen, who consumes only this hyper-energetic protein substance with unique biological properties. Harvesting royal jelly requires time, specialised equipment, and expert



beekeeping skills, which is why few beekeepers produce this valuable product. The intensive labour involved justifies its high market value.

Propolis is a plant resin collected by bees from the resinous secretions of plants, most commonly from the buds of certain trees. This complex, antioxidant-rich substance is used by bees for sterilization purposes within the hive, coating the interior walls entirely. Propolis, often mixed with wax, is also used to seal gaps where bees cannot enter or to mummify small intruders like mice that cannot be removed from the hive. It is harvested using special grids and is often used in paramedicine, particularly for treating sore throats. However, it is collected and marketed by only a small number of beekeepers.

Beeswax is secreted from the wax glands on the ventral side of the abdomen. The small wax plates are used to construct combs. Many beekeepers utilise pre-formed wax sheets to assist bees in building their combs. These sheets, which serve as the foundation for the comb structure, are typically purchased, although some beekeepers produce them from their own wax. To avoid imported wax that may contain contaminants such as pesticides, the FUAL has acquired a machine to produce pre-formed wax sheets from local beekeepers' wax. This service is available to beekeepers through the national association for a fee. Beeswax is also widely used in cosmetics.

**Liability**

It is common knowledge that bees have stingers and can inject venom. This defence mechanism is painful and can be dangerous for individuals with allergies. Owning beehives therefore entails a responsibility toward one's fellow citizens, requiring beekeepers to take every precaution to avoid potential issues.

Adhering to current recommendations for hive placement, particularly in residential areas, and following best practices is of utmost importance. This includes minimizing disturbances, avoiding hive visits during thunderstorms, providing and using protective equipment, and keeping suitable first aid kits readily available.

In any case, it is essential to secure liability insurance and inform others of the presence of your bees to prevent unpleasant surprises and maintain good relationships with neighbours. Beekeepers who join an association often benefit from liability insurance as part of their membership.

## Administrative Information

**Registration of Bee Colonies and Location Regulations**

Anyone intending to keep bees must annually register the colonies under their care with the Luxembourg Veterinary and Food Administration (Administration luxembourgeoise des services vétérinaires et alimentaires, ALVA). In urban areas and densely populated regions, beekeepers are also required to register their colonies in accordance with the Grand Ducal Regulation of July 26, 1999, concerning classified establishments of Class 4. This registration must be completed before starting any beekeeping activity.

**General Requirements:**

— Beehives must be professionally constructed and maintained.
— Beehives must be designed, equipped, and operated in a manner that does not produce noise or vibrations that may disturb the neighbourhood.

**Specific Conditions for Beehives:**

— All necessary measures must be taken to minimise excessive disturbances to immediate neighbours, such as careful placement of hive entrances and the use of hedges.
— Beehives must be positioned to prevent disturbance to neighbours and should be located at least 10 meters from the boundary of adjoining properties.
— Hive entrances should face away from residential buildings to direct bee flight paths away from homes.
— Bee flight paths must be redirected to a height of at least 2 meters using hedges or fences near the hives to prevent bees from continuing their path toward houses.
— Temporary and permanent apiaries outside of urban areas must be marked with a sign displaying the owner's name, phone number, and address.
— Beekeepers must have liability insurance.

An overview of the site requirements, the application form, and the contact details for the environmental authority can be found at www.guichet.public.lu or on the FUAL website at www.apis.lu.




Practical Implementation of Hive Placement in Urban Areas: In the first scenario, the beehive is located more than 10 meters from the property boundary. However, the hive entrance faces a residential building, and there are no structures to redirect the bees' flight paths away from the house. In the second scenario, while structures are in place to divert the bees' flight paths away from the house, the hive entrance still faces the building and does not maintain the required 10-meter distance from the property boundary. In the final scenario, all conditions are met: the flight paths are redirected away from the residential building, the hive entrance is oriented toward uninhabited areas, and the hive is placed more than 10 meters from neighbouring properties. Additionally, proximity to food sources is a significant advantage, as it helps prevent bees from dispersing near residential areas.

In the specific case of constructing a bee house in a green zone or placing hives in protected green areas (ZPIN and Natura 2000), the provisions of the amended law of July 18, 2018, and its update of March 3, 2022, concerning the protection of nature and natural resources must be followed. Additionally, a separate form must be completed, available at www.apis.lu. Permits for constructing bee houses in these areas are only granted for operations with more than 30 hives.

It is important to note that in both urban and green zones, a municipal building permit is required for constructing sheds, shelters, awnings, or other structures for hives.

According to the law of August 2, 2023, on promoting sustainable development in rural areas, beekeepers can apply for financial support for constructing or renovating beekeeping facilities and purchasing new equipment for honey marketing. The subsidy rate is 40%, with eligible amounts ranging from 1,000 € to 200,000 €. The full text of the law can be accessed at www.legilux.public.lu. Funded equipment must be used for at least ten years. If the activity is discontinued before this period, the subsidy must be reimbursed proportionally.

**Health Certificate**

Honeybees are susceptible to various parasites and diseases (see Chapter 2), which can significantly affect both colony health and beekeeping operations. Registration with veterinary authorities and reporting the number of hives between November 1 and November 30 is essential. This process can be invaluable for beekeepers in the event of a disease outbreak in their colonies. Several notifiable diseases require mandatory reporting and specific actions (see Chapter 2). To support beekeepers in managing these challenges, the FUAL has established a network of beekeepers who serve as points of contact and are part of a health service. Members of this service are listed in a registry defined by ministerial decree issued by the Ministry of Agriculture, Food and Viticulture.



Summary

| Registration of Beehives | Location | Beekeeping Project | Steps |
|---|---|---|---|
| Annual registration mandatory for all beekeepers | Urban Areas | Simple Placement of Beehives | — Notification of a Class IV facility to the Environmental Administration<br>— Guidelines for hive placement concerning neighbourhood proximity |
| | | Construction of a Beehive | — Notification of a Class IV facility to the Environmental Administration<br>— Guidelines for hive placement concerning neighbourhood proximity<br>— Municipal building permit |
| | Green Zones outside Protected Areas (Nationally Significant Protected Areas, Natura 2000) | Simple Placement of Beehives | No special requirements |
| | | Construction of a Beehive | — Application for a nature conservation permit with the Ministry of Environment, Climate and Biodiversity<br>— Municipal building permit |
| | Protected Green Zones (Nationally Significant Protected Areas, Natura 2000) | Simple Placement of Beehives | — Application for a nature conservation permit with the Ministry of Environment, Climate and Biodiversity |
| | | Construction of a Beehive | — Application for a nature conservation permit with the Ministry of Environment, Climate and Biodiversity<br>— Municipal building permit |
| Luxembourg Veterinary and Food Administration (ALVA) | In urban areas, it is essential to ensure that the guidelines for hive placement concerning neighbourhood proximity and safety are strictly followed. | The construction of beehives, shelters, or storage facilities in green zones is permitted only for operations managing more than 30 hives. | |



Life as a Beekeeper

# 2 Bees, Pollinators and their Environment

## Honeybees

The European honeybee (*Apis mellifera*) is a social insect belonging to the order Hymenoptera, like bumblebees, certain wasps, and ants. The genus Apis is believed to have originated in Asia, where several species coexist, including *Apis cerana*, the sister species of the European honeybee. Over time, *Apis mellifera* likely diverged from a common ancestor, forming its own lineage in North Africa, the Middle East, and Europe. However, its precise origins remain uncertain (Tihelka *et al.*, 2020). Today, the honeybee is a cosmopolitan species, having been imported worldwide for its pollination capabilities and honey production.

The rhythm of a honeybee colony is closely tied to weather conditions and the seasonal cycle in temperate zones. During winter, activity is minimal, and colonies are sparsely populated, consisting of a few thousand bees clustered together to conserve heat. They survive on their reserves, and at least 15 kilograms of honey should remain in the hive during this critical period.

At the end of winter, the queen resumes egg-laying. It takes approximately 21 days for a worker bee to develop and emerge. The first summer workers are born around early spring, coinciding with the start of the flowering season in March. Once spring has firmly set in and temperatures consistently rise, hive activity intensifies, and the queen's egg-laying can exceed 2,000 eggs per day! The colony grows rapidly, and the honeycomb begins to fill with nectar thanks to the abundance of spring blooms. The colony reaches its peak development in late spring, as the availability of flowers and nectar decreases in early summer. This period is also marked by swarming, a natural process where bees divide their colony. Swarming typically occurs when the hive becomes overcrowded or the queen ages. During summer, brood production declines, but worker bees continue collecting nectar and pollen to prepare reserves for the harsher months. By late summer and early autumn, colony activity slows, and the winter bees—those that will sustain the hive through the cold months—are reared.

The remarkable social structure of honeybees is organised into various classes and roles. Worker bees, in particular, progress through a series of distinct tasks over the course of their lives. Upon hatching, a bee initially assumes the role of a cleaner, removing waste from the hive. After a few days, it transitions into the role of a nurse, tending to the larvae. After about a week, it may participate in hive construction and take on the task of receiving nectar from foragers, which it processes into honey. By the second week, it becomes a guard, actively defending the hive and taking exploratory flights to familiarise itself with the surrounding environment. Around the third week, it finally becomes a forager, dedicating the rest of her life to gathering food. The average lifespan of a summer bee is only a few weeks, while winter bees, adapted to sustain the hive through colder months, can live for several months.



**The Needs of a Colony**

All living organisms have basic needs, and the honeybee is no exception. In beekeeping, there are three primary needs that beekeepers can influence: shelter, food, and protection from predators. In nature, honeybees nest in natural cavities, such as hollow trees. Beekeepers have long sought to replicate and improve these habitats by creating beehives. Today, there are many different hive designs, each with its own features and benefits. Regardless of the model, beekeepers must maintain their hives properly to meet the bees' evolving needs. This includes cleaning and disinfecting the equipment, protecting the hive from weather conditions, and treating the wood with linseed oil.

Proper maintenance of the hive can prevent many issues, including health problems, but it is not always sufficient. In many cases, beekeepers must actively protect their colonies from parasites and predators (see below).

Another critical aspect under a beekeeper's control is the bees' diet. The availability of food resources near the hive is of utmost importance. While honeybees are capable of traveling several kilometres in search of nectar and pollen, the energy expenditure and risks for foragers increase significantly with distance. Therefore, it is essential to evaluate the floral potential of a hive's location, particularly its proximity to abundant blooms. It is generally accepted that the primary foraging radius—the area where most of the foraging activity occurs—is about 3 km, although bees are capable of traveling much farther (Beekman & Ratnieks, 2001). Foraging activity fluctuates throughout the season. Couvillon *et al.* (2015) have documented these seasonal variations in both pollen and nectar collection. Over the course of a year, millions of flowers must be visited by a single colony to gather the resources necessary for its development and honey production.

**Diseases and Enemies**

The image of a bear stealing honey is firmly embedded in children's imaginations. While this can be a genuine issue in places like Sweden, Finland, or the Carpathians, bees in Luxembourg face many smaller but equally threatening enemies. One prominent threat is the Asian hornet, now present in Luxembourg and spreading rapidly throughout the country. This hornet poses a threat to a wide range of insects (Rome *et al.*, 2021), with honeybees being particularly vulnerable. While Apis species in Asia have co-evolved with this predator and developed defences, the European honeybee lacks such adaptations and is unable to protect itself effectively. Asian hornets are most active in late summer (August and September), when they linger near hives, waiting to snatch returning foragers mid-flight. The nests of Asian hornets resemble those of wasps or European hornets but can be much larger (up to 1 meter tall). These nests should be removed as soon as they are spotted—ideally before

young queens swarm in October and November. Sightings of nests must be reported to the Nature Administration (ANF). European wasps and hornets can also attack weakened colonies, especially later in the season (August and September). However, such predation is generally considered a natural occurrence, similar to birds or other arthropods preying on foragers.

In temperate zones, diseases are the primary regulators of bee populations rather than predators, as seen in tropical regions. Pathogens can infect either immature bees, adult bees, or both.

The most notorious parasite is *Varroa destructor*, aptly named the “destructive mite”. It is the most significant pest known to affect honeybee colonies. The *Varroa mite* reproduces in capped brood cells (the pupal stage of bees), feeding on the bee’s blood (haemolymph) and fat stores. Its population can double every month during the rearing season (February to November). Moreover, *Varroa mites* facilitate the spread of various viruses, further weakening colonies. When mites and viruses reach critical levels, the colony can collapse unless beekeepers intervene to halt the infestation. To combat *Varroa*, beekeepers must implement a comprehensive control strategy, typically involving biotechnical methods, medications, synthetic organic acids, or natural treatments. Efforts are underway to breed bees with enhanced hygienic behaviour to better manage mite infestations, potentially reducing the need for interventions in the future. Other pathogens, such as the *Black Queen Cell Virus*, which causes queen larvae to die, have no specific treatments available. Healthy colonies, whose immune systems are not compromised by pesticides or malnutrition, can often fend off such diseases on their own. Fungal infections, particularly under conditions of cold or excessive humidity, can attack bee larvae, turning them into mummies (chalkbrood). Protozoa may attack the bees’ digestive systems, disrupting their ability to absorb nutrients. Highly contagious diseases like American foulbrood are reportable in Luxembourg. In such cases, veterinary services intervene, with measures including quarantine, inspection, and potential destruction of infected hives, in accordance with the regulation of August 8, 1985, and the amended Livestock Health Act of July 29, 1912, updated on December 23, 1998.

In addition to these threats, some moths breed in honeycombs, feeding on the wax. However, these pests are generally harmless and are effectively managed by resilient and hygienic bee colonies. In most cases, pathogens are endemic to beehives, and bees have coexisted with them for millennia. However, these pathogens can become overwhelming when colonies are weakened, often due to environmental stressors or errors in hive management.



## The Yellow-Legged Hornet (*Vespa velutina nigrithorax*) - A Feared Predator

The Asian hornet, also known as the yellow-legged hornet, was first discovered in Luxembourg in 2020. Since then, nests have been found in multiple regions across the country (east, west, centre, and south). The species appears to have established itself nationwide, making coexistence with this new arrival inevitable.

**Identifying the Asian Hornet**

Although the Asian hornet is nearly the same size as the European hornet, it is slightly smaller. The two can be easily distinguished by their coloration. The Asian hornet is much darker (brown/black) and has distinctive yellow tips on its legs.

**An Annual Life Cycle**

At the beginning of spring, queen hornets emerge from hibernation and search for a suitable location to establish a new nest. They begin laying eggs, and approximately one month later, the first adult workers take over colony tasks. The queen continues to lay eggs for the remainder of her life. Typically, the initial nest is abandoned in August, and a secondary nest is built at a much greater height (often over 10 meters). The colony reaches its maximum size in the fall, which is also the time for reproduction. While some females may manage to overwinter in a nest, they are not fertilised and thus cannot start a new cycle. The rest of the colony perishes during the winter months. Only the future queens survive, hibernating in cold-protected environments such as leaf litter on the ground.

**Precautions and Management**

The first step to protecting your hives from the Asian hornet is to monitor them regularly. It is advisable to check frequently whether this predator has targeted your beehives and discovered your apiary as a new food source. Stay vigilant and report any sightings of this insect on the website www.data.mnhn.lu or the iNaturalist app. Reporting helps both to better assess the spread of the species and potentially locate nests.

Another critical aspect is safeguarding your hives. Several protective devices can be used, such as entrance reducers, muzzles, electric harps, or wire cages with a mesh size of 5.5 mm. These solutions significantly reduce predation pressure and stress on bees.

When attempting to trap Asian hornets, several factors must be considered. Unfortunately, no completely selective traps exist that catch only Asian hornets without harming other species. The use of non-selective traps, such as halved bottles filled with beer or other attractants, should be avoided as they indiscriminately trap numerous other insects. Maintaining a natural ecological balance is crucial for better resilience against the Asian hornet.

It is also important to avoid setting traps in spring, as studies have not demonstrated the effectiveness of this practice. Given the large number of queens emerging from a single nest (>500), it may be more effective to let the queens compete with one another.

In cases of repeated, severe attacks on hives by yellow-legged hornets, it may be worth considering selective traps, such as the Jabeprode trap, used with the appropriate attractant. However, the effectiveness of these traps and their potential impact on other insect species should always be carefully assessed. The most effective method remains the destruction of nests, which is carried out regularly in Luxembourg. Detecting nests is a crucial step in this process. Advanced detection methods, such as attaching radio transmitters to individual hornets, are still highly complex and require significant investment. Despite these challenges, public awareness and diligent monitoring remain key to successful management.

Luxembourg has implemented an action plan to combat invasive alien species, specifically targeting the Asian hornet. Several measures outlined in this plan have already been enacted. More information can be found at www.environnement.public.lu

© Thomas Beissel

### Transmission of Pathogens

In nature, bee colonies are typically spread out, which significantly limits the transmission of pathogens between them. Beekeepers should therefore position their hives in ways that minimise contact. Visual aids, such as shrubs in front of hives or distinct colours on the landing boards and hive fronts, can help bees easily locate their original colonies. A more serious issue arises when robbing bees raid colonies weakened by disease. These bees can carry pathogens back to their own hives, spreading infections further.

To prevent robbing as much as possible, entrance reducers can be used to enable colonies to better defend their hives. Dead colonies must be securely sealed to avoid further contamination. The exchange of biological materials also facilitates the transmission of pathogens. Strict hygiene measures are necessary, including disinfecting beekeeping equipment, particularly when a colony is suspected of being infected. Solitary bees and bumblebees also harbour pathogens such as viruses or mites, some of which are similar to those affecting honeybees. Research has shown that pathogens can be transmitted between bee species at shared food resources, with transmission occurring in both directions (Ravoet *et al.*, 2014; Murray *et al.*, 2019). We live in a world where such cross-species transmissions are commonplace. The only way to limit them is to match pollinator populations to local flora and restrict the introduction or exchange of foreign pollinators. For these reasons, it is recommended not to overcrowd any single location or region with too many hives and to use local honeybee species of controlled origin. The density of bee colonies per square kilometre is a critical factor and should be adjusted to the availability of floral resources throughout the year. Ideally, beekeepers should emulate natural conditions by distributing colonies across the landscape. The international import of biological materials (colonies, swarms, queens) is subject to strict regulations to prevent the transmission of infectious diseases.

The import of bee packages or colonies from outside the European Union is also prohibited.



## Wild Pollinators

The world of bees is vast, and the honeybee (*Apis mellifera*), despite undergoing specific selection processes that led to several distinct honeybee breeds, is only one of approximately 20,000 bee species worldwide. In Luxembourg alone, there are 347 known *Anthophila* species (Reverté *et al.*, 2023). The term “bee” encompasses honeybees, which live in colonies within hives or natural cavities; bumblebees, which form annual colonies; and solitary bees, whose females rear their offspring independently but may exhibit some social tendencies, such as shared nest entrances or communal lifestyles. Most bees consume nectar to meet their energy needs and use pollen primarily as a protein source for larval development. This distinguishes them from most wasps, whose larvae require animal protein (e.g., small insects) but may still transport pollen when visiting flowers for nectar. Some bees are kleptoparasites, meaning they neither collect pollen nor nectar, establish colonies, nor build nests. Many solitary bees dig nests in the ground, while others nest in plant stems, hollow wood, or abandoned snail shells. Solitary bees belong to six different families: *Andrenidae*, *Apidae* (which also includes honeybees), *Colletidae*, *Megachilidae*, *Halictidae*, and *Mellitidae* (Ghisbain *et al.*, 2023).

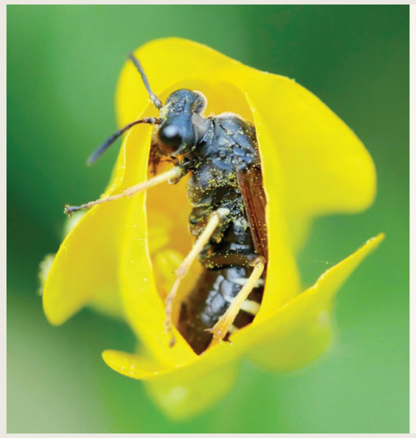
In addition to these Hymenopterans, there are Dipterans (insects with a single pair of wings), such as hoverflies. These flies typically prefer open flowers, unlike many bees. Their mimicry is remarkable, and at first glance, some hoverflies can easily be mistaken for bees, wasps, or bumblebees. Other fly families also contribute to pollination, though to a lesser extent. Another well-known group of pollinating insects is butterflies. Recognizable by their vivid colours, butterflies use their long proboscises to pollinate flowers with deep, narrow corollas. Lastly, various other insects contribute significantly to pollination. For instance, beetles transport pollen as well, and some plants are specifically adapted to beetle pollinators (Muinde & Katumo, 2024). Below, you will find a guide to identifying the different groups of pollinators:



### Bees:

- Up to 350 species have been recorded in Luxembourg.
- They predominantly nest in the ground but also in decayed wood, humus, leaf litter, and plant stems.
- They range in size from a few millimetres to three centimetres.
- They have two pairs of wings.
- They are highly specialised for collecting pollen.
- Females gather pollen using hairs on their legs or under their abdomen; only bumblebees possess pollen baskets.

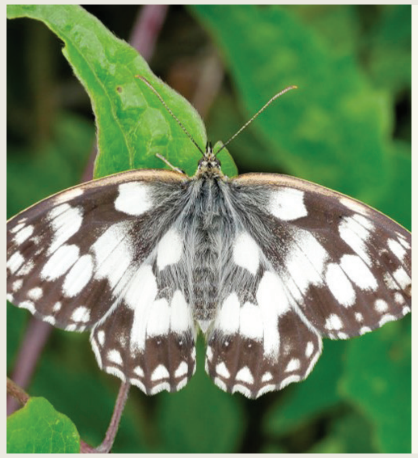
© Martin Heyeres, *Trachusa byssina*, a summer bee specialised in legumes.



### Other Hymenopterans:

- Numerous other Hymenopterans contribute to pollination.
- They can be social (e.g., wasps) or solitary (e.g., sawflies, cuckoo wasps).
- They exhibit significant variability in form and size.
- They have two pairs of wings.
- Their ecological roles vary greatly by group, including herbivores, predators, and parasites.

© Martin Heyeres, *Tenthredo koehleri*, a spring wasp with herbivorous larvae.



### Butterflies and Moths:

- 78 species and 3 species complexes of diurnal butterflies have been recorded, along with
- more than 1,735 nocturnal species, approximately 1,500 of which are pollinators
- Their wingspan ranges from a few millimetres to about eight centimetres.
- They have two pairs of wings, often patterned and colourful.
- Most possess a long proboscis for feeding, though there is significant variability among nocturnal species.
- They have a close connection to specific flora and habitats, with many caterpillars feeding on particular plant species.

© Martin Heyeres, *Melanargia galathea*, a summer butterfly commonly found in nutrient-poor meadows.

### Flies:

- There are several hundred species, including hoverflies, with at least 201 species recorded in Luxembourg.
- Their wingspan ranges from a few millimetres to about two centimetres.
- They have only one pair of wings.
- They prefer open flowers such as those of composite or umbelliferous plant.
- Their ecological roles are highly variable, with larvae that can be predatory, parasitic, or saprophagous.

© Martin Heyeres, *Helophilus pendulus*, a common hoverfly.

### Beetles:

- A highly diverse group, with some families showing a preference for visiting flowers.
- They range in size from a few millimetres to about two centimetres (e.g., the rose chafer).
- They have two pairs of wings, including hardened elytra that protect the body.
- They are important pollen feeders.
- They thrive in environments with abundant deadwood and proximity to forest edges.

© Martin Heyeres, *Cetonio aurata*, an impressive beetle that contributes to pollination.

### Other Groups:

- Many additional groups contribute to pollination in less conspicuous ways, such as true bugs (Hemiptera), lacewings (Neuroptera), and thrips (Thysanoptera), among others.
- Their ecological traits vary greatly between groups. They tend to favour heterogeneous habitats.

© Martin Heyeres, *Aelia acuminata*, a bug commonly found in meadows.



**The Needs of Wild Pollinators**

Each species has ecological preferences and occurs in a specific location only when several environmental conditions are met. With hundreds or even thousands of wild pollinator species in Luxembourg, it is impossible to outline the needs of every individual species. However, several general observations can be made.

Pollinating insects require suitable nesting sites (e.g. bees) or host plants and/or substrates for laying eggs to support their offspring. For example, ground-nesting bees such as Andrena species prefer sandy slopes or beaches, while other species, such as the red mason bee (*Osmia bicornis*) or scissor bee (*Chelostoma*), utilise dead wood, branches, or dry plant stems. The diversity of (micro-)structures in a habitat is therefore critical to attracting various bee species.

For butterflies, sawflies, and some hoverflies, larvae often feed on the leaves of one or more specific host plant species, while the adults visit flowers. Thus, the botanical diversity of a habitat plays a crucial role in its capacity to support these species. This also applies to bees, many of which collect pollen exclusively from one or a few specific plants. The coexistence of suitable nesting sites and food plants is therefore of fundamental importance.

Beetles and hoverflies are a special case, as their ecological requirements can vary widely between species. An abundance of dead wood is undeniably advantageous for the reproduction of certain beetles, which are generally less dependent on the pollen of specific plants. Instead, they benefit from a sufficient abundance of open flowers (e.g., blackberry, yarrow, umbelliferous plants, daisies) near forest edges. Similarly, dead wood is beneficial for the reproduction of some hoverflies, as are wetlands and a diverse botanical habitat. Hoverflies can thrive in nearly any environment due to their highly varied preferences.

Environmental variables such as exposure, sunlight, weather, and soil composition must also be considered. Exposure and sunlight promote insect activity, as their metabolism depends on warmth. Weather conditions strongly influence their survival and population dynamics. Finally, soil composition affects the distribution of specific plants and their associated pollinators, limiting where certain species can thrive.

**Luxembourg Hotspots for Pollinators**

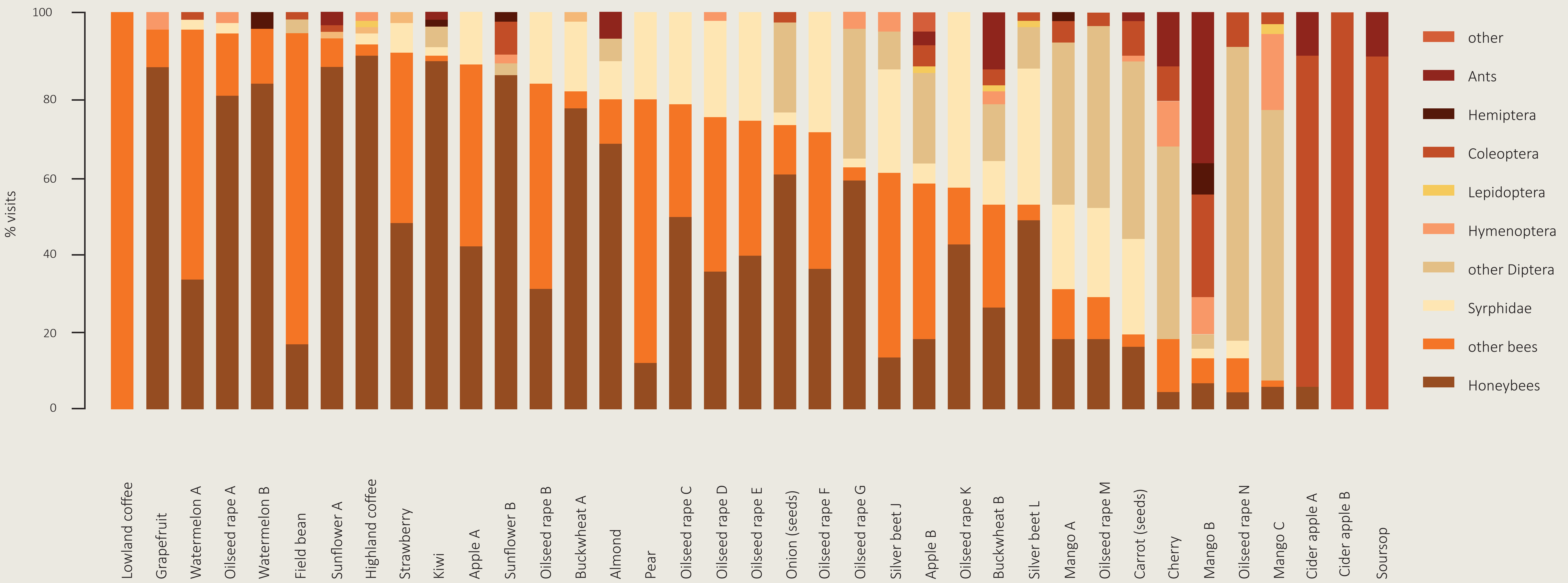
Currently, there is no national atlas highlighting areas with the highest abundance of pollinators in Luxembourg. However, studies on wild bees, hoverflies, and butterflies are already underway, coordinated by the Luxembourg Institute of Science and Technology (LIST) and the National Museum of Natural History. Two ecological regions are already recognised for their richness and diversity of pollinators, including rare species: the *Minette* region in the southwest and the *Moselle Valley* in the southeast of the country (A. Weigand, personal communication). These regions share the characteristics highlighted in the previous section. Their climates and soil conditions are favourable for insects, featuring nutrient-poor yet base-rich soils that support diverse flora, milder climates compared to other parts of the country, well-exposed locations, and heterogeneous, relatively undisturbed landscapes.

In other parts of Luxembourg, south-facing, structurally rich, and flower-abundant sites are often highly beneficial for pollinators.

**The Importance of Wild Pollinators**

Animal pollination plays a crucial role in food security and ecosystem functionality. It is essential for preserving biodiversity, particularly in systems where dependencies between specific plants and pollinators have evolved. Each pollinating insect varies in its efficiency depending on the plant species it visits. For instance, honeybees often need to visit certain flowers multiple times to achieve the same pollination efficiency as solitary bees or bumblebees, which are often better adapted to those flowers. Bumblebees, in particular, are among the only pollinators capable of „buzz pollination", a technique vital for crops such as tomatoes and other nightshades. Despite this, honeybees remain the most important pollinators for agricultural crops, followed by other bees (including bumblebees) and hoverflies. Their dominance is due to their large population numbers throughout the flying season. Each plant species, and even individual varieties, may have different pollination requirements. As a result, different groups of pollinating insects visit different crops depending on flower morphology and the accessibility of nectar and pollen. For example, bumblebees are almost the only pollinators capable of entering the flowers of peas and vetch, while they rarely visit the small flowers of buckwheat. In contrast, the widely open flowers of rapeseed or strawberries are visited by nearly all pollinators in the vicinity. Honeybees tend to focus on large clusters of flowers rich in nectar and/or pollen, often neglecting individual or scattered flowers in the landscape. Wild bees, on the other hand, particularly specialist species (oligoleges), visit plants essential for the development of their offspring, regardless of how common these plants are in the landscape. Recent studies have also shown that the complementarity of different pollinators significantly enhances production. A notable example is depicted in the following graphic: 100 visits from honeybees increase crop yields, but 100 visits from various solitary bees and bumblebees result in better outcomes (Garibaldi *et al.*, 2014). The highest yield is achieved when all types of bees—honeybees, solitary bees, and bumblebees—are present. A diverse array of pollinators is therefore ideal for achieving optimal pollination and meeting the needs of all flowering plants.

Global crop visitation by pollinator group
Adapted from Rader *et al.* (2015)



**Interactions between Domesticated and Wild Pollinators**

The investigation of interactions between honeybees and wild pollinators has become an active area of research in recent years, particularly since their importance and decline have been demonstrated and widely recognised. This interest is also due to the fact that honeybees have been imported worldwide outside their natural range, where they can be considered invasive species, such as in Australia (Cunningham *et al.*, 2022) or the Americas (Santos *et al.*, 2012). In the European context, honeybees are native and have long been part of natural landscapes (Tihelka *et al.*, 2020). However, human activities have changed significantly in recent decades, severely impacting the environment and natural equilibrium. Among the main assumed threats are food competition, the transmission of pathogens and changes in floral communities (Vereecken, Dufrêne & Aubert, 2015; Iwasaki & Hogendoorn, 2022).

Since honeybees are polylectic (generalist pollinators), they visit a large variety of flowers, including those preferred by wild pollinators. Honeybees are particularly attracted to abundant blooms such as rapeseed, brambles, linden trees, clover, or hawthorn. In Denmark, for instance, there is an average overlap of over 70% in food resources between wild bees and honeybees (Rasmussen *et al.*, 2021). This overlap is exacerbated by the sheer size of honeybee colonies, which form "superorganisms", and could reduce the availability of resources. Certain wild bees require significant amounts of pollen from a variety of flowers to raise their offspring (Müller *et al.*, 2006) and therefore need resource-rich habitats. A recent review by Iwasaki & Hogendoorn (2022) covered 216 articles examining the three main risks mentioned. About two-thirds of these studies focused on food competition between honeybees and wild bees. However, most studies were observational and conducted over short timeframes, making it challenging to extrapolate results to different ecological contexts or regions. Experimental, replicated, and larger-scale studies are still necessary to better understand the interactions between honeybees and wild pollinators (Mallinger *et al.*, 2017; Iwasaki & Hogendoorn, 2022; Gratzer & Brodschneider, 2023).

The following are examples of observational or experimental studies in the European context: Studies from the UK have shown that bumblebees in areas with honeybees tend to be smaller (Goulsen & Sparrow, 2009), possibly due to reduced food availability for larvae or the need for smaller workers, who usually remain in the colony, to forage (Goulsen & Sparrow, 2009). This observation is not isolated. For instance, bumblebee colonies located near an apiary with 50 hives accumulated fewer reserves and produced fewer queens (Elbgami *et al.*, 2014). The effects, however, depend on habitat quality. In Sweden, a decline in bumblebee density was observed in homogenous agricultural landscapes when hives were added, but not in heterogeneous landscapes (Herbertsson *et al.*, 2016). These initial studies already highlight the importance of habitat diversity and floral abundance in mitigating food competition. This is particularly critical because a honeybee colony collects a large amount of pollen over an extended period during the season. Cane and Tepedino (2016) estimated that the pollen consumed by a hive producing 20 kg of honey in a season is equivalent to the pollen needed to raise 33,000 medium-sized wild bees. In an experimental context, Hudewenz and Kelvin (2015) also showed a reduction in the number of larvae raised by the red mason bee (*Osmia rufa*) when it had to share limited floral resources with honeybees. This observation is relevant in areas with limited floral availability, where pollinator-friendly habitats are scarce, and competition is therefore high, though it is difficult to generalise to other scenarios. In an urban context in Switzerland, Casanellas-Abella *et al.* (2022) found that the availability of resources, rather than the presence of honeybees, influenced wild bee populations. Conversely, in Paris, Ropars *et al.* (2019) reported a negative correlation between hive density and the number of wild bees and beetles found on flowers, underscoring the context-dependent nature of food competition studies.

In florally rich landscapes with natural habitats, competition can be weaker or even negligible. For example, a German study found no significant impact of honeybee density (3.1 hives/km²) on bee richness and diversity in calcareous grasslands (Dewenter & Tscharntke, 2000). However, studies remain too limited to draw general conclusions (Vereecken, Dufrêne & Aubert, 2015). Higher hive densities can have significant effects, even within protected areas. A study by Henry & Rodet (2018) in a Mediterranean garrigue landscape, partially included in France's Natura 2000 network, documented the negative effects of migratory beekeeping. During the rosemary bloom, hive densities exceeded 14 hives/km², leading to a 55% reduction in wild bee presence within 900 meters of the hives and a 50% decrease in pollen collection success within 600 meters. In similar habitats in Spain, a hive density of just 3.5 hives/km² already had negative effects (Torné-Noguera *et al.*, 2016). An experiment in Swedish rapeseed fields also indicated competition. Authors observed a decrease in the number of other foraging insects on fields with added hives, as these insects were displaced to surrounding areas (Lindström *et al.*, 2016).

The studies highlighted above show that interactions and even competition between honeybees and wild pollinators can occur in certain contexts, especially in areas with scarce floral resources or high hive densities. However, the extent of this competition, its impact on insect populations, and the most vulnerable ecological environments remain unclear. Further research, particularly controlled experimental studies, is needed to identify causal mechanisms (Mallinger *et al.*, 2017; Iwasaki & Hogendoorn, 2022; Gratzer & Brodschneider, 2023).

The globalization of honeybees and the emergence of new diseases and parasites raise concerns for wild pollinators and honeybees alike. Research into disease transmission between honeybees and other insects has expanded significantly in recent years (Nanetti, Bortolotti & Cilia, 2021). Cases of malformations caused by the Deformed Wing Virus (DWV) have been documented in bumblebees (Genersch *et al.*, 2006; Cilia *et al.*, 2021), including in Luxembourg (Cantú-Salazar, 2019). However, the risks of pathogen transmission between bees remain largely unknown (Nanetti, Bortolotti & Cilia, 2021). In Luxembourg, the "DESPOT" project was recently launched to study the presence of honeybee viruses in wild bee populations. The collaboration between the Fédération des Unions d'Apiculteurs du Grand-Duché de Luxembourg (FUAL), the National Museum of Natural History (MNHN), and the Luxembourg Institute of Science and Technology (LIST) will undoubtedly contribute to a better understanding of this phenomenon and its effects in the future.

**Beehives and the Protection of Natural Heritage**

A beehive can be considered a superorganism, and the previous section highlights numerous proven or suspected interactions between honeybees and their wild counterparts. This naturally raises the question of how beekeeping projects align with the challenges of biodiversity conservation, particularly in protected natural areas. Currently, Luxembourg lacks an official stance on this matter. However, in Belgium, the *Conseil supérieur wallon de la conservation de la nature* (Walloon High Council on Nature Conservation) has issued a clear position on introducing colonies into such habitats. The council opposes the presence of beehives in these often small areas and even in their immediate surroundings (CSWCN, 2016). Nonetheless, the installation of hives in Natura 2000 areas is not entirely ruled out by the council. In Luxembourg, there are three primary systems for the protection of natural heritage:

1. Protected areas of national interest (PIN) are areas that have been proven to have great biological value at the national level, and which are designated as nature reserves, protected landscapes or ecological corridors, in order to either preserve habitats and species, protect the landscape, promote the well-being of the population or ensure ecological connectivity.

2. Sites of Community Importance (SCI) are areas of significant biological interest designated under the EU Habitats Directive (92/43/EEC) to maintain or restore natural habitats with animal and plant species of community interest.

3. Special Protection Areas (SPA) are areas of major biological interest to the European community, designated under the Birds Directive (2009/147/EC) for the protection of bird populations and their habitats, especially the most endangered species. Together with the SICs, the SPAs form the Natura 2000 network, which covers 27.13% of the country's surface area.



In Luxembourg, cases exist where the placement of beehives conflicts with the objectives of certain protected areas. For example, the management plan for the site *LU0001018 Vallée de la Mamer et de l'Eisch* specifies that beehives must not be placed within or near Calluna heaths (Habitat 4630) to support wild bees. It is therefore the responsibility of beekeepers operating within Natura 2000 areas or near protected zones to familiarise themselves with the objectives and management plans of the specific site to avoid errors.

## Recommendations Regarding Wild Pollinators

The question of whether beehives should be placed in nature conservation areas arises frequently, as these areas are fundamentally dedicated to preserving biodiversity. Introducing beehives may lead to excessive resource utilization by honeybees and an increased risk of food competition. Several authors, including Vereecken, Dufrêne & Aubert (2015), Henry & Rodet (2018), Geldmann & González-Varo (2018), and Iwasaki & Hogendoorn (2022), advocate for prohibiting beekeeping in conservation areas or establishing buffer zones around them, especially where rare or endangered species are present (Goulsen & Sparrow, 2009).

In Luxembourg, most beekeepers manage a limited number of hives, making it difficult to establish a universal regulation or outright prohibition of beekeeping in nature conservation areas, habitats, and buffer zones. A significant portion of agricultural land in Luxembourg is part of the Natura 2000 network, making it unrealistic to exclude all beekeeping from these areas. Beekeeping, like livestock farming, is an integral part of agriculture. Moreover, certain crops found in Natura 2000 areas, such as rapeseed and sunflowers, require large numbers of pollinators, including honeybees. Inclusive solutions that consider the well-being of all pollinators should be explored (Kleijn *et al.*, 2018). Many habitats particularly beneficial for wild pollinators, such as nutrient-poor meadows, tall herb communities, and calcareous grasslands, are often small and scattered across the landscape, making it impractical to define prohibited zones. However, as a precautionary measure, beehives should not be placed in the middle of landscapes that are critically important to wild pollinators.

It is generally inadvisable to establish beehives in Protected Areas of National Interest, nature reserves, or other areas identified as crucial for pollinators. Current research by Luxembourgish scientists will help identify these crucial areas in the future. Buffer zones around areas important for wild pollinators should be considered wherever feasible.

The next section outlines methods for assessing the suitability of a site for beekeeping while considering biodiversity, using map-based information. A practical example will explore various options for hive placements to minimise competition risks with wild pollinators.


The Junglinster region is rich in natural treasures. Red-marked locations are less suitable for establishing apiaries due to competition for food resources with wild pollinators. Blue-marked locations, on the other hand, maintain a buffer zone around protected areas and offer an environment well-suited for honeybees.

## The Environment around Beehives

### Choosing a Location

Honeybees interact with their environment far more than other animals. It is essential to ensure that their basic needs are met to avoid complications.

Water

While a nearby water source is important (especially in spring), overly damp locations such as valley floors prone to morning fog should be avoided.

Light

Bees shy away from moisture but require light. Many beekeeping guides emphasise the orientation of hives, often recommending a southeast-facing direction to allow colonies to start their day earlier. However, the direction of the hive entrance is less critical than ensuring sunlight reaches the hive's landing board. Excessive sunlight (rare in Luxembourg) should be avoided. Bees favour open areas that receive dappled light, often shaded by trees.

Wind

Hives should not be overly exposed to prevailing winds, especially in winter or early spring. Windbreaks such as hedges and shrubs placed a few meters from the hives can create a favourable microclimate.

Warmth

A practical trick for selecting a good location is to identify spots where snow melts quickly, indicating good sun exposure. Warmer locations allow bees to develop faster in spring, which is crucial given the relatively short season in the region. An additional one or two weeks of activity can significantly impact honey production. Warmth also helps combat certain pathogens, such as fungal infections.

Floral Availability

As noted in a previous chapter, a diverse and abundant supply of flowers must be available throughout the bees' active period. Within a 300–600 m radius around the hives, sufficient food sources should be present to give colonies a strong start. Hazelnut shrubs, but especially willow, cornelian cherry (rare), fruit trees (including blackthorn), and early-season flowers such as crocuses, daffodils, and snowdrops, play vital roles. Importantly, the overall bee density in a specific area is a critical factor to consider.



Accessibility

Beginners may overlook accessibility, but as the number of hives increases and honey supers fill, easy access becomes crucial. This is particularly important if the apiary is far from home and all necessary materials must be transported. Flat terrain is preferable. Climbing with a hive or heavy frames quickly becomes an insurmountable challenge. It's essential to have clear footing to avoid accidents when carrying hives or frames. Proximity to a storage space for equipment is a significant advantage. Ideally, the site should be reachable by vehicle; otherwise, transport tools like hive trolleys are necessary.

Legal Requirements

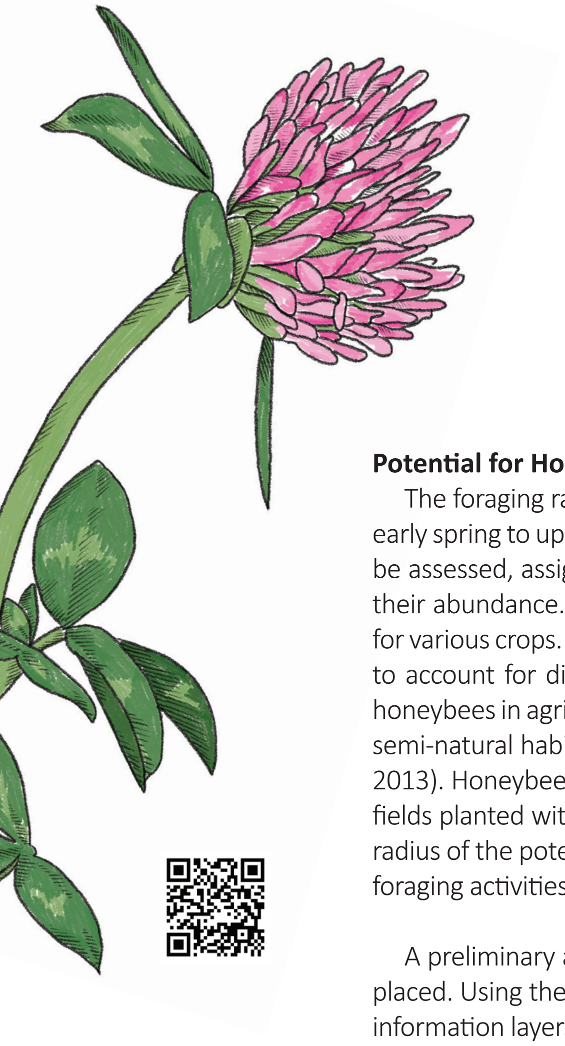
Chapter 1 provides comprehensive details on the legal requirements for placing hives or building apiaries.

Neighbours

Maintaining good relationships with neighbours benefits everyone. The presence of a hive is often perceived as a potential disturbance. Efforts should be made to alleviate such concerns. For instance, flight paths should not direct foraging bees to low altitudes over neighbouring properties. A distance of at least 5–10 m from hive entrances is recommended if surrounded by hedges or shrubs; otherwise, the distance should be at least double. This safety buffer is essential for property owners and their immediate neighbours, particularly near frequently used areas such as vegetable gardens or playgrounds. In residential areas, it is also advisable to select particularly docile bees and avoid actions that could provoke robbing behaviour or excessive aggression.

Arrangement of Beehives

In most apiaries, hives are arranged in a straight line. While this setup is convenient for beekeepers, it is not ideal for the bees. In such cases, there is often significant mixing of bees between colonies, with edge hives being populated by many bees from neighbouring hives. This phenomenon, known as drifting, poses a particular problem regarding the transmission of pathogens. In nature, colonies typically settle at least 300 meters away from their parent colony. Some beekeepers distribute their colonies across the available space, but this can become labour-intensive as the number of hives increases. Another solution is to arrange hives in a semicircle, with the hive entrances facing outward, making management easier. A more professional approach involves placing hives on four-pallet setups, orienting the entrances in different directions. These pallets can then be distributed across the site. However, such configurations can be challenging when working with bee houses. In such cases, arranging hives in an L- or U-shape can improve the situation.



**Potential for Honeybees and Biodiversity**

The foraging radius of bees varies with the seasons, ranging from approximately 600 meters in early spring to up to 6 kilometres on a fine summer day. Ideally, all parcels within this radius should be assessed, assigning each area a beekeeping potential based on the plant species present and their abundance. However, this task is labour-intensive and would need to be repeated annually for various crops. Additionally, such surveys would require multiple assessments during the season to account for different flowering periods. Research has shown that the foraging behaviour of honeybees in agricultural landscapes differs significantly from that of wild bees. Wild bees focus on semi-natural habitats, while honeybees predominantly target mass-flowering plants (Rollin *et al.*, 2013). Honeybees tend to concentrate on large flowering areas such as rapeseed, sunflowers, or fields planted with cover crops. Using a computer and internet tools, a zone within a 3-kilometer radius of the potential hive site can be analysed. This area is where colonies conduct most of their foraging activities.

A preliminary assessment can provide a rough overview of the area where the hives might be placed. Using the Geoportal (www.geoportail.lu) is recommended to visualise various geographic information layers. By utilizing a background map, such as the most recent aerial imagery, you can locate and zoom in on the area of interest to cover a radius of about 3 kilometres.

Several additional layers can be displayed on the screen and are useful for analysing the potential of a location for honeybees:

— Under the “Umwelt” menu, in “Landnutzung und Landbedeckung” you will find a categorization of land cover. This first classification provides an initial overview of the proportions of “macrohabitats” (forests, hedgerows, meadows, fields, etc.) within a 3 km radius.
— In the “Biotopkataster” category, more detailed classifications are available. These layers can help identify orchards or other protected open habitats, such as species-rich meadows, wetlands, and water bodies. Additionally, the “Waldbiotope” layer provides information on the diversity of forest types in the area.
— In the “Schutzgebiete” category, you will find the locations of areas dedicated to the conservation of natural heritage, such as Protected Areas of National Interest (PIN), Natura 2000 habitats, and Special Protection Areas for birds.
— Under the “Wasser” menu, in “Oberflächengewässer” you can view Luxembourg’s rivers, which are often associated with flower-rich wetlands and riparian strips.

On the portal, under the “Allgemein” menu, you will find the latest orthophoto under “Oberflächendarstellung” and then “Luft- und Satellitenbilder”.



Additionally, hedgerows, wooded areas, and the length of road, parcel, and forest edges must be considered. These features can be quantitatively assessed using the aerial photograph.

To gain a more precise understanding of the quality of a site, it is advisable to conduct at least one field visit during the warm season to assess the abundance of floral resources and other site characteristics. Here are some of the most important honey plants that can be found in different ecotopes: Maple, willows, fruit trees, hawthorn, linden, chestnut, brambles, privet, roses, umbellifers, thistles, clover, mustard, other cruciferous plants, cover crop, dandelion, ivy, and more.

To facilitate decision-making and enable comparisons between sites, a checklist is provided below. The most suitable site is the one where the highest number of green boxes can be ticked.

Parcels located within protected areas or listed in the Biotope Cadastre as associated with highly significant habitats are likely to host a greater diversity of wild pollinators.

**Checklist for Selecting a Beehive Location (+/- 3 km)**

- Access to a water source
- Adequate sunlight and protection from weather conditions
- Ease of access and site safety
- Proximity to diverse forests
- Richness in hedgerows
- Annual availability of blossoms (wild and cultivated plants)
- Presence of numerous gardens with diverse plant species
- Consideration of protected areas and wild pollinators
- Hive density at the site
- Compliance with legal requirements (mandatory)

Checklist for site selection. For each of the parameters to be taken into account, the reader is asked to indicate whether the site is favourable (green box), moderately favourable (orange box) or unfavourable (red box).



**Hive Density**

The density of beehives in a specific area can significantly impact the productivity of colonies. Excessive hive density promotes intraspecific competition and depletes floral resources, reducing both the productivity and vitality of the colonies. It also increases the risk of disease and parasite transmission, such as the Varroa mite. In nature, honeybee colonies are naturally dispersed. A recent study estimates the average density of wild *Apis mellifera* colonies in Europe at 0.26 colonies per km$^2$, whereas domesticated colonies are more than four times denser (Visick & Ratnieks, 2023). In Luxembourg, the number of beehives has been increasing, surpassing 8,000 in 2021, translating to more than three hives per square kilometre, though their actual distribution is likely very uneven. Contacting the local cantonal beekeeping association can help determine if the planned project is near other beekeepers and, if necessary, adjust the site. The hive density observed in Luxembourg is comparable to neighbouring countries, according to the infographic “Europe Apicole 2015”, published by the Belgian non-profit organisation CARI in 2016. It is currently impossible to determine an ideal hive density, as it heavily depends on the specific ecological context (Vereecken, Dufrêne & Aubry, 2015).

**Environmental Risks**

Pollinators are severely impacted by biodiversity loss and face numerous threats, as previously mentioned. Climate change disrupts the natural cycles and biological rhythms of pollinators. Extreme weather events, such as cold snaps or droughts, also pose significant challenges for honeybee colonies. Additionally, they are increasingly exposed to parasites, diseases, and predators. The immediate environment of bee colonies is under constant pressure. Examples include the rise in urbanization, the overzealous maintenance of green spaces, the simplification of landscapes, and the use of pesticides. When planning a beekeeping project, it is good practice to first analyse the environmental risks that the bees might face. Raising awareness and consulting with local stakeholders can help mitigate some of these risks. In particular, beekeepers must build trust with local farmers, who benefit from pollination services and whose activities have a significant impact on the bees’ surroundings and available resources.

Special attention should be given to sensitive areas such as nature reserves, particularly when they serve as refuges for specific pollinators and especially when bees or other protected insects are present. Some environments have a protected status and are listed among the official nature reserves. In these areas, conservation is the top priority, and efforts must be made to maintain the existing balance.

# 3 Commitment to Beehives and their Environment

## Creating a Pollinator-Friendly Environment

In most areas, except particularly privileged ones, enhancing floral diversity has become essential for pollinators to maintain a continuous food supply. Setting up beehives is often accompanied by actions like planting hedgerows, individual trees, flowerbeds, and creating wildflower meadows. These efforts aim to improve biodiversity and minimise competition with wild bees and other pollinators.

Beekeeping projects with an educational purpose should follow a didactic approach, for instance, showcasing regional nectar plants through flowerbeds. To support other pollinators, numerous examples of insect hotels can be found online. It is better to use small nesting aids to avoid competition and especially the pressure from parasitic species that target large nest groups. Creating microhabitats with sandy, woody, and rocky features is an excellent complement to flowerbeds.

Larger-scale initiatives can also be undertaken to make the surrounding environment more pollinator-friendly. Start by identifying areas beyond your own property where you might be able to act. Then, reach out to the landowner to raise awareness of the benefits to pollinators (see the “Dealing with Neighbours” section below). It is important to note that in our regions, most of the flowers visited by honeybees are found on trees and shrubs, which form the basis of nectar and pollen availability in the vicinity of hives. Another key source is flowers in large quantities on meadows (e.g., cuckooflowers, dandelions, clovers) or fields (e.g., rapeseed, cover crops). In contrast, individual or less abundant flowers are especially frequented by solitary bees and other pollinators. Under no circumstances should exotic honey plants with invasive potential, such as black locust (*Robinia pseudoacacia*), Japanese knotweed (*Fallopia japonica*), or Himalayan balsam (*Impatiens glandulifera*), be planted. These species can harm native flora and fauna.

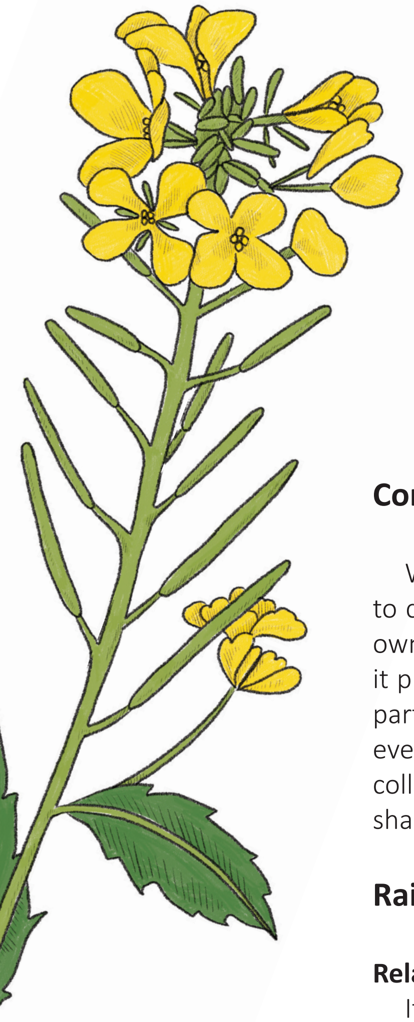
The *BeeFirst* project, led by the Luxembourg Institute of Science and Technology (LIST) and funded by the Ministry of Agriculture, Food and Viticulture, highlights which plant species in Luxembourg are most commonly used by honeybees for pollen collection.



The ten most pollen-rich plants:

1. *Brassica Napus* (Rapeseed)
2. *Rubus sp.* (Blackberry)
3. *Malus/Pyrus/Crataegus*-Typ (Apple, Pear, and Hawthorn Trees)
4. *Rosa* sp. (Roses)
5. *Asteraceae* T (Dandelion, Hawkweed, Chicory, etc.))
6. *Salix* sp. (Willows)
7. *Prunus* sp. (Sloe and Cherry)
8. *Trifolium repens* (White Clover)
9. *Asteraceae A* (Oxeye Daisy, Chamomile, Yarrow, Tansy, etc.)
10. *Trifolium pratense* (Red Clover)

The Agricultural Technical Services Administration (ASTA) and its horticultural department provide lists of native honey plants that can be ordered to enhance the environment around beehives (order form available on the website apis.lu). Additionally, the initiative “Wëllplanzesom Lëtzebuerg”, organised by the nature conservation syndicate SICONA, the Biological Stations, and the National Museum of Natural History, has established a production chain for the seeds of native plants.



## Community Involvement

Whether beekeeping is your passion, hobby, or profession, it also offers the opportunity to connect with others and share meaningful moments. Every canton in the country has its own beekeeping association. Joining one of these associations is highly recommended, as it provides access to valuable advice when setting up your hives, as well as opportunities to participate in meetings, stay informed about news, access equipment, and attend various events throughout the year. Membership also allows for the creation and implementation of collaborative projects, enabling members to benefit from collective expertise, save time, and share resources effectively.

## Raising Awareness among the Public and Local Authorities

### Relationships with Neighbours

It is crucial to consider the perspective of your future neighbours when setting up a beehive. Bees can be perceived as flying intruders that limit the use of private property—not to mention the potential risk of being stung. It is essential to reassure these individuals and educate them about bees and their behaviour. Every effort should be made to foster a harmonious coexistence and minimise any potential risks. Providing neighbours with accurate information about the actual impact of bees on their surroundings—both positive and negative—is extremely helpful. Additionally, it is important to highlight the steps taken to mitigate risks and minimise inconvenience. Neighbours should also have access to contact information for someone who can address issues or provide explanations. This becomes even more important when your hives are not located near your residence, as neighbours can serve as your eyes and ears on-site. In the event of a problem, they can notify you promptly.

When designing a pollinator-friendly environment, fostering good relationships with neighbours can be especially beneficial. It presents an opportunity to raise awareness about the importance of pollinators and encourage good practices on their properties.

### Relations with the Municipality

Apart from the neighbours, the local authorities can play a significant role in a beekeeping project, especially in urban areas, as they are responsible for managing green spaces. Often, these spaces are intensively maintained, with large areas of lawn that are sterile for biodiversity and therefore unsuitable for bees. Beekeepers can advocate with local authorities for better consideration of pollinators and more extensive management practices. Practices like delayed mowing are increasingly accepted and offer many benefits for wildlife and plant diversity. Similarly, creating wildflower meadows can greatly enhance biodiversity. A group of beekeepers or environmentally conscious citizens (e.g., neighbours of the apiary) is more likely to gain attention and support. Biological Stations, which already advise municipalities and work to integrate biodiversity into Luxembourg's landscapes, can also be valuable allies when engaging with local administrations. As more citizens become environmentally conscious and interested in beekeeping, forward-thinking municipalities are likely to embrace such initiatives. They may even actively support your beekeeping project by providing land or facilities, helping organise events, or assisting in raising awareness about your beekeeping passion.




There are numerous initiatives aimed at raising awareness about honeybees, wild pollinators, and their needs (e.g., environments with high floral and structural diversity).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