Becoming Neighbors With Butterflies In Milan

A Service Design Framework Exploration for The More-than-human City of The Future

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Academic year | 2022/2023
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Abstract (English)

We live in a world that bears the scars of human activities, where human actions have disrupted ecosystems and pushed biodiversity to the edge. The anthropocentric worldview of the Western world has isolated other life forms, neglecting the fact that these life forms are integral parts of the dynamic biosphere and essential components of our planet.

These multi-layered crises offer a clearer perspective on the relationships between human and non-human factors. Faced with conflicts between human processes and non-human ecosystems, we must establish new relationships and rekindle hope in our damaged ecosystems. The development of urbanization and population growth means the constant expansion of industry and cities. This also implies that humanity stands at the forefront of environmental change, with human behavior significantly impacting all lifeforms, human and non-human alike. Humans and non-humans inevitably need to coexist in urban environments. In this context, it is essential to integrate the urban environment and its characteristics to envision innovative practices and solutions more-than-human world.

While anthropologists and philosophers seek new paradigms, designers must explore these theoretical ideas and translate them into action. When considering non-human actors as part of an interconnected, diverse world, designers should adopt diverse perspectives to address complex issues and promote a shift in thinking. As the design perspective evolves, service design plays a crucial role in activating, sustaining, and guiding transformative practices and processes. Participatory design methods have gradually incorporated non-human entities into design practices. Service design-driven social innovation addresses sustainability transition issues, including interspecies justice and non-human perspectives. It can provide bottom-up action guidance for urban residents, especially in community ecosystems inhabited by various participants, including humans and other non-humans.

The project currently underway in this thesis pays special attention to overlooked non-human species due to one-sided understanding and stereotypes. Marginalized pollinators, such as butterflies, require broader social participation and attention to ensure their survival. In contrast to heavily propagated and protected bees, the diversity of pollinators can effectively enhance pollination and fruiting rates of plants. In the context of these interspecies relationships, the complementary roles of pollinators across different temporal and spatial dimensions are often overlooked. Therefore, this thesis aims to start from the perspective of butterflies and, through service design, incorporate more suitable habitats for their survival in the city.

Abstract (Italiano)

Viviamo in un mondo segnato dalle cicatrici delle attività umane, dove le azioni dell'uomo hanno interrotto gli ecosistemi e spinto la biodiversità sull'orlo del baratro. La visione antropocentrica del mondo occidentale ha isolato le altre forme di vita, trascurando il fatto che queste forme di vita sono parti integrali della biosfera dinamica e componenti essenziali del nostro pianeta.

Lo sviluppo dell'urbanizzazione e la crescita della popolazione comportano l'espansione costante dell'industria e delle città. Ciò implica anche che l'umanità si trova in prima linea nei cambiamenti ambientali, con il comportamento umano che ha un impatto significativo su tutte le forme di vita, umane e non umane. Queste crisi stratificate offrono una prospettiva più chiara sulle relazioni tra fattori umani e non umani. Di fronte ai conflitti tra i processi umani e gli ecosistemi non umani, dobbiamo stabilire nuove relazioni e ravvivare la speranza di cooperazione fra le diverse specie.In questo contesto, è essenziale integrare l'ambiente urbano e le sue caratteristiche per immaginare pratiche e soluzioni innovative per un mondo più ampio che comprenda non solo gli esseri umani.

Mentre gli antropologi e i filosofi cercano nuovi paradigmi, i designer devono esplorare queste idee teoriche e tradurle in azioni. Nel considerare gli attori non umani come parte di un mondo interconnesso e diversificato, i designer dovrebbero adottare prospettive diverse per affrontare questioni complesse e promuovere un cambiamento di pensiero. Con l'evoluzione della prospettiva progettuale, il design dei servizi svolge un ruolo cruciale nell'attivare, sostenere e guidare pratiche e processi trasformativi. I metodi di progettazione partecipativa hanno gradualmente incorporato entità non umane nelle pratiche di progettazione. L'innovazione sociale basata sul design del servizio affronta questioni di transizione verso la sostenibilità, compresa la giustizia tra le specie e le prospettive non umane. Può fornire orientamenti per azioni dal basso verso l'alto per i residenti urbani, specialmente negli ecosistemi comunitari abitati da vari partecipanti, tra cui esseri umani e altri non umani.

Il progetto attualmente in corso in questo articolo presta particolare attenzione alle specie non umane trascurate a causa di una comprensione unilaterale e stereotipata. Gli impollinatori emarginati, come le farfalle, richiedono una partecipazione e attenzione sociali più ampie per garantire la loro sopravvivenza. In contrasto con le api ampiamente propagate e protette, la diversità degli impollinatori può migliorare efficacemente i tassi di impollinazione e fruttificazione delle piante. Nel contesto di queste relazioni interspecifiche, spesso vengono trascurati i ruoli complementari degli impollinatori tra diverse dimensioni temporali e spaziali. Pertanto, questo articolo mira a partire dalla prospettiva delle farfalle e, attraverso il design del servizio, a incorporare habitat più adatti per la loro sopravvivenza in città.

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INTRODUCTION

Aim

This thesis aims to contribute to the habitat of pollinators, specifically butterflies, in urban areas. On one hand, butterflies face severe threats to their survival due to human activities. The diversity and abundance of butterflies have non-negligible impacts on the ecosystems associated with them. On the other hand, this thesis seeks to engage residents in bottom-up conservation efforts in response to policies and initiatives. To achieve this goal, the study is conducted in Milan, a vibrant and internationally diverse metropolis with a dynamic and supportive cultural environment. Furthermore, the Milan government is actively committed to transforming the city from a "grey city" to a "green city." This thesis aims to provide high-quality and continuous habitats for urban butterflies through the bottom-up action of residents, fostering social innovation for more-than-human and sustainable urban development.

Thesis structure

To achieve the established objectives, it is necessary to conduct a preliminary analysis of pollinators and butterflies.

The first chapter of this thesis provides a detailed exposition of the functions and values of pollinators, along with their significance within ecosystems. Through an analysis of pollinators and their ecosystems, it elucidates the importance of butterflies in interspecies relationships. Moreover, an analysis of butterfly species data underscores the imperative nature of addressing the survival needs of butterflies.

In the second chapter, this thesis discusses the necessity and feasibility of service design-driven social innovation. It also highlights the transformation of the designer's role in this process, with an aim to design for a more-than-human future.

The third chapter provides a background to the on-site research conducted in Milan. It offers a detailed account from three perspectives: Italy's macro-level data, Milan's green-related data, and the attitudes and culture of its residents. This background is essential for the execution of the on-site research in Milan.

To realize the research questions posed in this thesis and to facilitate the project effectively, the fourth chapter explores the framework, methodology, and methods employed in the project process. It delves into the use of design tools in various stages of the design.

The fifth chapter provides a comprehensive report on the research process, content, and outcomes of this thesis project. Based on the information and data collected, a thorough analysis is performed, accompanied by the visual representation of the needs of different stakeholders.

In the sixth chapter, a detailed account of the design process and content of the project is provided. The final service design concept is derived through discussions and selections involving participants and designers. Towards the end of this chapter, experts are invited to provide feedback and engage in iterations of the final concept.

The seventh chapter delineates the contents and outputs of the final concept. It elucidates the service design process, system, and related touchpoint designs, along with how this concept aligns with the project vision.

Lastly, the eighth chapter of this thesis summarizes and reflects on the project's shortcomings and offers prospects for future developments.

CHAPTER 1

PRELIMINARY RESEARCH

1.1 Pollinator Basics

The preservation of biodiversity and the myriad functions and services offered by ecosystems play a pivotal role in fostering sustainable development. However, it is disheartening to observe a worldwide deterioration of biodiversity, with both direct and indirect drivers of this decline accelerating over the past five decades.

Pollinators stand as a critical component of the global biodiversity resource, offering essential ecological services while relying on the food and habitat resources within ecosystems for their growth and breeding. Simultaneously, the complementary relationship between different species of pollinators contribute significantly to plant diversity.

Moreover, biodiversity holds diverse connections to human health. The reduction in biodiversity serves as a significant driver of disease risk and ill health. Consequently, the declining populations of pollinators and the decrease in overall biodiversity present not just as challenges for a specific species, but as genuine threats to entire ecosystems. Over the long term, the decline of pollinators will have profound and far-reaching impacts on a wide range of aspects, encompassing plant life, crop yields, and human health.

This chapter will meticulously examine the intricate relationship between pollinators and ecosystems, highlighting the plight of Lepidoptera (butterflies), and carefully evaluating the existing policies and measures along with their limitations.

1.1.1 What are pollinators?

Plant-pollinator interactions epitomize one of the most crucial ecological processes on our green planet, particularly considering that a majority of angiosperms[1] rely on animals for efficient pollen transportation. Pollinators, in essence, are animals that facilitate the transfer of pollen from a flower's male anther to the female stigma, culminating in fertilization and fruit set (Shuang-Quan, 2018). Concurrently, plants produce nectar, pollen, and other nutrients, serving as rewards for the pollinators. This intricate interaction between pollinators and plants significantly contributes to plant pollination, resulting in heightened crop fecundity, yield, and the development of native plant diversity.

According to Ollerton (2017), an estimated 350,000 pollinator species exist worldwide, primarily comprising insects, along with more than 1,000 species of birds, 200 species of bats, and over 100 species of flightless mammals. Notably, Lepidoptera (butterflies and moths) constitute 40% of all pollinator species, accounting for over 140,000 species, followed by Hymenoptera (beetles) at 22%, totaling approximately 77,000 species, and Hymenoptera (bees, etc.) at 20%, encompassing around 70,000 species.

Insects stand as the principal pollinators for a majority of plants, categorized into three primary groups: honeybees, other bees, and non-bees. The category of non-bee pollinators encompasses flies, beetles, moths, butterflies, wasps, ants, and various others. While the majority of pollinators are free-living or wild, a few taxa of honeybees are kept and managed in captivity (Rader et al., 2015). Together, they synergize to provide critical ecosystm services to plants and crops.

1. Angiosperms are plants that produce flowers and bear their seeds in fruits. They are the largest and most diverse group within the Plantae, with about 300,000 species. Angiosperms represent approximately 80 percent of all known living green plants (The Editors of Encyclopaedia Britannica, n.d., 2023). Angiosperms have to undergo a process called pollination before they can reproduce. Angiosperms have male sex organs called stamens. On the end of the stamen is the anther. This is where pollen is made. The pollen has to be taken to the pistil or the female part of the flower. The pollen is left on the stigma at the end of the pistil. The stigma carries the pollen down a tube called the style to the ovary (*Angiosperms - NatureWorks*, n.d., 2023).

1.1.2 The value of pollinators

The influence of pollinators on plants

Plant-pollinator interactions hold immense ecological significance. Without pollinators, numerous plants would struggle to set seed and reproduce, while the absence of plants offering pollen, nectar, and other incentives would lead to a decline in various animal species populations, consequently impacting interconnected species (Kearns et al., 1998). Furthermore, biological pollination is a vital factor in fostering the diversity of both plant and animal species (Dodd et al., 1999; Ollerton, 1999).

However, in conditions of limited monitoring, the European Pollinator Monitoring Programme revealed a notable reduction in pollinators and their associated plants (Nabhan & Buchmann, 1997; Kearns et al., 1998; NRC, 2007). This finding suggests an adverse effect on the quantity and diversity of pollinators and plants in the present and future.

The impact of pollinators on human beings

The reliance of humanity on crops pollinated by animals underscores the essential ecosystem services rendered by pollinators: 75% of the world's major food crops exhibit enhanced fruiting or fruit set through animal pollination (Klein et al., 2006b). The economic worth of this contribution amounts to EUR 153 billion annually, equivalent to 9.5% of the global agricultural production value (Gallai et al., 2009) (see Figure 1).

Crops dependent on pollinators supply vital resources for human health, including food, fiber, fuel, and crucial micronutrients (Chaplin-Kramer et al., 2014). The yield and quality of these crops are positively influenced by varying degrees of pollinator visits to the flora. Insect pollination provides crops with essential micronutrients such as vitamins and folic acid, contributing to dietary diversity (Nicole, 2015). Therefore, pollinating insects play a crucial role in plant and crop nutrition as mediators of plant pollination, indirectly affecting human micronutrient intake.

Despite the increasing global dependence on pollinators in agriculture, the growth and stability of pollinator-dependent crop yields are lower compared to non-pollinator-dependent crops. Given the diverse food preferences, foraging behavior, and activity patterns of pollinator species, a variety of pollinators can offer plants and crops a greater likelihood of ensuring stable and adequate pollination (Potts, Imperatriz-Fonseca, et al., 2016).

Pollinators are essential for both nature and mankind. In the EU, nearly four-fifths of temperate wildflowers and crops depend to varying extents on insect pollination. An EU-financed project estimated the yearly contribution of insect pollinators to European agriculture at around €15 billion. Pollinators enhance the quantity and quality of food, ultimately ensuring our food supply.

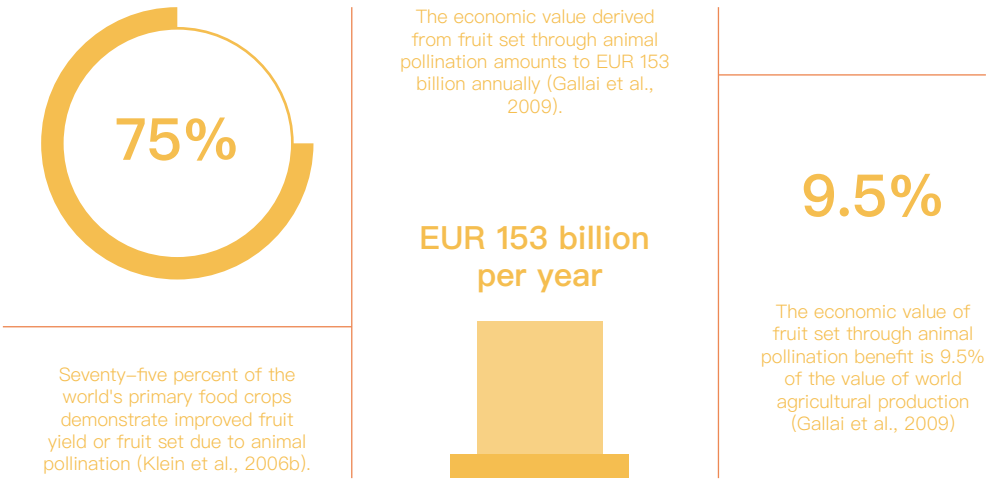


Figure 1. Pollinator impacts on crops.

1.1.3 The threat to pollinators

In recent decades, the European Union (EU) has witnessed a decline in both the number and diversity of wild pollinators. An assessment by the International Union for Conservation of Nature (IUCN) Red List reveals that 16.5% of vertebrate pollinators face a global threat of extinction, a number that increases to 30% for island species. Regional and national assessments further highlight the high vulnerability of specific bee and butterfly populations. In Europe, 9% of bee and butterfly species are deemed threatened, with 37% of bees and 31% of butterflies (excluding species with limited data, including 57% of bees) experiencing a decline (Van Swaay et al., 2010) (see Figure 2).

Figure 2. Decline in pollinator abundance and diversity.

The Global Pollinator Status Assessment in 2016 (Potts et al., 2016) underscored the decline of wild pollinators, largely attributed to the escalating threat of human activities, such as climate change.

A 2019 Global Insect Assessment (Sánchez-Bayo & Wyckhuys, 2019) corroborated an overarching decline in insect populations, with more than 40% of insect species facing a perilous threat of extinction. Among the severely affected insect species are butterflies, moths, bees, and beetles. The reasons behind this decline are multifaceted, encompassing exposure to pathogens, parasites, and pesticides; habitat fragmentation and loss; climate change; market forces; intra- and interspecific competition with both native and invasive species; and genetic alterations. Reductions in pollinator diversity or abundance can significantly impact the quantity and source of pollen deposited on the reproductive parts of flowers or stigmas (Aizen & Harder, 2007).

In 2020, the World Economic Forum (Global Risk Report 2020 | World Economic Forum, 2023) designated biodiversity loss as one of the top five long-term global risks. This loss has resulted in a decline in pollinator populations, prompting a shift in crop cultivation from nutrient-rich food crops (fruits, vegetables, and nuts- all of which depend on pollinators) to energy-intensive, nutrient-poor staple crops (e.g., rice, maize, wheat, soybeans, and potatoes). The main culprits behind this decline are habitat loss and the extensive use of pesticides and fertilizers (*Special Report: Pollinators*, n.d.).

1.1.4 Pollinator interspecific relationships

Pollinators from various species interact with each other, significantly affecting pollinator diversity, plant fertilization, and fruit set. Due to differences in species and habits, different species of pollinators can enhance the chances of pollination and pollination quality in plants by visiting different parts of the plant, at different times of the year, in various weather conditions, and over different ranges of plants to transfer pollen effectively. Although honeybees (both managed and wild bees) are considered the primary contributors to pollination, the contributions of other species are equally essential. This section elaborates on the complementary relationships between different pollinator species, with a particular emphasis on the negative impacts of the decreasing numbers and diversity of non-bee pollinators, mainly butterflies, on interspecific relationships and ecosystems.

Research has shown that different combinations of pollinating insects can increase pollination services due to complementary resource use resulting from morphological and behavioral differences between pollinator taxa (Albrecht et al., 2012) (see Figure 3). For example, pollinators may visit different parts of a flower or inflorescence and different flowers on a plant (high vs. low), thereby improving the quality or quantity of the overall pollination service (Winfree & Kremen, 2008). In particular, non-bee species often have a broader temporal range of activity than bees, and they can provide pollination services at different times and in weather conditions of the day when bees cannot forage (Rader et al., 2015). In addition, under some conditions, non-bee species may be more effective at delivering pollen to some crops (Rader et al., 2009b) and carry pollen over longer distances than some bees (Rader et al., 2011). Such long-distance pollen transfer may hold genetic importance for wild plants (Herrera, 1987).

A synthesis of 39 field studies from five continents directly measured crop pollination services provided by non-bees, honeybees, and other bees to compare the relative contributions of these taxa. Non-bees accounted for 25-50% of total pollination. Although non-bees are less efficient pollinators than honeybees, they pollinate more often; therefore, these two factors compensate for each other, resulting in non-bees providing pollination services similar to honeybees (Rader et al., 2015). Research has shown that non-bee insect pollinators play an essential role in global crop production and that non-bee insects provide unique benefits that bees cannot.

Non-bee insects are not as dependent on the natural or semi-natural habitats in the surrounding landscape as bees are. Non-bees respond differently to landscape structure than bees, which may make their crop pollination services more robust to changes in land use. Non-bee insects provide a valuable service and a potential safeguard against declining bee abundance (Rader et al., 2015).

It is evident that non-bee pollinators are complementary to honey bee pollinators and that the contribution of non-bee pollinators is equally non-negligible (*Special Report: Pollinators*, n.d.-c).

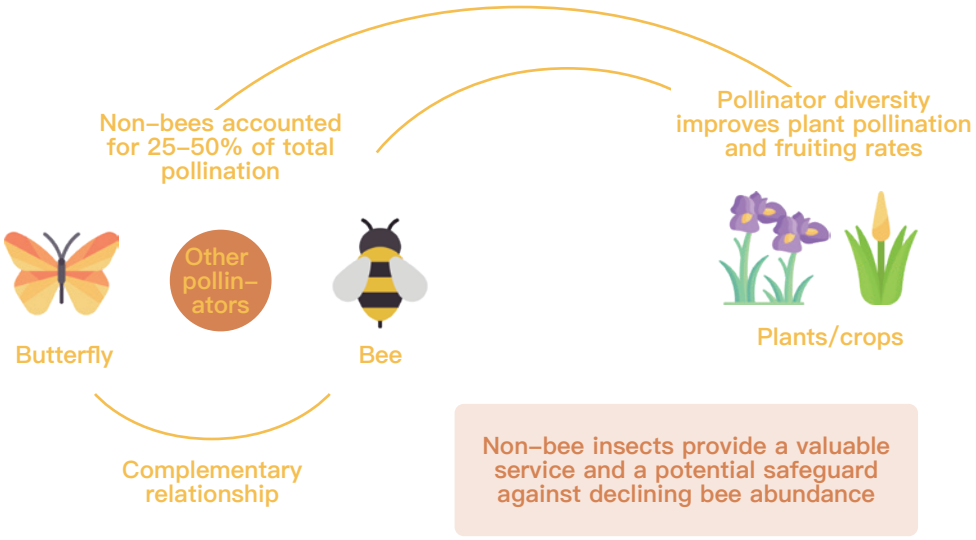


Figure 3. Interspecific relationships between pollinators and plants.

As illustrated in Figure 4, insect pollinators other than bees, including flies, beetles, moths, and butterflies, play an equally crucial role in the production of certain crops. Unfortunately, the contribution of non-bee insects (e.g., flies, wasps, beetles, and butterflies) to crop pollination has often been overlooked (Rader et al., 2015).

Furthermore, local-scale studies have demonstrated that fields with diverse and abundant pollinator communities yield higher crop yields compared to those with less diverse pollinator communities. Wild pollinators contribute significantly more to global crop production for certain crops than bees. Managed bees often fall short in compensating for the loss of wild pollinators, demonstrating lesser effectiveness in pollinating many crops and struggling to meet pollination needs in many countries due to inadequate numbers. Studies in open-field systems have emphasized the necessity for a variety of pollination methods, incorporating both wild and managed species, especially in unpredictable weather and environmental conditions (Potts, Imperatriz-Fonseca, et al., 2016).

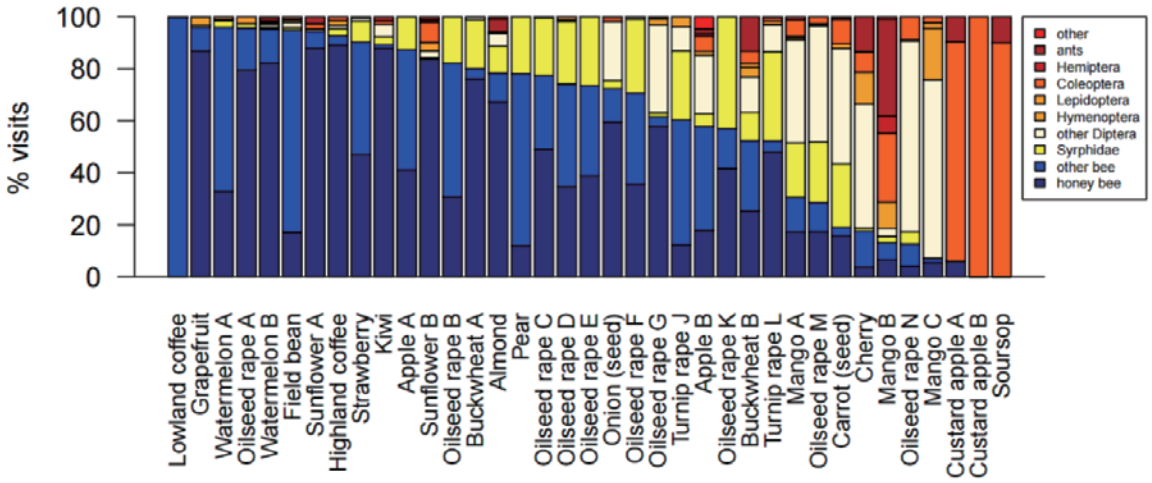


Figure 4. Excerpted from Non–Bee Insects Are Important Contributors to lobal Crop Pollination.

1.1.5 The Overlooked Butterfly

As mentioned previously, non-bee pollinators also play a crucial role in maintaining stable species diversity and abundance. However, the numbers and diversity of wild insect pollinators in Europe, including bees, butterflies, beetles, and moths, have significantly declined in recent decades (Brussels, 2021). According to the European Red List, approximately one-third of bee and butterfly species are experiencing a decline in numbers, while about one-tenth of the species face the threat of extinction (*European Redlist - Environment - European Commission*, n.d.).

Although research on various pollinator species has made inroads into ecological studies and related fields, broader societal, cultural, and capitalist frameworks have yet to adequately encompass these marginalized non-human practices. The mainstream systems tend to disregard a spectrum of pollinators, including solitary bees and butterflies. This particular lacuna is vividly depicted in the data presented in Figure 5. Out of 1884 bee species, 659 did not receive adequate attention, while around 421 species of butterflies are more or less neglected or in a state of crisis. Despite their comparable ecological significance and vital roles within the ecosystem, actions directed at conserving bees significantly surpass those aimed at similarly marginalized pollinators like butterflies.

Therefore, preserving non-bee pollinators, particularly butterfly species, demands immediate attention. The diversity and richness of butterflies face significant threats arising from their inherent evolutionary fragility and adverse effects resulting from changes in other species within their associated ecosystems. In the following section, the thesis delves into a thorough and specific study focused on butterflies in the EU region.

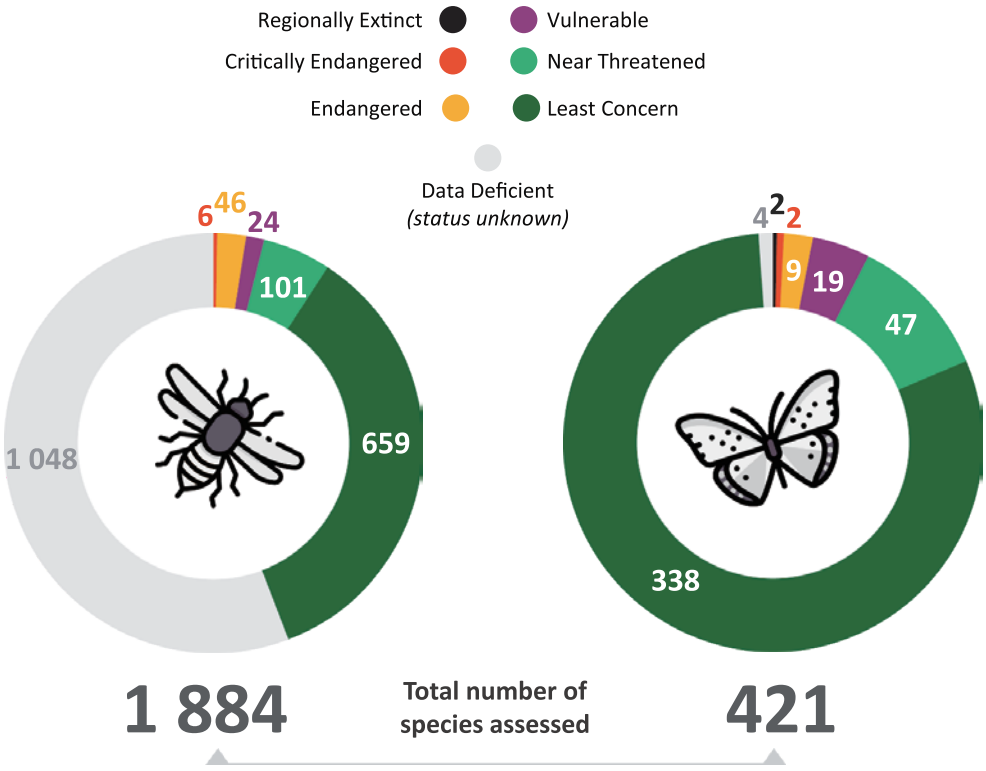


Figure 5. Excerpted from Source: ECA based on the European red lists for bees and butterflies.

1.2 The Plight of The European Butterfly

1.2.1 Butterfly Basics

Butterflies, belonging to the general evolutionary branch of Lepidoptera called Papilionoidea (scientific name: Papilionoidea, also known as the General Family of True Butterflies), are a class of insects that predominantly fly during the daytime (Heikkilä et al., 2015).

The life cycle of the vast majority of butterflies comprises four stages: egg, larva (caterpillar), pupa (chrysalis), and imago (adult) (see Figure 6). A few species, such as those in the genera Colias, Erebia, Euchloe, and Parnassius, reproduce semi-parthenogenetically, where a partially developed larva emerges from the abdomen of the female after her death. In some tropical regions, certain butterfly species may have multiple generations in a year, while others have a single generation. Conversely, in colder locations, some species may take several years to complete their entire life cycle (*Wikipedia contributors*, 2023).

Egg

The chorion, a hard-ridged outer layer of the shell, protects butterfly eggs. The chorion is coated with a thin layer of wax, preventing the egg from drying out before the larva fully develops. Each egg has tiny funnel-shaped openings at one end, known as micropyles, which allow sperm to enter and fertilize the egg. Butterfly eggs vary significantly in size and shape between species but are usually upright and finely sculptured. Some species lay eggs individually, while others lay them in batches. Many females can produce between one hundred and two hundred eggs (Capinera, 2004).

Butterfly eggs are almost always laid on plants. Each butterfly species has its range of host plants. While some butterfly species are restricted to just one plant, others use a range of plant species, often including members of a common family (Capinera, 2004b). In certain species, like the great spangled fritillary, eggs are deposited close to but not directly on the food plant. This is likely to occur when the egg overwinters before hatching and when the host plant sheds its leaves in winter, as seen in violets (Shepard & Guppy, 2011).

The egg stage lasts a few weeks for most butterflies, but eggs laid close to winter, especially in temperate regions, undergo a diapause (resting) stage, with hatching potentially occurring only in spring (British Butterflies- a Photographic Guide by Steven Cheshire, n.d.). Some butterflies in temperate regions, such as the Camberwell beauty, lay their eggs in spring, and hatching occurs in summer (*Camberwell Beauty, Nymphalis Antiopa - Butterflies - NatureGate*, n.d.).

Caterpillar (Larva)

Caterpillars undergo a series of developmental stages known as instars as they mature. Near the end of each stage, the larva undergoes apolysis, a process mediated by the release of a series of neurohormones. During this phase, the strong outer layer known as the cuticle, composed of a mixture of chitin and specialized proteins, is shed from the softer epidermis underneath. The epidermis then initiates the formation of a new cuticle. At the end of each instar, the larva molts—the old cuticle splits, and the new cuticle expands, rapidly hardening and developing pigment. The development of butterfly wing patterns commences during the last larval instar (Klowden, 2013).

Certain larvae, especially those belonging to Lycaenidae, form mutualistic associations with ants. They communicate with ants using vibrations transmitted through the substrate as well as chemical signals. The ants provide a certain degree of protection to these larvae and gather honeydew secretions (DeVries, 1988). Large blue (Phengaris arion) caterpillars deceive Myrmica ants into carrying them back to the ant colony, where they feed on ant eggs and larvae, establishing a parasitic relationship (Thomas et al., 2010).

Chrysalis (Pupa)

When the larva reaches full growth, hormones such as prothoracicotropic hormone (PTTH) are produced. At this stage, the larva ceases feeding and begins to 'wander,' searching for a suitable site for pupation, often on the underside of a leaf or in a concealed location. It then spins a button of silk to fasten its body to the surface and undergoes a final molt. While some caterpillars spin a cocoon to protect the pupa, the majority of species do not. The exposed pupa, commonly known as a chrysalis, typically hangs head-down from the cremaster, a spiny pad at the posterior end. However, in certain species, a silken girdle may be spun to keep the pupa in a head-up position (Capinera, 2008). During this stage, most of the larva's tissues and cells break down as the constituent materials are reassembled to form the imago. The transformation of the insect's structure is visible from the exterior, with the wings folded flat on the ventral surface and the two halves of the proboscis, along with the antennae and legs, between them (Lepidopteran | Definition, Characteristics, Life Cycle, & Classification, 1999).

The chrysalis undergoes metamorphosis to become a butterfly, transitioning from the tiny wings visible outside the pupa to large structures suitable for flight. The wings in the pupal stage undergo rapid mitosis and absorb many nutrients. If one wing is surgically removed early in this stage, the other three wings will grow larger. Inside the pupa, the wing forms a structure that compresses from top to bottom and pleats from proximal to distal ends as it grows, enabling it to be rapidly unfolded to its full adult size (Brunetti et al., 2001).

Imago (Adult)

The reproductive stage of the insect is the winged adult or imago. The surface of both butterflies and moths is covered by scales, each originating from a single epidermal cell. The head is small and dominated by two large compound eyes. These eyes can distinguish flower shapes or motion but cannot view distant objects. Color perception is particularly acute, especially in some species within the blue/violet range. The antennae have numerous segments and clubbed tips (unlike moths with tapering or feathery antennae). Sensory receptors are concentrated at the tips and can detect odors. Taste receptors are located on the palps and the feet. The mouthparts are adapted for sucking, with the mandibles usually reduced in size or absent. The first maxillae elongate into a tubular proboscis that is curled up at rest and expanded when needed for feeding. The first and second maxillae bear palps that serve as sensory organs. Some species have a reduced proboscis or maxillary palps and do not feed as adults (Lepidopteran | Definition, Characteristics, Life Cycle, & Classification, 1999b).

In many Heliconius butterflies, the proboscis is also used for feeding on pollen (Harpel et al., 2015). In these species, only 20% of the amino acids used in reproduction come from larval feeding, allowing them to develop more rapidly as caterpillars and resulting in a longer lifespan of several months as adults. In both sexes, the genitalia are adorned with various spines, teeth, scales, and bristles, serving to prevent the butterfly from mating with an insect of another species (Lepidopteran | Definition, Characteristics, Life Cycle, & Classification, 1999b). After emerging from the pupal stage, a butterfly cannot fly until its wings are unfolded. A newly emerged butterfly needs to spend some time inflating its wings with hemolymph and allowing them to dry, during which time it is highly vulnerable to predators (Woodbury, 1994).

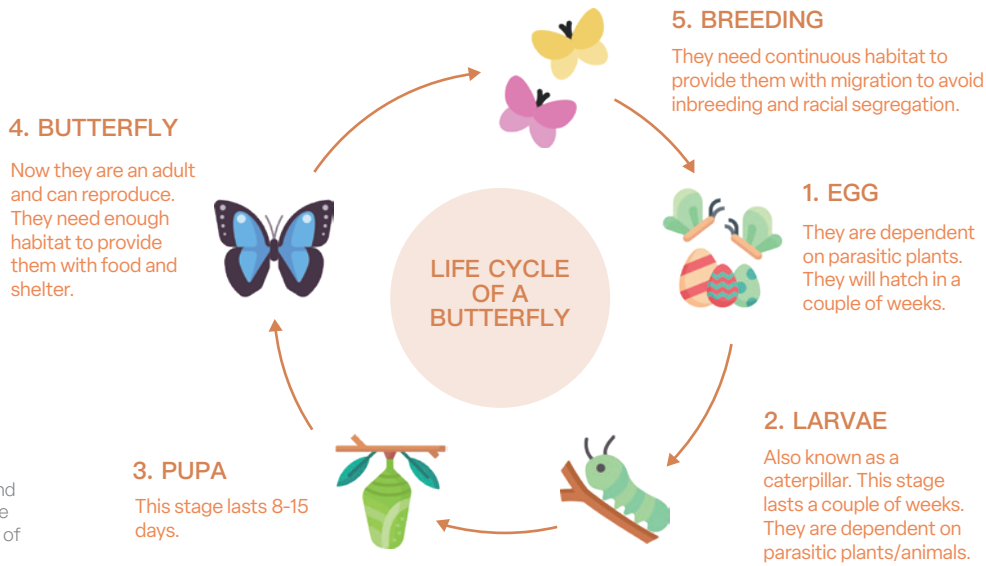


Figure 6. Graphics and Content Edited by the Author——Life cycle of a butterfly.

1.2.2 Analysis of the main factors

An assessment of the status of all 482 European butterfly species was conducted in 2010 using distribution monitoring data, published studies, and expert opinions (van Swaay et al., 2011). The findings revealed that one species is regionally extinct in Europe, and among the 435 assessed species, 37 (9%) were classified as threatened (3 critically endangered, 12 endangered, and 22 vulnerable). Additionally, 44 species (10%) are experiencing a rapid decline and are categorized as Near Threatened. However, due to the lack of accurate data for much of Eastern Europe, this Red List assessment may underestimate the overall threat to European butterflies (van Swaay et al., 2011).

In the absence of data for other insect species, monitoring data available for butterflies can provide insights into the status of many other insects in the EU. EU Member States collect data for 17 grassland butterfly species under the European butterfly monitoring scheme. The European Environment Agency (EEA) utilizes this data to calculate the European grassland butterfly index. The index shows that since 1990, the population of monitored butterflies has declined by 39%, indicating a considerable loss. However, the situation has seemingly stabilized since 2013 (see Figure 7) (*European Redlist - Environment - European Commission*, n.d.).

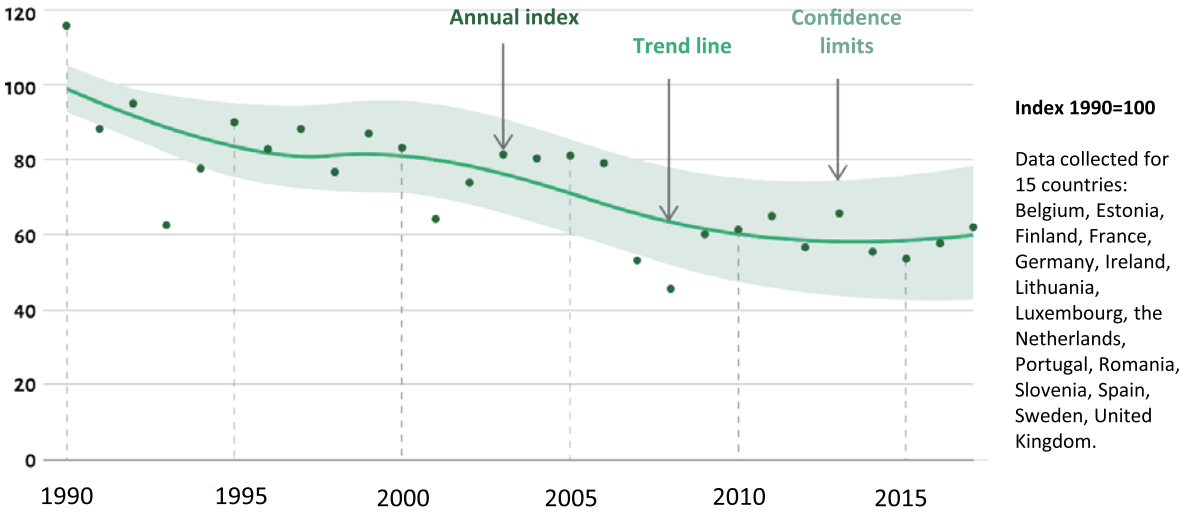


Figure 7. Excerpted from Source: ECA based on EEA data.

Factors contributing to the decline in butterfly populations fall into three main categories: habitat loss/degradation, chemical pollution, and climate change (the latter having both positive and negative impacts depending on the species and region).

Habitat fragmentation

The foremost reason behind the decline in butterfly populations is habitat loss and degradation. Since the 1950s, the UK has seen a decline of 97% in flowering grasslands, 80% in calcareous grasslands, 50% in ancient native woodlands, and 40% in lowland heathland (Asher, 2001). Many other European countries have also suffered varying degrees of loss.

In the first half of the 20th century, large-scale intensive farming practices replaced traditional systems like extensive grazing or grass cutting in much of Western Europe. This complete overhaul was accompanied by significant changes in habitat management, resulting in a substantial reduction of the herb and nectar resources on which many butterflies depend (Wallisdevries et al., 2012). For instance, within woodlands, several butterflies breed in the canopy (feeding on deciduous trees), while others thrive in open spaces within the woodland, like rides, glades, and clearings. These open space species are also experiencing a decline due to the lack of traditional management or the replanting of non-native coniferous trees (Warren et al., 2021).

Furthermore, the habitat for many species is fragmented by impervious surfaces (roads, buildings, etc.) or other human-influenced areas (farmland, recreational areas, etc.), resulting in landscape fragmentation and a reduction in the area of natural habitat (Fahrig, 2003). Simultaneously, functional connectivity, i.e., the movement of individuals between patches,

is affected, subsequently impacting gene flow and reducing genetic diversity (Hitchings and Beebee, 1997; Fahrig, 2003; Coulon et al.) (see Figure 8).

A consequence of widespread habitat loss and degradation is that the remaining habitats tend to be relatively small and isolated. These smaller or isolated habitats struggle to support butterfly survival and reproduction. Butterfly populations that breed in these areas are more likely to face extinction due to normal stochastic processes or inbreeding (Hanski, 1999).

Habitat fragmentation is now a severe issue for many butterflies, particularly for species with specific habitats. In Europe, habitat fragmentation has been notably significant (Jaeger et al., 2011) and remains a pressing concern.

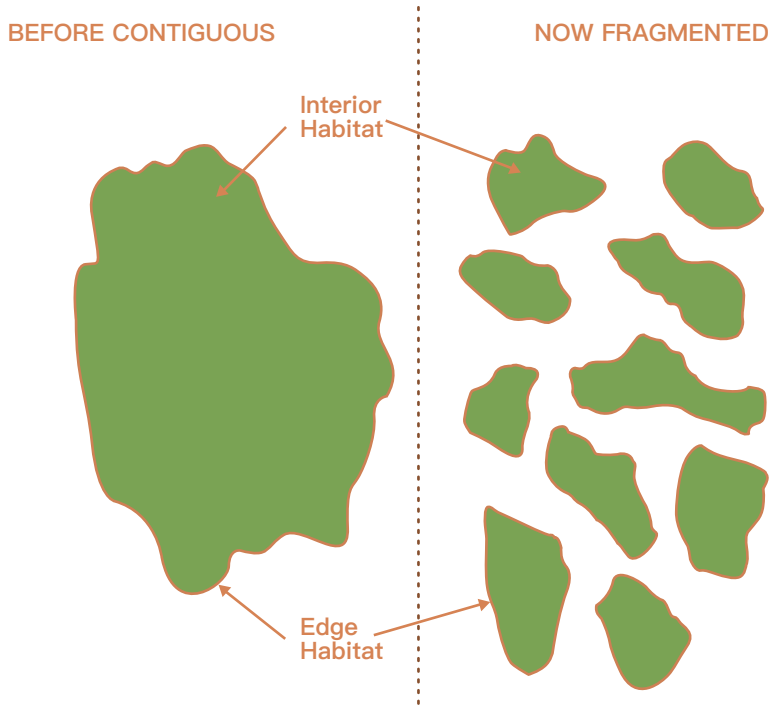


Figure 8. Excerpted from Source: The Nature Trust of British Columbia.

Chemical Pollution

Chemical pollution encompasses a range of substances that adversely affect butterflies and their habitats. A prominent contributor to this issue is pesticides, often sprayed on arable crops or landscape plants to mitigate damage caused by insects and other organisms (Davis et al., 1991).

Another harmful pollutant is airborne nitrogen deposition, primarily sourced from ammonia in intensive livestock rearing and nitrogen oxides from vehicle emissions (WallisDeVries & van Swaay, 2006). Nitrogen pollution alters the microclimate and the nature of the vegetation in which butterflies breed (Kurze et al., 2018), leading to the decline of certain butterfly species.

There is increasing evidence that nitrogen deposition can cool an otherwise warm microclimate. Consequently, butterfly species that overwinter as eggs or caterpillars decline more rapidly than those that overwinter as adults or pupae (Wallis-DeVries & van Swaay, 2006b). In early spring, vegetation overgrows, and the temperature within the vegetation decreases, thereby reducing the growth rate and survival chances of caterpillars (O'Connor et al., 2014). Ultimately, caterpillars become victims of rapid vegetation growth, diminishing butterfly abundance.

Climate Change

Europe's growing season has extended by over ten days since 1992 (*Growing Season for Agricultural Crops*, n.d.). The rapid growth of natural vegetation affects the microclimate of species associated with vegetation succession (the process by which the species structure of an ecological community changes over time) or the nutritional quality of butterfly food plants (Habel et al., 2019).

Climate change is likely to escalate the frequency of extreme weather events such as droughts and floods. Prolonged rainfall and storms will reduce reproductive success and decrease overall population size. In fragmented landscapes, this could increase the extinction rate of local species and impact the viability of various pollinator populations (Warren et al., 2021).

As depicted in Figure 9, in addition to the three primary factors mentioned earlier, several other elements come into play, such as alien species (either pollinators or plants), infections and diseases, and disruptions caused by human activities. These factors interact with each other, as exemplified by the following:

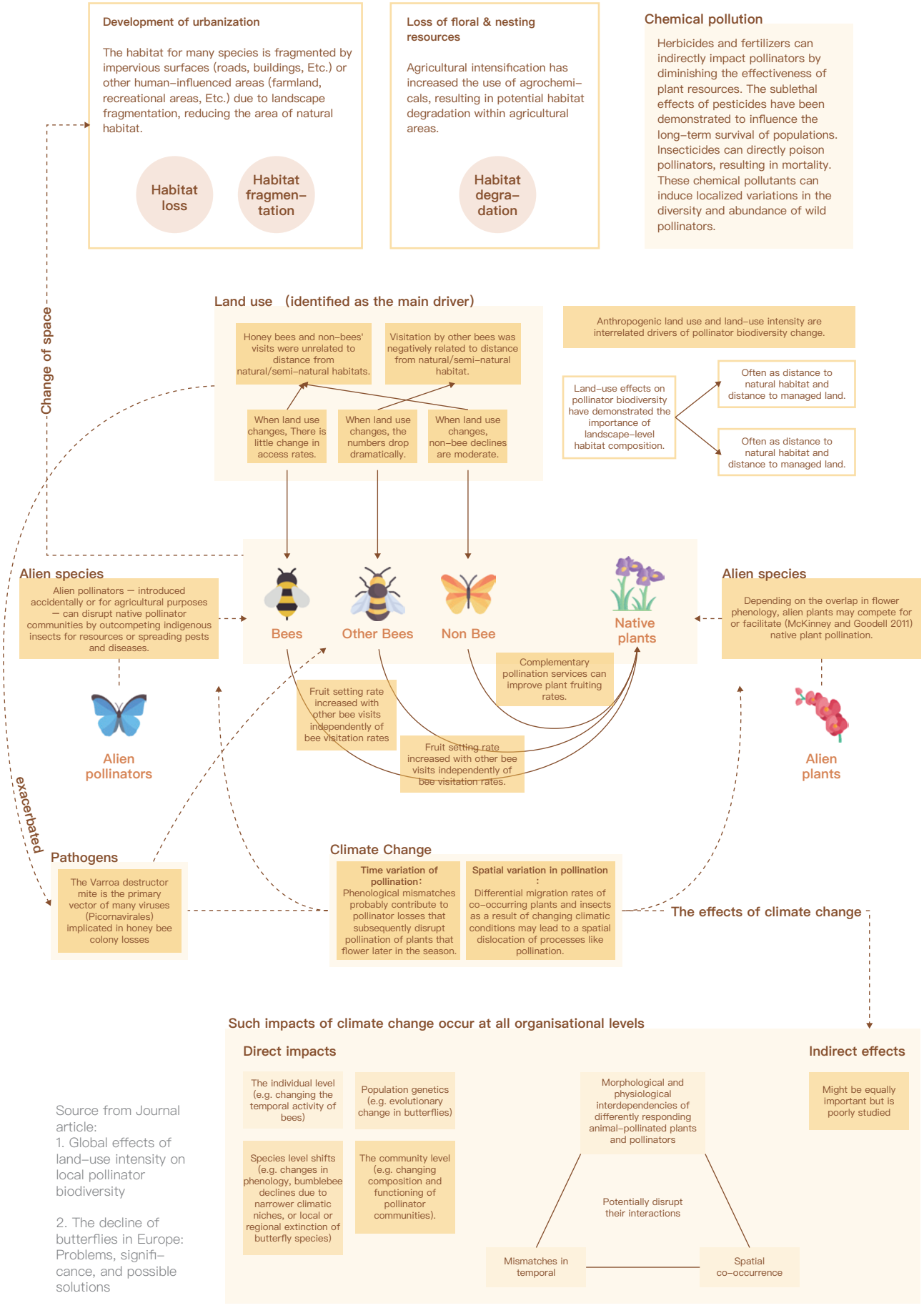
- Climate warming could lead to alterations in pollination time and space. Species and climate mismatch might result in pollinator loss, and interdependent plants and pollinators might experience spatial or temporal misalignment.

- In urban landscapes, alien plants may supplant local plants as food sources for pollinators, eventually causing a decline in local plant diversity. Nevertheless, alien plants can provide a food supply for local pollinators under the environmental changes induced by climate warming.

- Human activities and urbanization have resulted in the coverage of many pollinator habitats with impermeable surfaces, reducing habitat area and inducing landscape fragmentation. Concurrently, intensified agriculture has escalated chemical pollution, leading to habitat degradation.

- Land-use alterations have modified climate and environmental changes, be it the urban heat island effect or microclimates amid vegetation. These alterations also exacerbate the transmission of infections and diseases among pollinators.

These transformations underscore that land use and habitat composition at the landscape level significantly impact pollinator insect biodiversity. However, not all scenarios are pessimistic; at least, the effects of alterations in land use on non-bee populations are moderate. Furthermore, research suggests that non-bee visits are unrelated to the distance from natural or semi-natural habitats. This implies that, despite the exacerbation of butterfly diversity and richness reduction due to changes in various factors, positive impacts on butterfly species may transpire if human actions or land use undergo transformation.



Source from Journal article:
1. Global effects of land-use intensity on local pollinator biodiversity

2. The decline of butterflies in Europe: Problems, signifi-cance, and possible solutions

Figure 9. Factor analysis of pollinator decline.

1.2.3 The Importance of Protecting Butterflies in Cities

Among the primary factors contributing to butterfly decline, urban development and land use stand out as significant drivers of habitat reduction and fragmentation. The continuous expansion of cities has led to detrimental alterations in ecological habitats and associated biodiversity (Grimm et al., 2008). Pollinators, especially butterflies with specific plant and habitat requirements, are profoundly impacted. The urbanization surge has drastically reduced the native plants on which butterflies depend, while urban structures (e.g., buildings, impervious surfaces, etc.) have severely impeded butterfly migration. As habitats shrink or disappear, butterfly populations decline and move beyond city boundaries, often due to the negligence of species' habitats and associated ecosystems in urban planning (*Canadian Biodiversity Information Network*, 2005).

Some studies have demonstrated that indigenous urban vegetation offers superior ecosystem services compared to traditional urban habitats, such as managed lawns in cities (Robinson & Lundholm, 2012). Native plants and native pollinators contribute significantly in this regard. Specifically, certain urban environments provide shelters for native plants and animals (Yasuda & Koike, 2006; Huang et al., 2019). This interdependence between native plants and animals in cities implies that native plants can offer a higher quality habitat for native butterflies, and conversely, butterfly pollination can boost the abundance of native plants.

The ecosystem services rendered by urban flora and vegetation are widely acknowledged in urban development and are crucial for enhancing the health and well-being of urban residents (Botzat et al., 2016; Cox et al., 2017b). However, many studies on urban flora and ecosystems have focused on the quality of urban parks, green spaces, or landscape amenities (Tzoulas et al., 2007; Moseley et al., 2013; Hüse et al., 2016). Unfortunately, most of these studies only delve into specific aspects of urban flora, such as exotic species, habitats (e.g., roadsides, green roofs, etc.), and land use in urban environments (Celesti-Grapow & Blasi, 1998; Celesti-Grapow et al.; Catalano et al., 2016). Only a few studies have focused on wild pollinator species in cities and the associated ecology.

In this context, researchers, designers, and managers need to propose urban approaches that simultaneously promote ecological functions and human-nature relationships (Aronson et al., 2017; Gaston et al., 2013; Soga & Gaston, 2016) or integrate ecological service systems for urban habitats, including habitats of often overlooked species (railroads, transportation modes, vacant and abandoned areas, historic buildings, etc.). Urban ecology should not only consider human outcomes and benefits but also the potential broader impacts on non-human species and urban nature. Overlooking these impacts may underestimate or disregard the non-human species and ecosystems that might be affected, irrespective of how insignificant or invisible they may seem. The presence and activities of natural features and many other species contribute to making cities suitable and healthy places to live (Egorov et al., 2016; Frumkin, 2003; Lowe et al., 2015).

In summary, integrating ecological service systems in urban habitats, valuing native plants and animals, and duly considering the interests of non-human species in cities are essential. Urban environments can provide food and shelter for butterfly species. Enhancing the environment of butterfly habitats in cities can positively impact butterfly abundance. The European Union has also introduced policies in this regard, and the following section elaborates on the initiatives and actions launched by the European Commission for pollinators and butterflies, as well as the limitations of these actions.

1.3 European Union Policy

1.3.1 Action by the European Union

The decline of wild pollinators is a matter of grave concern, given that approximately 80% of the EU's crop and wildflower plant species rely, to some extent, on animal pollination. Roughly EUR 3.7 billion of the EU's annual agricultural output is directly dependent on insect pollinators. Without pollinators, many plant species would decline and eventually disappear, posing a threat to nature, human well-being, and the economy (Brussels, 2021). For instance, this includes the animal pollination of wild plants and the contribution of pollinators to nutritional security and human health.

In recent decades, there has been a significant decline in the number and diversity of wild insect pollinators in Europe, such as bees, butterflies, gophers, and moths. The European Red List indicates that about one-third of bee and butterfly species are declining, while approximately one-tenth are facing extinction (*European Redlist - Environment - European Commission*, n.d.-b).

Since 1992, the Habitats Directive has aimed to promote the protection of rare, threatened, or endemic habitats, animal species, and plant species. The Directive encompasses 56 species of wild insect pollinators, including 42 species of butterflies and the rest being moths and beetles (Sands & Galizzi, 2006). A report under the Habitats Directive references a butterfly study across six European Union countries and regions, indicating that butterfly populations in protected areas are declining at a similar rate to those outside protected areas. The report also highlights the positive impact of the Natura 2000 natural site on butterfly species abundance (*Special Report: Pollinators*, n.d.-b).

Since 2018, the LIFE program has significantly increased its support for pollinator conservation. Several ongoing LIFE projects have identified pollinator conservation as a goal. These projects primarily focus on habitat restoration and increasing public knowledge and awareness to improve the conservation status of threatened butterfly species (*LIFE Programme - EU Pollinator Information Hive - EC Public Wiki*, n.d.).

In June 2018, the European Commission published the EU Pollinator Initiative as a Commission Communique, accompanied by a staff working document (*the Directorate-General for Environment*, n.d.). Although the Pollinator Initiative doesn't possess legal authority, it acknowledges the severe decline in the number and diversity of wild insect pollinators in the EU, emphasizing the need for EU action to address this issue. The initiative lists actions until 2020 aimed at contributing to three long-term goals:

- Enhancing scientific knowledge about pollinator decline.
- Addressing the primary threats to pollinators.
- Enhancing cooperation among stakeholders.

In 2019, the Commission collected best practices and developed a guide for pollinator-friendly cities (Action 6A). The guide (*Cities - EU Pollinator Information Hive - EC Public Wiki*, n.d.) was published in January 2020, providing exemplary cases and guidance to policymakers, decision-makers, spatial planners, project developers, and town land use managers on creating a conducive urban environment for pollinators.

In October 2020, the European Commission formulated a plan for sustainable land use and nature-based solutions. The green infrastructure and biodiversity actions outlined in this plan will support pollinator-friendly urban environments. Additionally, the new Biodiversity Strategy's "Green City Accord" initiative (Green City Accord, 2022) and the Urban Greening Program (*EUR-Lex - 52020DC0380 - EN - EUR-Lex*, n.d.) will further promote action on pollinators.

Furthermore, to encourage more effective pollinator action, the committee has developed a methodology for mapping urban areas suitable for pollinator survival (Joachim et al., 2019). Several cities have utilized this approach to understand how to manage urban green spaces to increase the number of pollinators. The Commission aims to widely promote this tool among city authorities.

Depending on the priorities outlined in national and regional operational plans, actions related to pollinator conservation in urban areas or the broader landscape could benefit from EU funding. The Commission advocates for landscape-level actions that preserve, connect, and restore pollinator habitats through its guidelines on EU-level green infrastructure and the integration of ecosystems and their services into decision-making (Action 6C).

1.3.2 Limitations of EU Action

Despite numerous policy initiatives within the EU, a 2020 special report by Joachim et al. noted the following:

"We scrutinized whether the Commission has maintained a consistent approach to safeguarding wild pollinators in the EU. Our overall finding was that this was not the case. We pinpointed gaps in key EU policies addressing the primary threats to wild pollinators and observed that the Pollinator Initiative lacks the tools and mechanisms to effectively address these issues."

The updated EU Pollinator Initiative delineates actions and goals for 2030. One of the focal points is enhancing pollinator conservation and tackling the root causes of their decline, encompassing the enhancement of pollinator habitats in urban areas (*Press Corner*, n.d.).

The initiative also aims to enhance public awareness regarding pollinator decline, its causative factors, and the resulting consequences. Proposed actions include establishing a comprehensive monitoring system, supporting research and assessments, mapping critical pollinator areas by 2025, and advocating for the construction of urban pollinator habitats, along with disseminating knowledge to citizens. Additionally, the Commission and member states should support citizens and businesses in taking proactive measures, such as heightening public awareness and endorsing citizen science.

In summary, despite a wide array of policies and initiatives proposed by the EU, the intricate nature of ecological diversity poses challenges in implementing many of these measures. Crucially, enhancing pollinator habitats in urban areas is indispensable for future sustainable development. To realize the vision of "improving pollinator habitats in urban areas," a thorough consideration of the unique circumstances of local urban environments and designated species is essential, given the diversity and complexity of urban landscapes and natural heritage across different countries and regions.

1.4 Conclusion

Despite the existing policies and institutions being disconnected from the survival needs of non-human entities. Fortunately, urban spaces present many advantages for butterfly pollinators despite numerous disadvantages. In other words, incorporating the perspective of pollinators (butterflies) in the process of developing urban environments will have a positive impact on improving habitat existence for butterflies in urban areas. Simultaneously, this has a positive effect on the sustainable development of future cities.

In order to realize the vision of "improving butterfly habitats in urban areas," what can social innovation do for non-human actors and other lifeforms? How can changes related to non-humans in urban areas be promoted? To answer these questions, the next chapter will explore the role of designers in design for non-human projects from the perspective of sustainable social innovation.

CHAPTER 2

SOCIAL INNOVATION FOR MORE-THAN-HUMAN

2.1 More-than-human World

We live in a challenged world where human impact has endangered biodiversity, destroyed ecosystems, created multiple crises, and continuously depleted natural resources. Today, the growth of urbanization means that industry and cities continue to expand. The current world population of 7.6 billion is expected to reach 8.6 billion in 2030, 9.8 billion in 2050, and 11.2 billion in 2100, according to a new United Nations report (*United Nations*, n.d.). This growth means that humans and wildlife may need to coexist in urban environments, posing a significant environmental challenge due to the negative impacts of cities and pollution (Fieuw et al., 2022b).

The Anthropocene, as defined by Crutzen, delineates a new evolutionary period wherein human activities wield more substantial environmental consequences than all other activities on Earth (Crutzen, 2002). This positions humans at the forefront of environmental change, signifying that human actions significantly impact all human and non-human life forms. As argued by Anna Tsing (2015), we should not aspire to revert to better times; the Anthropocene is unsustainable, and we must forge new relationships and rebuild hope in our damaged landscapes.

In contrast to the "Anthropocene" view, "more-than-human" encompasses the diverse creatures co-inhabiting the Earth, including human and more-than-human societies (De Souza Júnior, 2021). Recognizing the more-than-human world implies understanding the existence of other "selves" with distinct centers of experience within a vast inter-subjective and inter-entity horizon. As described by Bellacasa (2017), "in a web of living co-vulnerabilities," there are multi-species universes of reciprocity and (dis)encounters between different entities. The interconnections inherent in the vulnerability of being on and from Earth unite the varied forms of more-than-human existence (De Souza Júnior, 2021). Abram (2010) views each mineral, vegetable, or animal entity on Earth as a telluric variation of the texture and pulse of the same sensitive world and cosmos. When approaching a center of reference that animates the warp and woof of existence, there are ways to subvert human isolationism regarding other beings that are part of the biosphere's dynamics. Similar to the animism of traditional populations (Danowski & De Castro, 2017), it is conceivable to contemplate an expansion in thought involving terrestrial sentience shared among the diverse beings on the planet (see Figure 10).

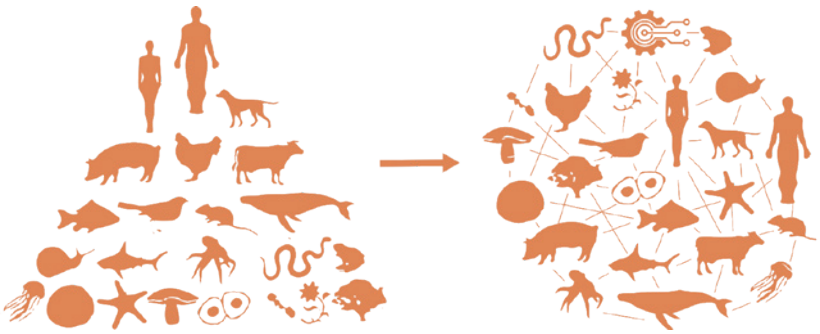


Figure 10. The move from human–centred design to more–than–human–centred design.

Thus, the concept of transhumanism acknowledges that human behavior impacts not only humans but also non-human actors in the ecosystem. Therefore, we need to rethink the involvement of non-human actors—wildlife, plants, air, forests, climate activities, rivers, and other organisms (Wright, 2020). In this context, design-driven social innovation that focuses on more than just humans can help non-human stakeholders continually co-create and respond to environmental change (Yang & Sung, 2016).

The 'more-than-human city' is one such concept that recognises the presence, rights and ethics of nonhuman natures in the city while repositioning humans in relational, ecological terms (Plumwood, 2009). More-than-human perspectives can be applied to spaces, tempos, ethics and the rights of non-human others, which extend beyond animals and plants to include soils, water, climate and more (McGregor & Alam, 2022). This perspective builds on a trajectory of work that strives to overcome conceptual divisions between human and nonhuman worlds, such as Hinchliffe and Whatmore's (2006) 'living cities', Haraway's (2008) 'becoming with', Puig de la Bellacasa's (2017) 'living with' and Hyvärinen's (2019) 'multispecies livelihoods'.

At the practical level, non-anthropocentric design and futuring are still emergent fields (Edwards & Pettersen, 2023). But scholars have, in the context of design, begun to explore what shifts to more-than-human ways of co-creating and designing may entail (for example, Pettersen et al., 2018; Akama et al., 2020; Clarke et al., 2019; Dolejšová et al., 2023; Olsen, 2022; Roudavski, 2020; Sheikh et al., 2023). On one hand, 'more-than-human city' needs to consider a more-than-human perspective and vision. On the other hand, social innovation for more-than-humans means some socio-technical shifts and is oriented toward social change (Manzini, 2015). This shift also implies a change in the role of the actors, both designers and non-designers, in this dynamic process.

2.2 Sustainable Social Innovation

2.2.1 Designing for sustainable social innovation

As described in the previous chapter, the study begins with an initial investigation into pollinator decline in Europe and then progresses to an examination of the survival challenges facing butterflies in urban environments. It becomes evident that the inclusion of wild pollinators in cities is vital; however, there are limitations to effectively safeguarding butterflies within urban areas. The diversity and richness of butterflies in many European countries are gradually decreasing. Despite continuous efforts and policies by the European Union aimed at creating opportunities for the flourishing of wild pollinators, the current measures have proven to be insufficient in many urban environments across Europe. Addressing these issues and challenges necessitates substantial, social, and systemic transformations to achieve a more sustainable future that enhances prosperity for all and safeguards the planet, addressing poverty, inequality, climate change, environmental degradation, prosperity, peace, and justice (UN Sustainable Development Goals, 2018).

In the context of the challenges mentioned above, particularly those related to more-than-human populations and sustainable development involving multiple species, traditional design approaches are inadequate for addressing such intricate issues. In this regard, service design-driven social innovation can provide appropriate processes, tools, and activities to effectively tackle this problem (see Figure 11). Social innovation is not a novel concept but has existed throughout history, adapting to changing societal characteristics. It can be defined as an idea that resolves social problems and explores new possibilities (Ezio Manzini, 2015), meeting social needs and fostering the capacity for social action (Geoff Mulgan et al., 2007).

Since the 21st century, social innovation has become increasingly intertwined with design, akin to the manner in which technological innovation did in the 20th century. Esteemed design theorist Ezio Manzini (2015) posits that design possesses all the possibilities and characteristics to initiate and support social change. In this context, design can be viewed as a model of innovation, offering skills, tools, and methods that guide people towards social innovation solutions (Chick, 2012).

In the contemporary context, top-down or one-way policy-making and service delivery are ineffective due to global economic and environmental challenges, as well as the inefficiency or low quality of overall societal operations (Bovaird, 2007). Instead, bottom-up approaches are essential. Social innovation, which generates novel ideas, whether in the form of a product or service, through new social collaboration (co-creation), enables multidisciplinary stakeholders to engage in open discussion and collaboration to shape policies and designs that yield social benefits (Needham, 2008). Social innovation has the potential to address social needs in a more effective, efficient, and sustainable manner compared to current service provisions organized by the State (De Mello Freire et al., 2011).

Meanwhile, the value generated by social innovation benefits the entire society, transcending the confines of individuals and organizations within human society, and considering ecosystems involving more-than-human or non-human entities and institutions. This shift in approach is the primary reason why "social innovation" is now widely discussed. Social innovation can provide novel solutions to social problems that are more efficient, effective, and sustainable than existing solutions (Phills et al., 2008).

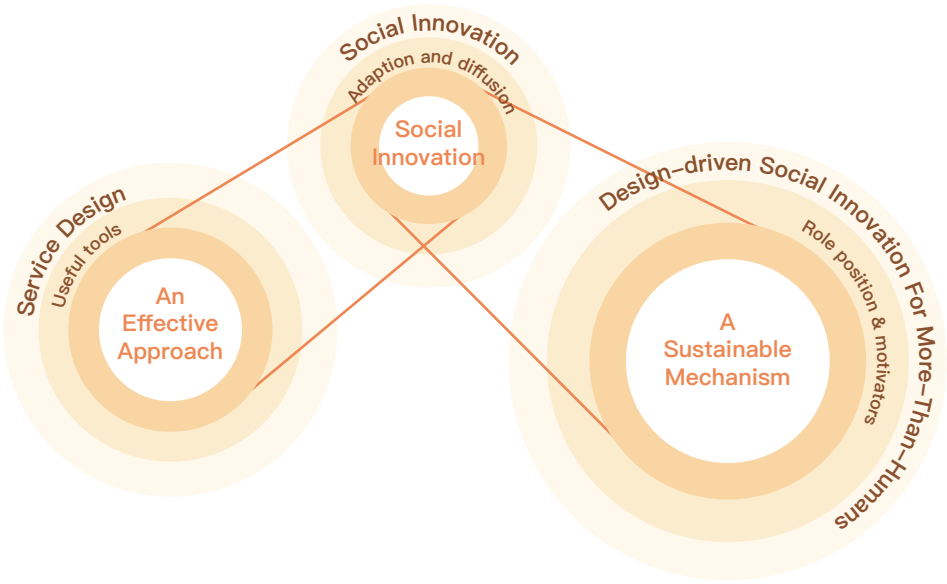


Figure 11. The conceptual model for the practical applications of service design in social innovation. (Adapted from – Social Innovation Service Design through Participatory Action Research, unpublished – b)

2.2.2 The Change of design role

In many past design endeavors, a human-centered, anthropocentric perspective has frequently overlooked the rights of non-human entities. Design, driven by this hierarchical anthropocentric perspective, has led to unsustainable changes in current ecosystems by promoting anthropocentric modes of production and consumption (Forlano, 2017b). Therefore, in considering non-human actors as part of an interconnected and pluralistic world, design and designers should adopt a pluralistic vision to address complex problems and foster a shift in thinking (Escobar, 2018).

However, a general challenge in sustainability is that people have difficulty relating to the non-human world (animals, plants, natural ecosystems, etc.) (Nisbet et al., 2008b; Mayer & Frantz, 2004). Focusing solely on human needs reinforces unsustainable solution development, while considering human and non-human needs is necessary to shape solutions that benefit all stakeholders in the planetary ecosystem (Akama et al., 2020; Forlano, 2007a; Veselova & Gaziulusoy, 2022). Therefore, designers must shift their culture and practices to become proactive agents in the transition toward sustainable lifestyles. This shift requires the development of new concepts, methodological tools, and the conception of new ideas, solutions, and visions. Designers need to actively engage in the social discourse on 'how to imagine and build a sustainable future' (Manzini, 2007).

As previously emphasized, while cities were once viewed as degraded and impoverished forms of habitat (Parris et al., 2018), this notion is now openly contested by evidence demonstrating how some plants and animals benefit from cities, while others adapt to cities becoming more urbanized than previously assumed (Ives et al., 2016; Jones, 2002).

Future designs for multispecies coexistence must engage with more than just human cultures. Existing work in biology, ecology, environmental history, animal studies, ethnography, geography, and other disciplines suggests that multispecies interactions are a common phenomenon, justifying a focus on design work in this direction (Roudavski, 2020). To contribute effectively, design disciplines must update their practices, including education, certification, and tools (Roudavski, 2020).

The ongoing loss of non-human habitat is not inevitable, and human settlements can accommodate many more lifeforms than they currently do (Roudavski, 2020). The reintroduction of non-human life and species into areas inhabited by humans requires considering principles that govern the interaction between species and individuals (Roudavski, 2020).

In the interconnected urban ecosystem of humans and non-humans, human behavior is an unavoidable factor affecting non-human entities. Therefore, how might we achieve symbiosis among different lifeforms and incorporate the required habitat for butterflies in the city? How might a shift in human behavior bring about a positive impact on urban butterflies? These are the questions that designers need to consider and address carefully.

2.3 Service Design for More-than-human

2.3.1 Service Design and participatory design approaches

Service design is a collaborative and creative approach focused on envisioning and facilitating new forms of value co-creation among stakeholders (Ostrom et al., 2015; WetterEdman et al., 2014). By harnessing multidisciplinary contributions (Yu & Sangiorgi, 2017), service design facilitates innovative ways of integrating resources, promoting service innovation at various levels, such as organizations, networks, and service ecosystems (Joly, Teixeira, Patrício, & Sangiorgi, 2018). Employing a creative and transformative approach, service design envisions new futures while adopting a holistic perspective on service systems (Sangiorgi et al., 2017). Consequently, it offers an integrative approach for innovating complex ecosystems and designing for more-than-humans by understanding non-human perspectives and translating this understanding into a vision for a new future.

Participatory design, as a cross-discipline of service design, can complement service design-driven social innovation. Particularly for social innovations involving more than humans- complex problems with stakeholders of different species- the integration of participatory design can better encourage citizen awareness and participation. Participatory design offers an evolving set of critical, conceptual, and practical tools to support the active involvement of users in the design of various systems, services, and products (Hagen et al., 2012).

Simultaneously, participatory design approaches can actively engage citizens in transforming social innovation (Meroni & Sangiorgi, 2011). Social innovation beyond humans does not only serve non-humans; citizen participation is equally co-creative and caring. Apart from recognizing the co-created nature of services, people's engagement in co-design processes is also associated with empowerment and emancipation goals, promoting self-reflection and stimulating hope and imagination for the future (Sangiorgi, 2011). It is worth mentioning that anthropologist Anna Tsing (2015 and 2020) conducted research focusing on a specific form of culturally and politically sensitive observation. Noticing involves becoming aware of something and recognizing it as worthy of acknowledgment and attention. Tsing regards noticing as a culturally and politically sensitive skill that acknowledges the interconnectedness of ecological, economic, and cultural systems and comprehends how these systems operate from perspectives beyond the human. Therefore, the act of noticing, concerns, actions, and engagement of citizens is of particular significance. Service design tools can enhance the practice of participatory design, promoting its advancement and driving social innovation and transformation.

2.3.2 Participatory design for more-than-human

Participatory design is often used to facilitate the creation of collaborative ideas on a given topic, relying on the potential to generate new concepts by involving different perspectives in a non-hierarchical manner (Kensing & Blomberg, 1998). Even though this approach initially focused on human engagement, it represents an effective tool for considering different agencies by engaging with different stakeholders (Group, 2018). However, as design perspectives have shifted, participatory design for non-human agencies has been gradually added to design practice to address issues of sustainability transformation, including interspecies justice and transhuman perspectives (Romani et al., 2022).

Designers can create new future scenarios by collaborating with different actors to address complex and uncertain challenges on socio-technical and environmental themes (Fauré et al., 2017), define future research agendas (Matschoss et al., 2020), and develop new tools for policymakers and decision-making processes (Gudowsky & Peissl, 2016; Rosa et al., 2021).

Participation is a design process to answer the questions posed in the previous section, promoting sustainability, environmental action, or conservation (Phillips et al., 2020). In its most basic form, participatory design is a prototyping process in which designers work directly with stakeholders to explore contextual challenges and jointly iterate on possible responses (i.e., create and test) (Telier et al., Citation2011). Stakeholders here are participatory co-creators who actively contribute to designing appropriate solutions (Sanders & Stappers Citation2008, 12).

As social innovation changes and the role of design shifts, and the rights of non-human species are recognized, the once human-centered social innovation framework and participatory design approaches have shifted accordingly. Although there are currently few rigorous design frameworks and design logic in design projects for more-than-human. However, social innovation frameworks and participatory design methods have been recognized and used in many practical projects.

This thesis aims to provide greater potential for a more-than-human future through participatory design methodologies, driving sustainable social innovation. Simultaneously, this thesis aspires for designers to collaborate with stakeholders linked to human stakeholders (residents), incorporating the perspective of non-human stakeholders (butterflies) within the design process. On the one hand, participatory design can assist non-human stakeholders (butterflies) in gaining more habitats within the city, providing increased opportunities for butterflies to survive and enhancing species diversity in the relevant ecosystems. On the other hand, participatory design can provide the city's residents (human stakeholders) with bottom-up guidance on actions to protect the non-human stakeholders associated with the butterfly.

2.4 Case Study

To validate the feasibility of participatory design in projects involving non-human entities and to draw on practical methodologies and organizational processes of participatory design in these projects, this thesis selected six case studies related to citizen engagement with wild pollinators and biodiversity conservation. These cases investigated four primary inquiries:

- How can citizens be directed towards urgent biodiversity issues and actively participate in them?
- How can participatory design enable citizens to understand the non-human perspective and provide ideas and designs for the needs of non-human stakeholders?
- How can non-human stakeholders manifest and share their roles and perspectives in the participatory design process?
- When involving non-human stakeholders, how should the workflow of participatory design activities be organized?

Case study 1 – Instructions on habitat creation for wild pollinators

Overview

Information and picture Sources: https://cop-demos.jrc.ec.europa.eu/jrc-makers-in-residence/edition-1

In this creator residency program, four creators developed several prototypes focused on pollinators: a sensing kit and a pollinator hotel to explore coexistence with insects in urban areas; a filmmaking workshop envisioning different biodiversity futures; a tool for insect photography; and an interactive pollinator habitat simulator. All of these prototypes provide entry points for discussing various aspects of pollinator conservation.

Problems & Opportunities

The project aims to explore these topics and encourage citizens to create more biodiverse habitats to address a severe ecological problem worldwide: the decline of pollinators (Zattara & Aizen, 2021). Due to high rates of urbanization and extensive landscape homogenization for agricultural use, many insect species are experiencing significant habitat loss and a decreased supply of floral and nesting materials (Hall et al., 2017), constituting the main factors contributing to pollinator decline. The importance of the abundance and biodiversity of wild pollinators is undeniable – many plants (both wild and cultivated) rely on specific insect species for reproduction (Zattara & Aizen, 2021).

Simultaneously, cities present a vital opportunity to become a refuge for biodiverse insect species and play a key role in conservation efforts (Hall et al., 2017). The project aims to leverage these opportunities to facilitate and initiate the numerous steps required to create a balanced habitat where citizens and nature can coexist harmoniously.

Figure 12 & Figure 13.
Event site and participants.

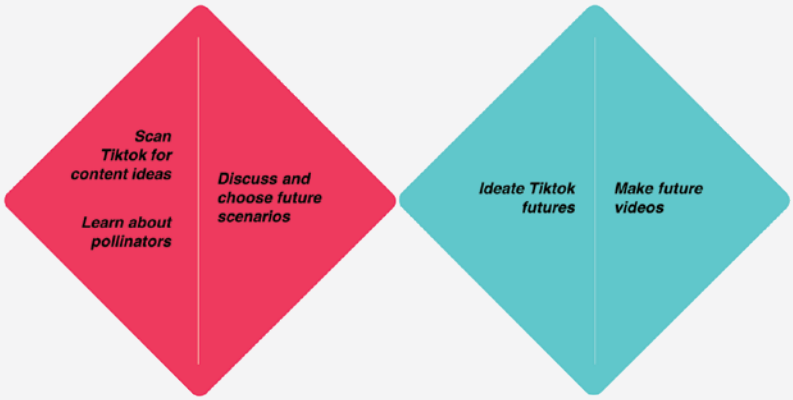


Figure 14. Image information from Homepage | COP CC on Participatory and Deliberative Democracy.

Making the toolkit

For this project, a workshop has been developed to raise awareness and allow urban residents to explore the relationship between humans and the wild flora and fauna. Additionally, a newly created open-source toolkit provides actionable tools to expedite a regenerative urban transformation. Together, the workshop and the toolkit share a unified vision- a symbiotic urban environment where cities value and nurture the wild and biodiverse essence of nature rather than alienating it.

TikTok Futures

TikTok Futures is a workshop format that empowers young individuals to envision the future. The workshop aims to empower young people, providing agency and optimism for the future by imparting skills and mindsets for strategic long-term thinking. These skills transform the future from something that 'just happens to you' to something you can actively shape. The workshop employs TikTok in a fun way (no lectures or classic workshop approaches). Young participants watch films and engage in games about the future before using TikTok as a means to share and express the futures they have imagined for themselves. By placing creative authorship into young people's hands, the project helps them share and shape their visions of the future.

The workshop follows a double diamond process (see Figure 14): In the first step, young participants familiarize themselves with a topic by watching videos and exploring pre-prepared future trends. They then engage in discussions about pre-constructed scenario 'sketches' that outline possible ways the topic could evolve in the future.

In the second step, the participants select a specific future for a more detailed exploration and generate ideas about the kinds of TikTok videos they might encounter in that future. Subsequently, they create these videos with their smartphones, producing thought-provoking speculative content envisioning potential futures.

Learn about

- The practice of the Double Diamond model framework in this project has proven to be effective. It helps participants understand topics related to non-human entities and envision future scenarios, enabling them to collectively explore more concepts and possibilities.

- In the process of social innovation for non-humans, various material and technological supports (e.g., toolkits, new media technologies, and envisioning future scenarios) can guide people in their daily activities and cultural transformation.

- Designing for non-humans requires participants to understand non-human perspectives, especially in participatory design processes. Engaging urban residents in exploring the meaning behind humans and wildlife drives the transformation of the urban environment.

Case study 2– BIKE FOR BEES

Overview

Information and picture Sources: https://pollinatorambassadors.org/?page_id=1207

The project is a collaborative effort involving young environmental educators and activists, with a focus on capacity building in youth environmental advocacy and citizen science. Youth experts use a peer-to-peer approach, experimental methods, and workshop formats to explore what to include and how to reach different groups, from students to youth NGO members. In these activities, young people employ systems thinking to explore issues, co-create ideas based on a theory of change approach, and identify connections between their passions and pollinator conservation. The primary objective of these activities is to integrate learning into the daily lives of young people, aligning with their existing activities, interests, and focal points.

Challenge

Honey bees, bumblebees, butterflies, moths, and hoverflies warrant our attention. Seventy percent of the world's 124 major crops rely on insect pollination. In Europe, the figure soars as high as 84 percent. This renders the findings of a long-term study all the more concerning: the flying insect biomass has witnessed a 75 percent decline over the last 27 years! Pollinators endure the adverse impacts of industrial agriculture, invasive species, habitat loss, air pollution, and climate change. Despite biodiversity loss being a constant topic in the media, public awareness of this problem remains shockingly low.

Solution

Bees are the symbol of all pollinators. Without pollinators, we would miss out on honey and essential nutrients because they are vital pollinators! It is why we believe that beekeepers are the perfect ambassadors for all pollinators. They are very knowledgeable and know the natural environment, like the back of their hand. On the "BikeForBees" tours in Austria, Italy, Slovenia, and Croatia, Nadine invites beekeepers, young people, and locals to dialogue about biodiversity, pollination, and the role of humans in our ecosystem. Biking allows for spontaneous encounters with locals and magnificent scenery, including even the tiniest inhabitants- pollinators. Pollinators and biodiversity are highlighted through social media and in the field. We also promote CO^2-neutral mobility and encourage people to exercise and explore nature.

How it went

The bike tour started in Austria on June 20, 2021. Nadine Schuller gave ten workshops on the road during the four countries visited. She rode for 27 days with an average distance of 48 kilometers and an altitude of 565 meters.

Overall, the adventurer rode 1,300 kilometers for the Bee and climbed 15,240 meters in average daytime temperatures of 30 degrees Celsius. Throughout her journey, Nynke supported her through reports, social media, and being a good friend and listener!

After many fascinating planned and unplanned encounters, sore muscles, rough roads, and breathtaking scenery, the Pollinator Ambassador continues to share her fascination with pollinators. Many people are inspired to become Pollinator Ambassadors so future generations can live in whole ecosystems.

Learn about

- In the design process, system thinking can be applied to explore issues. Methods based on change theory and collaborative efforts with residents are utilized to generate ideas and ascertain the connections between their enthusiasm and pollinator conservation.

- Regarding social innovation for non-humans, it is a long-term process that requires collaborative efforts involving various stakeholders, citizens, and institutions. Thus, promoting knowledge dissemination and cultural change is of paramount importance. Participatory design can offer citizens a broader perspective on pollinators.

Nadine Schuller's Story

The Inspiration

The idea for #BikeForBees arose from a 2-month cycling journey through Greece and Turkey. Cycling is a great way to connect people and share knowledge. Why not do it for the benefit of pollinators?

Kick-Off: Austria

Day 1 started with the presence of Nadine's family and representatives of her municipality. It was such a beautiful experience to see them all come together to wish her luck in her endeavor to save pollinators.

Slovenian Bee Expertise

The journey through Slovenia was packed with cultural events around honeybees. How can urban beekeeping work in Maribor? Why do tourist guides join beekeeper associations, and what is the Ljubljana Bee Path? Nadine met important ambassadors for pollinators in the field of archeology, landscape architecture and policy-making.

Educational Materials

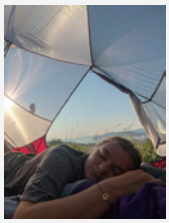
10 on-site workshops were held. Nynke Blömer designed posters on funding opportunities and pollinators, which we donated to each visited youth group and to beekeepers.

What Do You(th) Need?

One particular question Nadine explored were the obstacles for youth to takefurther action for biodiversity. There are so many active Europeans out there! What do they enjoy, what are their motivations and how can we help them to progress?

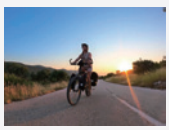
Pollinator Ambassadorship in Action

People from all walks of life proved that everybody can be active for pollinators. You don't need to have a big garden to make meaningful impact.



Recovery

Cycling 1300 km in the summer heat takes up energy. Nadine promoted and enjoyed camping every night – a great way to reconnect to nature. Together with cycling, it is a low-impact way of traveling!



It is done!

Six weeks later, tired and full of new connections, we gratefully close this journey. We would like to thank all participants, collaborators and waves and smiles along the road. But don't think this campaign is over yet!
We hope for #BikeForBees to become a yearly adventure. Please reach out to share your thoughts. Let's make it happen again!

Figure 15. Event site and participants.

Case study 3 – Science and Technology for Pollinating Insects

Overview

Information and picture Sources: https://cop-demos.jrc.ec.europa.eu/citizen-engagement-projects/sting-science-and-technology-pollinating-insects

In recent years, the decline in the occurrence and diversity of European wild insect pollinators has garnered public attention. Given the crucial role of pollination in the propagation of many plant species and the ecosystem services they provide, this trend represents a significant concern for both biodiversity protection and agriculture.

This project focuses on the relationship between citizens and farmers. Agriculture is at the heart of the pollinator decline issue. While certain farming practices are primary drivers of this decline, food production heavily relies on pollination services, and many farming methods and practices can indeed support pollinating insects. Thus, the project conducted a series of participatory processes in five European countries to explore how citizens and farmers can build trust, broaden the public debate to incorporate their concerns and interests, and ultimately develop locally-centered interventions based on local culture, needs, and capacities.

The STING project is developed under the European Initiative on Pollinators (COM(2018) 395). The Joint Research Centre (JRC) is supporting the Directorate-General for Environment (DG Environment) in addressing one priority action of the Pollinators Initiative: raising awareness, engaging society, and promoting collaboration on the decline of pollinators. Particularly, JRC is exploring approaches to actively involve citizens in providing knowledge and ideas, identifying issues and matters of concern, setting priorities, and creating and implementing interventions.

How

The project entailed a series of citizen engagement processes facilitated by external experts in the field. These processes were held in five EU countries, where various strategies for deliberation and co-creation were tested. Collaborating with the Competence Centre on Participatory and Deliberative Democracy, the experts designed these strategies. They carefully designed the event structure based on a comprehensive analysis of the local context, considering narratives, frames, policy context, and existing activities. Each citizen engagement event was conducted in two distinct locations with differing environmental and social characteristics within each country. This approach

aimed to gain deeper insights into how contextual factors influence the design and execution of citizen engagement processes related to the decline of pollinators.

Purpose

The primary objective of organizing citizen engagement processes was to broaden the discussion framework regarding the decline of pollinators. This involved exploring the issue from the perspectives of both farmers and citizens, encompassing their interests, concerns, needs, viewpoints, and caring priorities. Additionally, the aim was to collaboratively devise local interventions that support pollinators, informed by this enhanced understanding of the issue.

Like any citizen engagement process, the underlying principle of facilitating collective efforts was to gain a deeper understanding of the critical aspects in defining the issue and to develop meaningful solutions. Moreover, it aimed to enhance mutual understanding among stakeholders regarding their respective visions and concerns, as well as to establish or enhance relationships between them.

Outcome

The project is ongoing

Learn about

- In projects that require citizen participation, it is necessary to examine the issue from the perspectives of farmers and citizens, including their interests, concerns, needs, viewpoints, and priority matters of concern.

- Developing meaningful solutions requires enhancing mutual understanding among stakeholders regarding their respective visions and concerns. It also involves establishing or strengthening relationships between them.

Case study 4 – Science and Technology for Pollinating Insects

Overview

Information and picture Sources: Tomitsch, M., Fredericks, J., Vo, D., Frawley, J. K., & Foth, M. (2021b). Non-human Personas. Including Nature in the Participatory Design of Smart Cities. Interaction Design and Architecture(S), 50, 102–130. https://doi.org/10.55612/s-5002-050-006

The project aims to design smart urban furniture that facilitates the harmonious cohabitation of humans and natural ecosystems. It initiated an exploration of intelligent urban furniture to delve into designing roles more-than-humans in cutting-edge city projects. Conducting a concrete design study, albeit speculative, allowed individuals to craft artifacts while simultaneously contemplating the role of these artifacts throughout the design process. The emphasis on urban furniture stems from its representation as an application of smart city technology, necessitating immediate consideration of citizens as end-users (Tomitsch et al., 2021b).

Aim

To achieve this goal, the project's research focused on two aspects. First, how can intelligent urban furniture be designed for human and non-human stakeholders to create green cohabitation spaces in urban environments? Second, how can participatory design methods contribute to creating a participatory design approach that involves human and non-human stakeholders? (Tomitsch et al., 2021b).

Within the broader field of smart cities, this case study set out to investigate ways of restoring the connection between humans and non-humans within urban environments by applying a more-than-human approach to smart furniture design. Following previous literature on more-than-human participation (Tomitsch, 2018) and considerations for such an approach, particularly regarding digital technologies in cities (Boer et al., 2013), the study considered non-human species in the design process. The personas method was chosen to represent the primary users of urban furniture. Based on preliminary research, urban dwellers with limited access to green spaces were selected as human users, specifically considering office workers and tenants in urbanized areas. As non-human 'users,' the study selected representatives of flora and fauna native to the Sydney seaside suburb of Manly, the chosen geographical location for the study (see Figures 16 & 17). Specifically, representatives of possums, birds, bees, and plants native to the chosen location were considered (Tomitsch et al., 2021b).

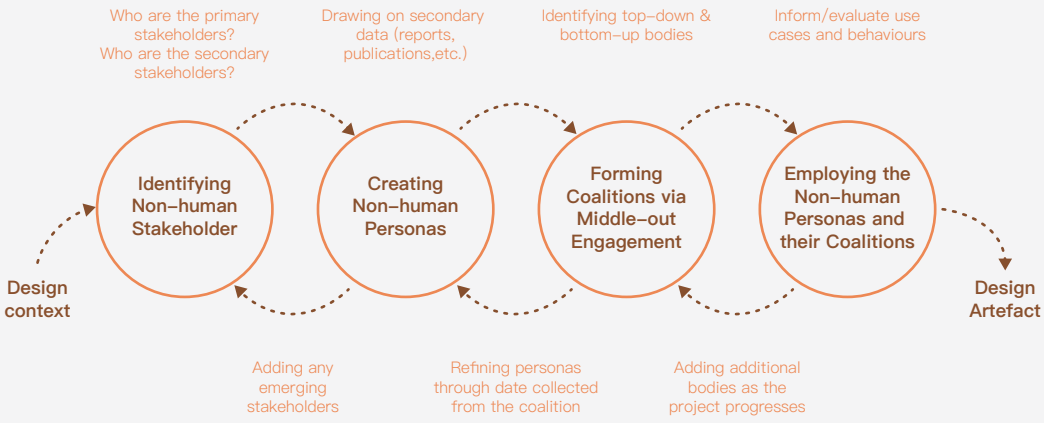


Figure 16. The four steps of the non–human personas framework. The diagram captures the fact that developing the fact that developing the personas is an iterative and ongoing process.

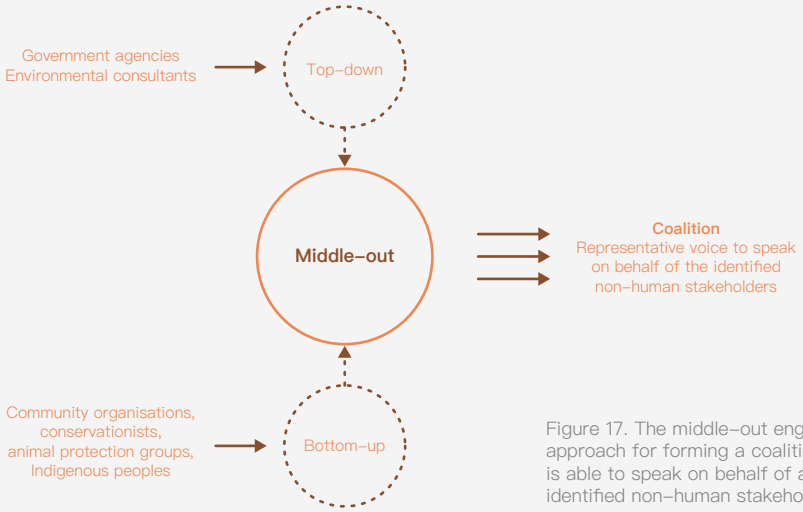


Figure 17. The middle–out engagement approach for forming a coalition that is able to speak on behalf of an identified non–human stakeholder.

Human personas and non-human personas

Based on a review of studies on the utilization of urban green spaces and cohabitation between humans and non-humans, office workers and property owners in urbanized areas were identified as examples of urban dwellers and were selected to be portrayed through human personas. In terms of structure, the human personas follow a standard format, including a backstory, motivation, frustration, ideal experiences, goals, desires, and feelings.

To identify non-human stakeholders, the case study began by focusing on ringtail and brushtail possums, which are native species commonly found in urbanized areas in Australia. These possums are prevalent urban dwellers that could benefit from urban furniture designs. Possums often thrive in cities due to abundant food sources, such as residential gardens. Threats to possums living in urban areas include the loss of tree hollows as cities cut down trees, replacing them with young trees that take years to form hollows, roadkill, and attacks from domestic animals such as cats and dogs. These factors have led to the displacement of many native possums associated with urban development. Moreover, most residents consider possums harmful and are reluctant to cooperate with conservation actions.

As additional non-human stakeholders, the case study identified representatives of native flora, seeking candidates that, although not native to inner-city areas, would thrive in an urban location while also providing a source of food and nesting materials for possums.

The non-human persona in this case study was constructed using secondary data from existing research literature. Its contents include backstory, motivations, frustrations, and issues related to habitat and food identified from the literature. The non-human persona does not encompass their ideal experience, goals, aspirations, and feelings. This is due to the challenge of gathering relevant information about these aspects from secondary data. The non-human personas served as a representation to amplify the agency of the non-human stakeholders who could not voice themselves in the participatory design process.

Learn about

- Other stakeholders associated with non-human "users" need to be considered, whether they are human representatives or non-human representatives. These relevant stakeholders can contribute to the thriving of the target users in the urban environment.

- Non-human personas serve to broaden the perspective of non-human stakeholders who cannot express their viewpoints in the participatory design process.

- Non-human personas may not encompass their ideal experiences, goals, desires, and feelings. This is due to the challenge of collecting pertinent information about these aspects from secondary data.

Case study 5 – Avoiding Ecocidal Smart Cities: Participatory Design for More–than–Human Futures

Overview

Information Sources: Clarke, R. I., Heitlinger, S., Foth, M., DiSalvo, C., Light, A., & Forlano, L. (2018b). More-than-human urban futures. https://doi.org/10.1145/3210604.3210641

The project aims to advance the development of sustainable smart cities through participatory design, complemented by workshops centered on democratic and political subjects. It convened designers, practitioners, and researchers to deeply explore the interconnectedness and interdependence of cities, nature, humans, and non-humans. The primary objective of the project is to conceive novel concepts that transcend traditional dualities, unlocking fresh possibilities for envisioning participatory design within the urban environment, especially in a digital-physical hybrid space. Furthermore, the project delves into practical ideas on how a more-than-human perspective can inform tangible participatory design practices and urban policies. The case provides a detailed organizational process of participatory design. Therefore, this paper extracts the project workshop timeline for presentation.

Workshop topics of interest

The topics of interest for the workshop encompass, though are not confined to, the following (Clarke et al., 2018b):

• Participatory design and the utilization of smart cities, urban informatics, and IoT technologies delving into human/more-than-human relationships;

• Methodological approaches, including the opportunities and challenges for designing in more-than-human contexts;

• Speculative designs, design fiction, and artistic projects;

• Ethical and legal considerations, such as design responses to the new legal status of nature;

• Designs that decenter the human or prioritize other species;

• Cultural aspects of sustainable smart cities within this domain;

• Theoretical perspectives from the literature, e.g., Anthropocene, Capitalocene, Chthulucene; and

• "World-making"—what a more-than-human city could potentially be?

Draft Schedule

The preliminary workshop schedule is as follows (Clarke et al., 2018b) :
9:00 – Introductions
9:15 – Encounters (ca. 5 minutes each): participants will present an artifact relating to an urban encounter or experience of cohabitation with other-than-human. Followed by a discussion.
11:30 – Coffee
12:00 – Interrogate and discuss existing examples of prototypes, visions, and projects through photos, videos, reports, newspaper articles (Cork, 2017), and artifacts, to begin to elicit opportunities and challenges and serve as inspiration for the afternoon session.
13:00 – Lunch
14:00 – Group work: Prototypes, theories, methods: an
exercise done in groups of 4-5 people, working on prototyping futures for multispecies entanglements in smart cities, including technologies, services, methodologies, legal and ethical frameworks, and theoretical lenses. Participants have the opportunity to produce low-fi prototypes in the FabLab workshop, including laser cutting, electronics, and 3D printing as well as from craft and

low-tech materials. These prototypes will serve as the basis for a Situated Action (also accepted at PDC).
15:30 – Presenting back to the rest of the group
16:00 – Coffee
16:30 – Group reflections and next steps
17:30 – Finish and workshop dinner

Post-workshop plans

The artifacts and materials generated during the project's workshops will form the basis of Situated Action as a broader approach to audience interaction. The workshop papers will be available via the workshop website prior to and after the workshop, providing the opportunity for The workshop papers will be available via the workshop website prior and after the workshop, providing the opportunity for participants to familiarise themselves with all papers prior to their presentation (Clarke et al., 2018b).

Learn about

- In organizing participatory design workshops related to non-human entities, participants need to comprehend the perspective of these non-human entities.

- Participants can gain insight into the non-human perspective through various mediums such as photographs, videos, and reports. The materials generated during the project's workshops will form the foundation for "contextual actions."

Case study 6 – The robot who wanted to be a pollinator

Overview

Information and picture Sources: https://www.percorsoimpollinatori.com/robot

The project aims to engage citizens in addressing the issue of pollinator decline, particularly through the STING project (Science and Technology for Pollinating Insects). The STING project utilizes robots to enhance citizens' connection with pollinators. By employing a robot that observes pollinator pollination behavior, the project enables citizens to view the perspective of pollinators through captured images. The robot was deployed to Cesena in the Emilia-Romagna region and was later relocated to a nearby agricultural field to fulfill its mission. However, an intriguing consideration arises: What if, during its mission, the robot develops an affinity for flowers? Can it learn to function as a pollinator itself? This captivating possibility remains to be explored...

The robot is scheduled to remain in the field until the end of August 2022 and will eventually gather the people of Cesena for a final and significant participatory exercise (*"The Robot Who Wanted to Be a Pollinator" | CoP CC on Participatory and Deliberative Democracy*, n.d.).

About The STING Project

The STING project operates within the framework of the European Initiative on Pollinators (COM(2018) 395). The Joint Research Centre (JRC) is collaborating with DG ENV to address a crucial action of the EU Initiative: raising awareness, engaging society, and promoting collaboration to combat the decline of pollinators.

- The JRC is currently conducting a series of citizen engagement activities with the following objectives:

- Co-creating new frameworks and narratives regarding pollinator decline to shift attention from honey bees to wild pollinators.

The design and implementation of these activities are proceeding along two streams to achieve the outlined objectives:

- Engaging youth to empower them regarding the issue and improve conditions for a sustained, informed debate. Through civic engagement activities, the aim is to engage youth and incorporate a youth-led perspective on the problems and solutions related to pollinator decline. These events will specifically address furthering conservation practices and raising awareness about the decline of wild pollinators. This includes fostering collaboration between beekeepers and farmers and empowering citizens to acquire the knowledge, understanding, and direction for action.

- Facilitating dialogue between farmers and the general public.Four citizen engagement events are planned to involve farmers and the general public, advancing the discussion on pollinator decline. These events will take place in four Member States (IT, RO, PL, BE) (Democracy, n.d.).

Learn about

- Numerous cultural dissemination activities can stimulate stakeholders' attention and engagement, promoting public awareness and discussion about the decline of pollinating insects.

- Engaging citizens in these activities incorporates their perspectives into issues and potential solutions related to pollinator decline. This process empowers citizens, providing them with knowledge, understanding, and actionable directions during this endeavor.

Figure 18. Event site and participants.
Figure 19. Event site.
Figure 20. Event site and participants.

2.5 Conclusion

In summary, service design utilizes creative and transformative methods to envision a new future. It provides a comprehensive framework and approach for innovation within complex ecosystems. Driving societal innovation that encompasses more-than-human aspects through the service design and participatory design approach is effective and necessary. While differences exist among the aforementioned case studies, they share a fundamental commonality: the emphasis on representing non-human stakeholders' perspectives in the design process and effectively conveying non-human viewpoints through various mediums. Concurrently, in cases pertaining to urban spaces, the perceptions, attitudes, and actions of local residents are pivotal. Hence, the participatory design approach is a prudent choice, addressing the needs of both human and non-human stakeholders and effectively propelling social innovation actions through the bottom-up initiatives of urban residents and the subjective agency of non-human roles.

These cases illustrate the process of participatory design workshops or civic engagement activities, underscoring the creation of toolkits and communication media to aid participants in comprehending non-human perspectives in participatory design workshops. Furthermore, specific cases underscore how participatory design methods integrate non-human perspectives into the design process, advancing more-than-human design practices.

It is worth noting that thorough research and analysis of the needs and definitions of non-human roles are pivotal before embarking on participatory design workshops. Special attention is warranted to comprehend the local urban geography, climate, non-human habitats, survival requisites of local non-human entities, and inter-species relationships within the ecosystem. Consequently, this thesis will conduct on-site research on butterflies and related ecosystems in the Milan urban area (Italy), using the framework of service design and the participatory design approach.

CHAPTER

3

BACKGROUND

3.1 The Status of Butterfly In Italy
3.2 The Status of Green Space In Milan
3.2 Urban Citizens and Pollinators

3.1 The Status of Butterflies in Italy

The geography of Italy is characterized by extensive gradients in both altitude and latitude. Altitude varies from sea level to the towering 4809 meters of Monte Bianco (or Mont Blanc), the highest mountain in Europe. Latitude ranges from 47° 05' 31" N (Mt Testa Gemella Occidentale or Westlicher Zwillingskopf) to 35° 29' 34" N (the southernmost tip of the Isle of Lampedusa). The geological complexity of Italy, combined with these gradients, contributes to the diverse climates and natural environments found in the country, placing Italy within a global biodiversity hotspot (Myers et al., 2000).

Italy's geographical position, traversing the central Mediterranean from North to South, has fostered an exceptionally varied fauna. This fauna includes species from various zoogeographical subregions, with many marginal elements primarily found in the Balkans, North Africa, or the westernmost parts of Europe. Italy boasts one of the richest faunas on the European Continent, with approximately 10% of its animal species being endemic (Blasi, 2005).

Among the fauna, butterflies (Papilionoidea) hold significant importance. In terms of species richness, Italy's butterfly fauna is second only to Turkey within the Euro-Mediterranean region, hosting 290 species within its political borders. Furthermore, 29 butterfly species are protected by the European Habitats Directives (HD). Consequently, Italy has the highest number of HD-protected animal species (17) among European states (Bonelli et al., 2018).

In Italy, the overall human population density is considerably higher than the European average, at 201 inhabitants/km² compared to the average of 113. This has led to a rapidly increasing rate of soil conversion around major towns. However, the abandonment of less suitable agricultural areas has facilitated the re-naturalization of some environments (Falcucci et al., 2007).

During the initial stages of land abandonment, transitional areas are created, which are likely to be favorable for many butterflies. However, in the subsequent years, various types of forests are expected to expand (Marull et al., 2015). Since 52% of the total Italian butterfly species occur in transitional areas, 34% are primarily found in grasslands, and only 9% are woodland species (the rest occur in screes or ravines), the expansion of forests is not anticipated to significantly benefit Italian butterfly communities (Bonelli et al., 2018). On the other hand, agricultural intensification has led to the elimination or significant reduction of semi-natural areas within and between cultivated regions, particularly impacting hay meadows (Stefanescu et al., 2005). This reduction drastically diminishes their role in biodiversity conservation, both generally and specifically for butterflies (Bonelli et al., 2018).

As shown in Figure 21, endangered butterflies in Italy are predominantly concentrated in the northern regions or on the southern islands.

The predominant threat to Italian butterflies is habitat loss and degradation resulting from changes in land use and agricultural practices. These alterations likely lead to reduced population sizes and contribute to habitat fragmentation and isolation, thereby amplifying adverse effects through stochastic events (see Figure 22) (Bonelli et al., 2018).

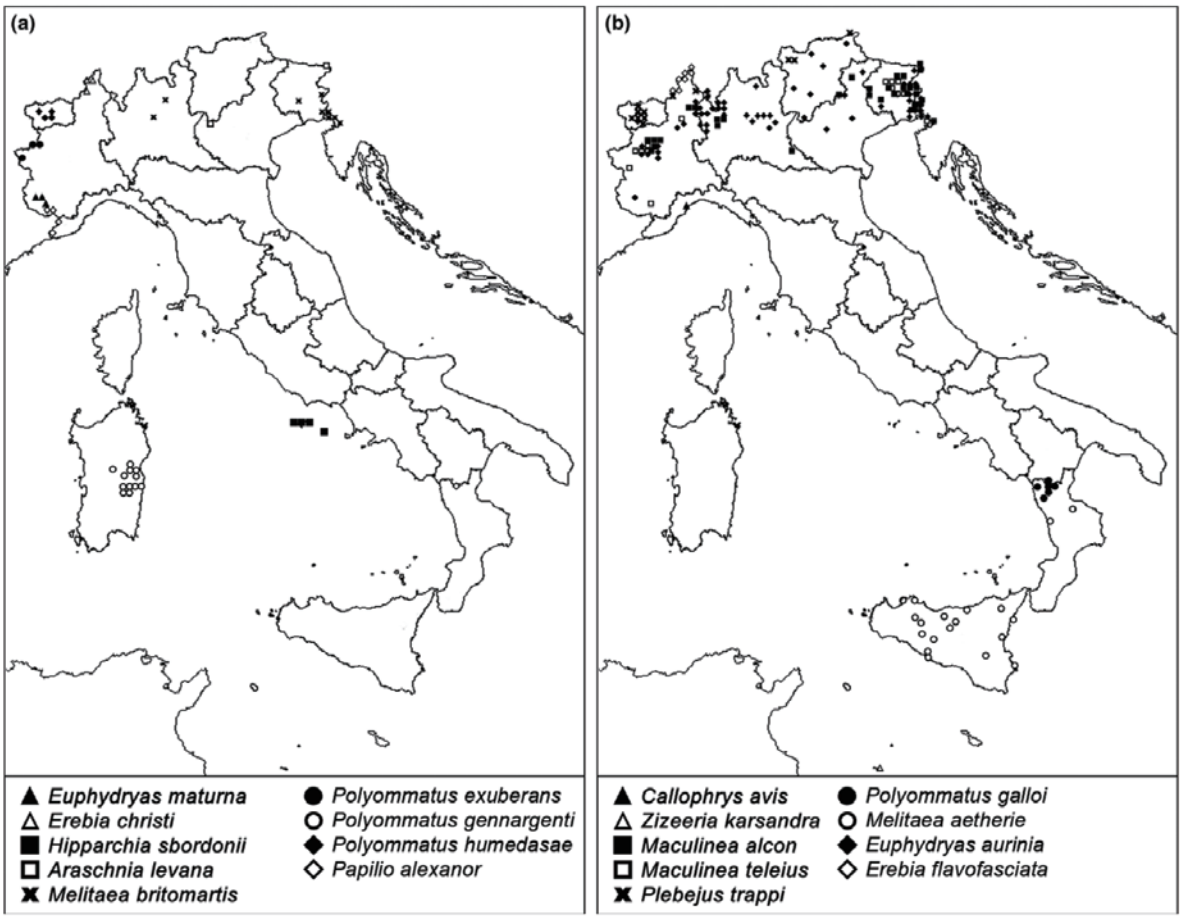


Figure 21. Distribution map of threatened butterflies in Italy. Each symbol refers to populations of a) Critically and Endangered species and b) Vulnerable butterfly species.

Intensive pasture management, aimed at maximizing yields by frequently cutting grass or cutting at inappropriate times of the year, or even the abandonment of pastures followed by natural reforestation, severely impacts butterfly populations (Konvicka et al., 2008; Nilsson et al., 2013; Bubova et al., 2015).

Bushfires are a common occurrence in the Mediterranean region and can be detrimental to narrowly endemic species (Scandurra et al., 2014). Occasionally, they may also threaten species flying at higher elevations. Also falling under the general IUCN threat category of 'ecosystem modification' is excessive pumping from the water table, which is becoming increasingly widespread, particularly during the summer, for both agricultural and household needs (Bonelli et al., 2018).

Ranked third among the most significant threats, climate change impacts butterfly populations in various ways (Hufnagel & Kocsis, 2011). Winter thermal anomalies and alterations in precipitation patterns lead to a serious decrease in snow cover thickness in the Alps (Terzago et al., 2010) and in the Apennines (Petriccione, 2005), which is crucial for sheltering larvae of strictly alpine species from excessively low winter temperatures (Vrba et al., 2012). Moreover, some mountain species face potential altitudinal habitat shifts. Even at lower elevations, precipitation anomalies are correlated with the extinction of at least one species (Cerrato et al., 2014). These climatic changes may cause a disconnect between the phenologies of adult butterflies and those of their larval food plants (Cerrato et al., 2016).

As illustrated in Figures 23 and 24, the forest, shrubland, grassland, wetland, and rocky area regions are experiencing pronounced adverse effects, resulting in a noticeable decline in butterfly populations. The reduction in butterfly species is most prominent in the shrubland and grassland regions. These detrimental impacts have a significant influence on the diversity and abundance of butterflies in Italy.

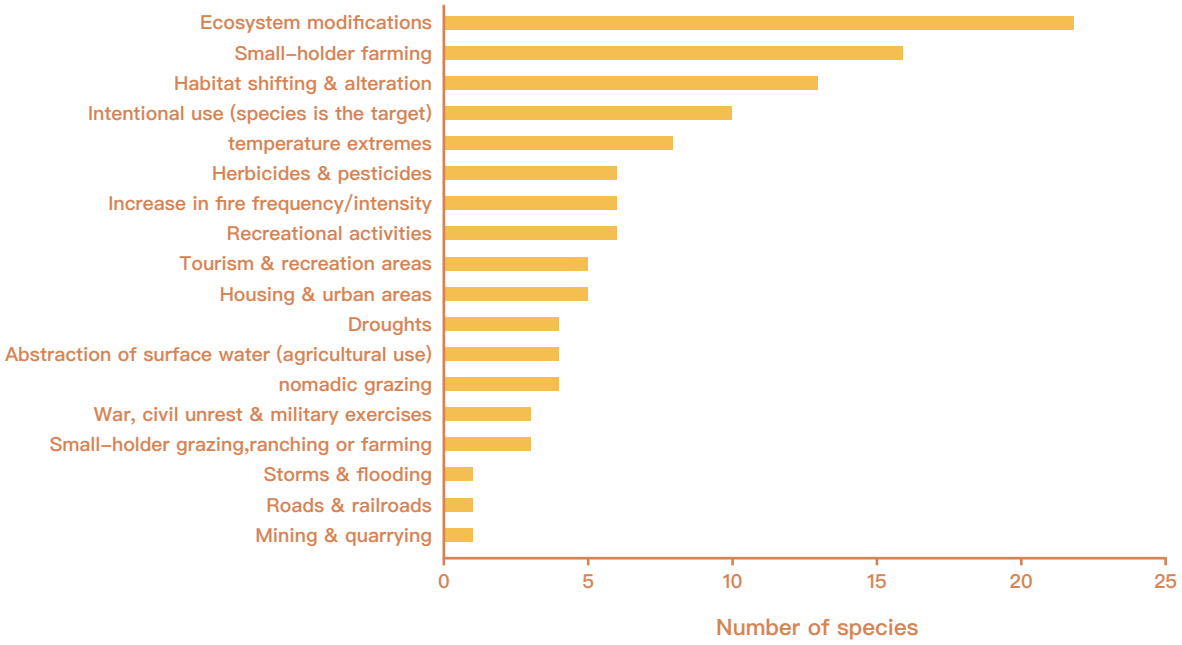


Figure 22. Main threats sffecting the threatened Italian butterflies following the categorisation by IUCN – Threats Classification Scheme Vers. 3.2. Each species has been assigned from one to ten threats.

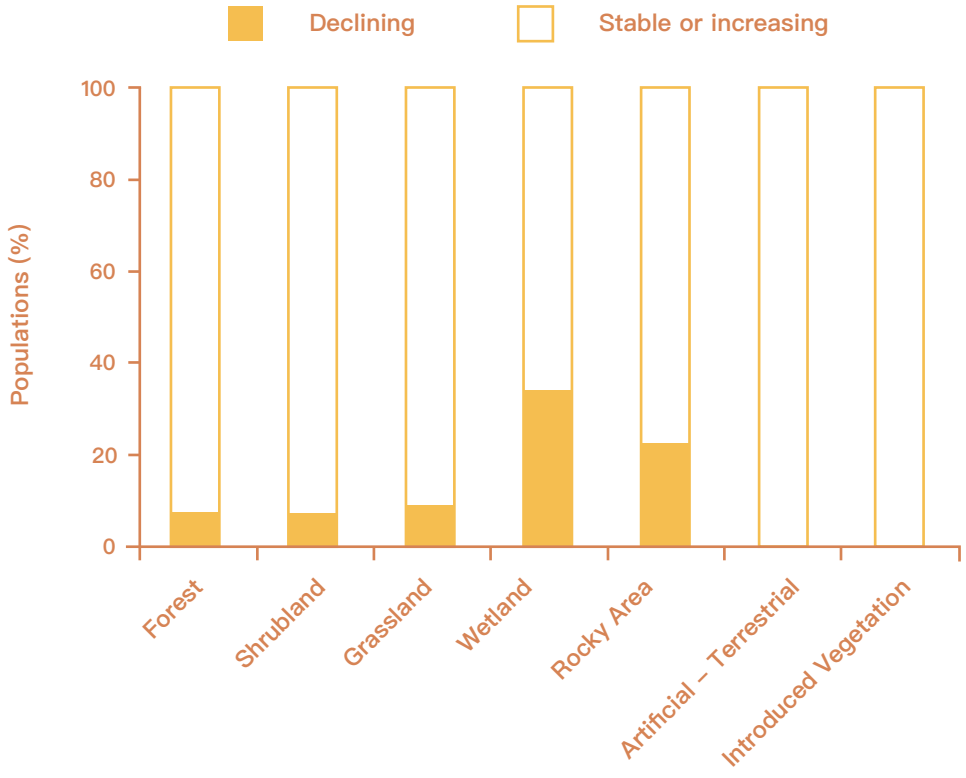


Figure 23. Number of threatened and non–threatened Italian butterfly species divided per habitat type.

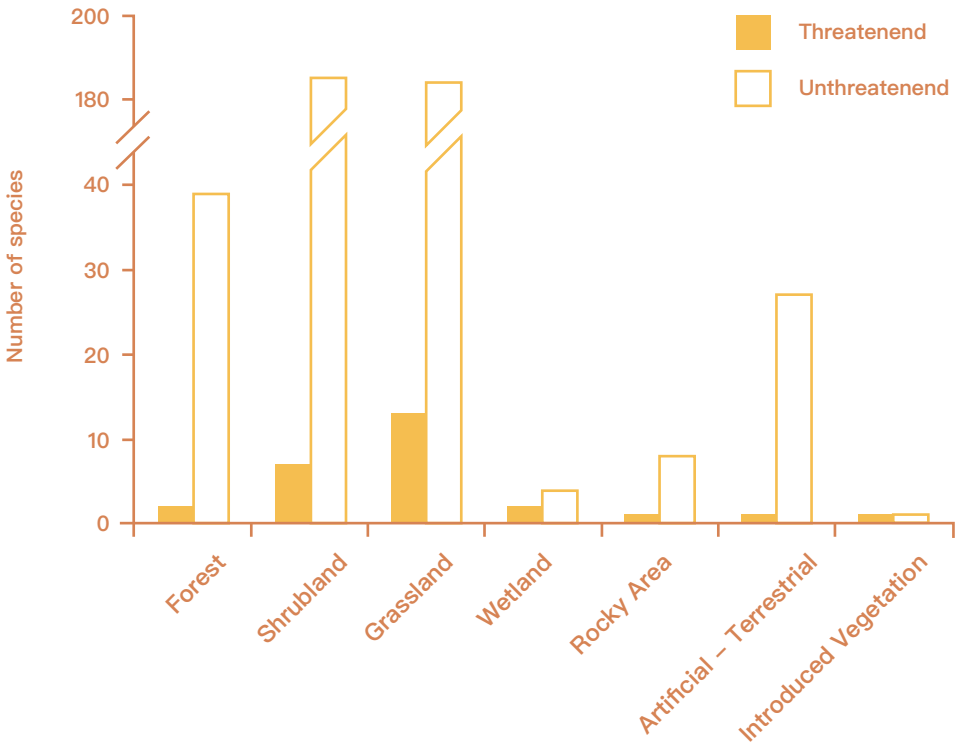


Figure 24. Demographic trends of the threatened Italian butterflies divided per habitat type.

In comparison with the overall European scenario (van Swaay et al., 2010) or specific situations like the British Red List of Butterflies, where 37% of the total are classified as Regionally Extinct or Threatened (Fox et al., 2011), the Italian butterfly fauna is in relatively favorable condition. The pronounced environmental heterogeneity and the wide variety of soil uses generally contribute to maintaining high levels of species richness all along the peninsula and its islands. At the same time, Italy has a special responsibility for butterfly conservation at the European level, as several butterfly species considered particularly threatened in Europe still occur in various parts of the country (Bonelli et al., 2018).

In Italian urban areas, urban development and land use (e.g., residential areas, production areas, and major roads) have often overlooked the vital role of species in the habitat during the construction process. This oversight leads to habitat loss and deprivation of food sources for butterflies (Säumel et al., 2016).

Therefore, this thesis focuses on urban land use in Italy, as land use in cities is closely related to people's daily lives and involves intimate connections between humans and non-humans. While many diverse and complex factors have contributed to the reduction in butterfly diversity and abundance, changes in human behavior and land use may positively impact butterfly species. As described earlier, land use is not entirely negative; certain urban landscapes, such as plant communities in gardens, create beneficial habitats for multiple species, although human-centered living experiences and aesthetic values are often considered more in the design process.

Unlike primary pollinators such as bees, butterflies have undergone evolutionary changes in their dietary and environmental preferences. While stakeholders, such as urban governments and institutions, are increasingly recognizing the importance of urban biodiversity, and many cities are developing appropriate habitats to offer survival spaces for pollinators, these habitats primarily emphasize biodiversity. The nuanced changes in butterfly growth have not received adequate attention. This gap in understanding is one of the reasons why the efforts to preserve butterfly species diversity have not yielded significant results. Therefore, this thesis aims to integrate Italy's geographical environment and butterflies' current status. In the following section, a specific region, the urban environment of Milan, will be surveyed. This is the background of the project of this thesis and the basis for the development of the research and the project.

3.2 The Status of Green Space in Milan

With approximately 1.4 million inhabitants, Milan is the second most populous urban area in Italy (*Home - Comune Di Milano*, n.d.) after Rome. The city is situated in the Po Valley at an average altitude of 120 m. It experiences a temperate climate (continental, characterized by cold winters and hot, humid summers), with an average annual temperature of 13.2 °C (1952- 2018; Milano-Linate weather station, ENAC) and an average annual precipitation of 1,002 mm (Ceriani and Carelli, 2000).

The original natural land cover of the region, representing potential vegetation, transitions from a Padania-Illyrian broadleaf forest to a mesic Padania mixed oak forest, prominently featuring oak and hornbeam Carpinus betulus L. (Gentili et al., 2019). Presently in Milan, autochthonous flora and secondary vegetation are found in semi-natural and artificial habitats such as parks, gardens, residential squares, historic buildings, avenues, street sides, railroad embankments, and canals.

As depicted in Figure 25, Milan hosts a multitude of potential habitats throughout the city, covering a total area of approximately 21,000,000 square meters. Large parks account for about 70%, small parks for 15%, and medium parks for 6%, with governmental ownership comprising 11% of all parks and gardens (Access to Green Areas and Public Realm: The Case of Milan- Transform Transport, 2023).

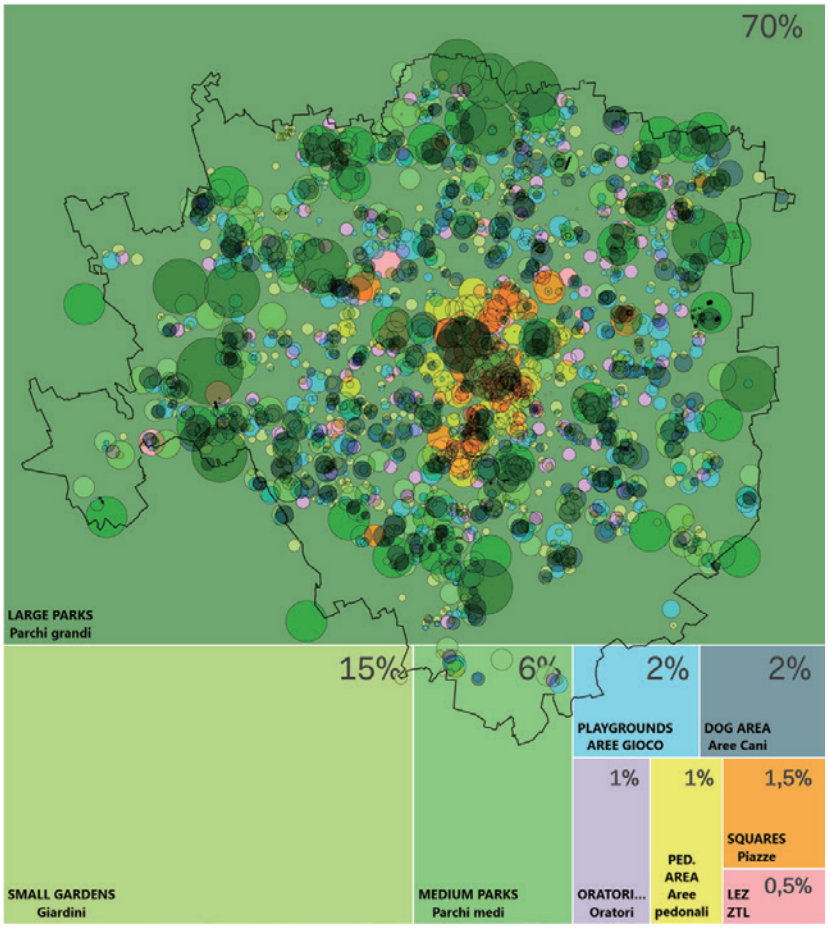


Figure 25. Image credits: Access to green areas and public realm: the case of Milan.

A 2018 study summarized the flora across major land use types (landscapes) in this section of Milan's city center, encircled by freeway ring roads (Toffolo et al., 2021). Milan's land types and associated flora can be broadly categorized into four types:

- Built-up areas (Built-up): Urbanized spaces encompassing human-height fences, ground-level squares, and production areas (e.g., parking lots, commercial areas, etc.) adjacent to recent and historical buildings.
- Main roads (Roads): Central boulevards and expansive avenues (sidewalks, decks, flower beds, curbs).
- Railroad areas (Railways): The spaces between tracks (both active and abandoned during permitted times), areas on both sides of the tracks, stations, platforms, and their surroundings (e.g., inventory points, train car wash areas, etc.).
- Green spaces (Green): Public areas within parks, gardens, and orchards.

Their findings indicate that Milan's average number of insect pollinator species is highest in the railroad areas and lowest in the built-up areas (Toffolo et al., 2021). Among the three land use types—built-up areas, green areas, and roads—studies consistently confirm the positive impact of green land use on enhancing biodiversity and ecological value. Green spaces exhibit higher levels of total species richness, tree abundance, and perennial rhizomatous herbaceous plants compared to built-up areas and road sites, consequently enhancing habitat structure for the well-being of both people and animals like pollinators and birds (Goldstein-Golding, 1991).

However, the study by Banfi & Galasso (1998) emphasized that built-up areas (residential and production areas) or certain arterial roads are lacking in biodiversity concerning species hosting, often neglecting the critical role of plants. Dispersed plant species can offer ecosystem services to citizens and microfauna, contributing to lower street temperatures and providing shelter and food for the latter (Säumel et al., 2016). Most green projects in urban Milan focus on expanding built-up areas (land use) and implementing mitigation or "compensatory measures," which could entail creating new green spaces or afforestation actions. However, these initiatives might simply manifest as urban facilities with limited biodiversity (Toffolo et al., 2021). Such broadly targeted urban landscapes may not significantly impact butterfly species in the Milan region.

In line with the aforementioned study, it was found that butterflies have varying environmental requirements at different stages of growth. However, a uniformly managed urban landscape often struggles to adequately address these distinct needs of butterflies. Hence, to create higher-quality habitats for butterflies in cities, it's imperative to consider the survival needs of specific butterflies and their related ecosystems. Concurrently, studies by Kowarik et al. (2011) on European wastelands, DeCandido et al. (2007) on "wildflower" meadows in residential areas and parks, and Mutch (2007) on urban grassland restoration in North America suggest that urban green spaces hold significant potential in increasing plant species richness. Given the interactive relationship between plant diversity and butterfly diversity, abundant and appropriate plant resources can create superior habitats, offering more opportunities for butterflies to thrive in urban environments.

Subsequent studies have underscored the positive impacts of plant species richness on faunal diversity (Scherber et al., 2010). This consideration is also applicable to urban insect diversity (Höttinger, 2000; Rennwald & Rennwald, 2004). Globally, the biodiversity potential of urban green spaces is still largely overlooked, and they have distinct advantages over agricultural green spaces in terms of restoration. For instance, urban landscapes and ecologies are not focused on maximizing crop yields and encompass significant amounts of managed green spaces (Toffolo et al., 2021). Leveraging these advantages through effective urban land and landscape management can mitigate barriers to butterfly survival in cities, preserving species diversity and richness.

In summary, there remains a need for further development of plants, green spaces, and landscapes in the city of Milan. Whether incorporating considerations for non-human habitats in urban green spaces or enhancing plant diversity in dispersed built-up areas, enriching the plant content in these spaces plays a crucial role in the ecosystems of the Milan region. However, for non-human stakeholders such as butterflies, intricate physiological changes imply more complex survival needs. Considering the main reasons for the decline in the number of butterflies in Italy, urbanization and changes in land use have severely affected their habitat and related ecosystems. Therefore, how to use the positive aspects of urban plants and landscapes, allowing butterflies to share space with humans in the city of Milan?

3.3 Urban Citizens and Pollinators (Butterflies)

As mentioned earlier, urban areas and their green spaces are expected to play an increasingly crucial role in global biodiversity conservation and human well-being (Aronson et al., 2017; Capotorti et al., 2020). By 2050, it is projected that 68% of the global population (approximately 6.5 billion out of 9.77 billion residents) will reside in urban areas (United Nations, 2019). The growing urban population, moving further away from natural environments, has implications for civil society and health, particularly among the younger generation, who have limited opportunities to interact with nature (Warber et al., 2015). Given the intricate relationship between landscape, biodiversity, and public health, green spaces or corners within urban environments are becoming increasingly vital (Mills et al., 2019). In cities, vegetated road verges are described as crucial corridors providing various ecosystem services (Säumel et al., 2016). Some urban environments can serve as shelters or "refugia" for local plants and animals (Yasuda and Koike, 2006; Huang et al., 2019).

Throughout human history, perspectives of the public towards nature have shifted, and urbanization has significantly reduced daily human interactions with plants or animals. Especially within the framework of a "human-centered" society, the natural world is often perceived as a "peripheral" environment with which most people have no direct connection. However, the reality is that human survival largely depends on the connection with nature (Takano, 2002). Life sciences indicate a worrisome decline in global pollinator populations. This decline is accompanied by an overall loss of biodiversity, even within the context of urban landscapes and human welfare. Concurrently, social sciences are discussing the increasing distance between citizens and nature. Even in urban areas, there is substantial evidence supporting the close link between public interest and the sustainability of pollinators (Giovanetti et al., 2020).

Pollinators represent a vital component of ecosystem services in the natural world. In recent years, due to concerns about the reduction in global insect pollinators, pollination ecosystem services have been protected and brought to attention (Biesmeijer et al., 2006; Hall & Martins, 2020; Potts et al., 2010). The decrease in insect pollinators is attributed to various anthropogenic factors, including habitat loss, pesticide use, parasites and diseases, pollution, and climate change (IPBES, 2016; Potts et al., 2010; Vanbergen et al., 2013). Thus, spotlighting pollinators is essential not only for human well-being (Jabareen, 2013; Swanwick et al., 2003) but also for the ecological services they sustain (Baró et al., 2015; Bolund & Hunhammar, 1999).

To effectively implement biodiversity conservation, protective measures need to be taken across various domains of human life, including individuals, businesses, and governments (Cardinale et al., 2012; IPBES, 2019). Enhancing access to scientific information and garnering public support for protective measures (Meuser, Harshaw, & Mooers, 2009; Rose et al., 2018) is likely the key to formulating more evidence-based environmental policies, enhancing the quality of protective measures and their effectiveness (Hunter & Hunter, 2008; Power, Kelly, & Stout, 2013). In the past decade, although the European Union has introduced several national strategies for insect pollinator protection to address the decline in pollinators and raise public awareness of this issue (Underwood, Darwin, & Gerritsen, 2017), there is still a lack of consensus among the public regarding the importance of natural resources, the services provided by natural ecosystems, and the interconnections among species (Braito et al., 2017; Tzoulas et al., 2007; Van Kamp et al., 2003; Vlek & Steg, 2007). This implies that in bottom-up actions, hindrances may arise during the implementation of activities, policies, and initiatives due to citizens' lack of scientific information and consensus, as well as understanding of specific species and their interactions, such as butterflies.

Thankfully, despite a potential lack of understanding, the public is increasingly focusing on and showing interest in the reduction of insect pollinators and their protection (Hall & Martins, 2020). However, for specific pollinators such as butterflies, which have complex and varying habitat requirements due to their metamorphic development, initiating effective bottom-up actions remains a challenge. Therefore, how cities can become a shared habitat for both humans and butterflies still requires further practical endeavors.

CHAPTER

4

RESEARCH QUESTIONS AND METHODS

4.1 Research Questions

Preliminary research has brought to light a biodiversity crisis stemming from human activities, notably urbanization, leading to the destruction or severe reduction of butterfly habitats.

This thesis adopts the perspective of butterflies, unveiling intricately intertwined ecological networks associated with pollinators. Concurrently, it emphasizes that due to human activities, vital insect species (butterflies) crucial to the ecosystem face severe threats to their survival, even risking extinction. Despite their close connection and mutual influence on human life, these species are frequently overlooked. Thankfully, an increasing number of people have come to recognize this range of negative impacts and losses. The thesis aims to bridge the gap between humans and non-humans, fostering a deeper understanding and connection between humans and butterflies. Furthermore, it is essential for humans to acknowledge the vulnerability of various life forms on Earth and the necessity of coexisting with them. Citizens, through a bottom-up action process, can reach a consensus on how to measure the survival needs of natural resources and the roles of non-humans in the city.

Consequently, designers need to transition from a "Human-centered" to a“More-than-Humans" perspective, shifting from human isolationism towards other species. Service design drives social innovation, and methods like participatory design are increasingly practiced and applied in this domain. This thesis aims to drive social innovation beyond humans through service design, creating more opportunities for the survival of non-human roles like butterflies in the city. This fosters harmony among everyone, nature, non-humans, diverse ecosystems, and a sustainable future.

Biodiversity is relevant to everyone's life, and there is still a need for more practice on how urban residents can engage in bottom-up actions to protect urban butterflies. Service design methods and tools play a pivotal role in social innovation for more-than-human contexts. Due to the specificity of non-human roles, participatory design methods can better blend human and non-human perspectives. On the one hand, participatory design methods help to promote a bottom-up movement of citizens in response to new forms of innovation; on the other hand, participatory design allows designers and participants to explore or critique possible futures and create speculative future scenarios.

Although participatory design has been utilized in several projects related to non-human and more-than-human contexts, the practice remains underexplored. For instance, butterfly species in the Milan area and their associated ecosystems. Even though the European Commission has launched numerous actions and initiatives related to pollinators, unclear methods or programs for citizens may hinder broader practice and application. Therefore, this thesis aims to explore the possibilities of future city life around butterflies in the Milan area through a participatory design-based approach that promotes bottom-up action by residents.

To achieve this goal, it is necessary to explore the challenges butterflies face in the city of Milan and the limitations urban residents face in their action processes. Milan and its region have a specific geography and ecosystem, implying the necessity to study the city of Milan. These issues form the basis for guiding the research and design. Therefore, studying native butterflies, plants, and landscapes requires further research and analysis.

The research objectives of this thesis are:

- Explore the current status of butterflies in the Milan area and the primary challenges and obstacles to their survival in the city.

- Understand the attitudes and perceptions of Milan's urban residents towards butterfly conservation and explore ways to promote bottom-up butterfly conservation actions among residents.

This thesis endeavors to answer these questions through a comprehensive study. The research will be conducted in the city of Milan, integrating the tools of service design and participatory design methods to envision future possibilities for more-than-human collaboration with Milanese citizens.

4.2 Methodological

The objective of developing service design is to create a systems perspective (Julier & Moor, 2009) and provide more comprehensive design tools (Stickdorn & Schneider, 2012), offering potential pathways to scale up design and promote democratic infrastructure and governance (Margolin, 2012). On a practical front, service design can adopt a participatory design approach, inviting stakeholders to engage in design workshops and providing toolkits. For example, to comprehensively address urban issues, it is necessary to activate the capacity of individuals and communities, thus requiring active citizen participation (Concilio & Rizzo, 2016).

In this thesis, the participatory design process is mainly promoted in the design phase through the form of Co-Design. Service-driven social innovation for more-than-human entities encourages diverse stakeholders to collaborate and share their ideas during a service innovation process through co-design (Trischler et al., 2017). Participants and designers can achieve varying levels of engagement during this process, ranging from involving users in exploration phases to actively engaging them in decision-making activities (Halskov & Hansen, 2015).

Therefore, to comprehensively develop the project practice of this thesis, the service design framework and participatory design methods is adopted to study and develop the project. The purpose is to integrate the different perspectives of butterflies and citizens, enabling butterflies and related ecosystems to share living space within the city.

4.2.1 Service Design Framework

The most challenging aspect of this thesis is the participatory design component, primarily due to the intricate nature of non-human perspectives and the limitations within citizen action. For instance, citizens' confusion and misconceptions regarding the survival requirements of non-human species in their actions on behalf of them can result in ineffective, adverse impacts, or even disruptions in action. Therefore, citizens need to grasp the needs and viewpoints of non-humans within participatory design processes, forming the foundation for unfolding "large-scale action." Selloni and Rossi (2018) define a framework for organizing the methods, tools, and phases of this emerging practice.

As shown in Figure 26, the framework is built upon the renowned Double Diamond Model proposed by the Design Council (2014), delineating four phases involving alternating divergent and convergent thinking:

- **Discovery:** gathering insights from ethnographic research;
- **Definition:** identifying the design challenge;
- **Development:** creating and testing various solutions;
- **Delivery:** finalizing the project.

In contemporary times, collaborative practices influence all phases and contexts of design activity and processes (Sanders and Stappers, 2008; Steen, 2013), encompassing opportunity finding to prototyping, creation to evaluation, and laboratories to the streets (Ehn, in DiSalvo, 2017).

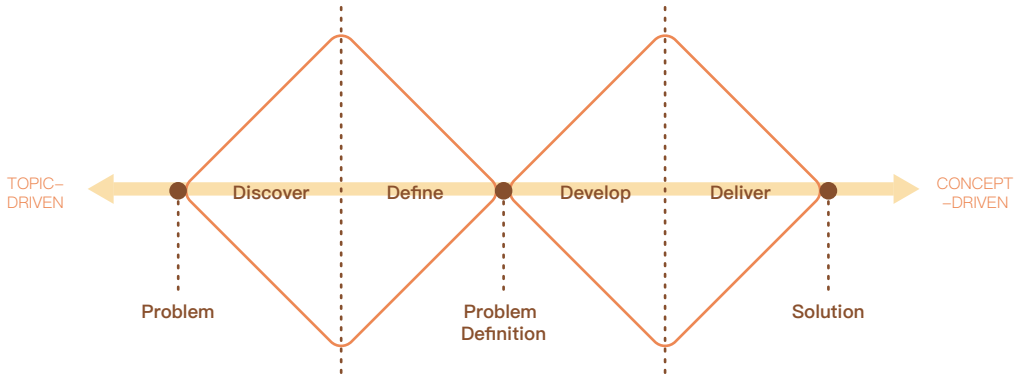


Figure 26. The Double Diamond scheme elaborated with two polarities about the subject matter of design.

- The 'Discover' phase: aims to define the scope of the work, which usually involves rapid ethnographic fieldwork and, in conjunction with other research activities, facilitates a deeper understanding of the problem.

- The "Definition" phase: aimed at interpreting all the possibilities identified during the discovery phase, it often requires interaction with experts or other relevant project stakeholders to define the actual "project brief" that describes the design challenge and its fundamental specifications. For this result, a rather dialectic approach is taken (Sennett, 2012), in which diverging positions have to progressively converge and reach a synthesis (Meroni & Rossi, 2018).

- The "Development" phase: aimed at creating, (pre)prototyping, and iterating solutions or concepts, is the most regular activity in the design process, almost collaborative and multi-actor in nature (Meroni & Rossi, 2018).

- The "Delivery" phase: aims to finalize and produce the project results. It implies all stakeholders' joint participation to achieve the objectives (Meroni & Rossi, 2018).

Considering that this series of phases is a linear as well as an iterative process, it is common to use a two-tiered axis to summarize the theme behind it (Meroni & Rossi, 2018):

- On one side are "Topic-driven" activities, which refer to issues/situations that have to be investigated throughout the project,
- On the other side, "Concept-driven" activities refer to the direction set in the problem-solving brief.

4.2.2 Collaboration within a Creative Process

However, how can citizens perceive the "voices" of non-human roles? Within the context of this thesis, how can designers incorporate the perspective of non-human actors into their interactions with participants, integrate the needs of non-human actors into the conceptual development process, listen to the 'voices' of non-human actors in the collaborative process, and consider non-human actors in their visions for the future? This thesis integrates the collaborative design framework (see Figure 27) into the service design framework, particularly in the "develop" stage of service design. It can assist citizens in better "perceiving" non-human roles. This aspect is crucial for social innovation involving more-than-human entities. It is a process in which participants can express and share their experiences, discuss and negotiate their roles and interests, and collaboratively bring about positive change (Steen, 2013, pp. 27- 28). The way the designer interacts with other participants influences their awareness of the process, contribution, relationship, critical thinking, self-criticism, and capacity to think beyond what is already known and their own "comfort zone" (Meroni & Rossi, 2018).

Building upon the considerations of the philosopher Dewey (1938), during co-design, both the "perceptive" (the capacity to see, hear, touch, smell, and taste what is) and "conceptive" (the capacity to imagine and envision what could be) capacities of all participants need to be adequately challenged and applied. Thus, the guidance of the approach can range between two stances: "active listening" and being "thought-provoking," reflecting a difference in purpose and situation (Meroni & Rossi, 2018):

- The "active listening" style encourages the free flow of thoughts and fosters empathy and sympathy between participants.

- The "thought-provoking" style directs the participants' thoughts toward critical aspects or opportunities of a given topic or concept. This guidance is likely to lead the participants on paths of thought and speculative journeys aiming to generate reactions and, in general, responsiveness to a given status.

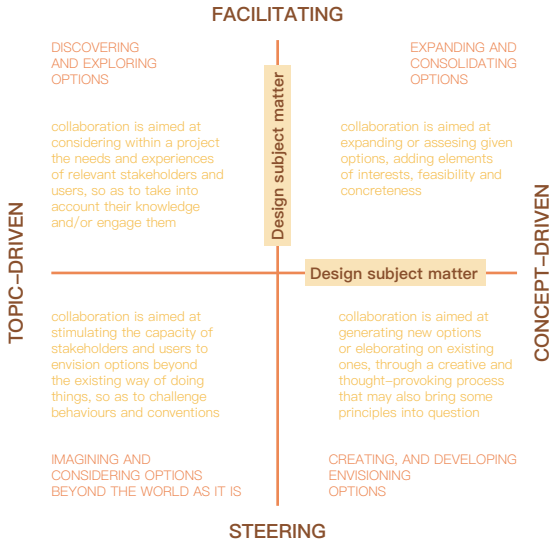


Figure 27. The Collaborative Design Framework.

Polarizing these two styles of guidance and the axes proposed by Meroni et al. (2018) allows us to visualize the different approaches to governing and conducting co-design activities:

- On one side, there is "(designerly) facilitation," which primarily relies on the techniques of "active listening" and related theories.

- On the other side, there is "(designerly) steering," which predominantly adopts the "thought-provoking" posture of designers as experts in envisioning the future.

In the "Topic-Driven" and "Facilitating" quadrant, we can categorize co-design initiatives that aim to Discover and Explore Options.

In the "Topic-Driven" and "Steering" quadrant, we can categorize co-design initiatives that aim to Imagine and Consider Options Beyond the World as It Is.

In the "Concept-Driven" and "Facilitating" quadrant, we can categorize co-design initiatives that aim to Expand and Consolidate Options.

In the "Concept-Driven" and "Steering" quadrant, we can finally categorize co-design initiatives that aim to Create, Envision, and Develop Options.

This thesis integrates the frameworks of service design and collaborative design. It aims not only to conduct a systematic study of the research issue but also to balance the survival needs of both humans and non-humans in the city. Through studying and analyzing butterfly species in the Milan urban area, the challenges faced by butterflies in the city are listened to from the perspective of butterflies. During the design phase, considering the different perspectives of butterflies and residents, fostering a deeper understanding and connection between the two, and co-designing a city where humans and non-humans coexist. This thesis hopes that through this framework, marginalized pollinators can be protected, and inclusive urban spaces for non-human roles can be created.

4.3 Research Methods

This thesis primarily focuses on detailed research and analysis in the following three aspects during the research phase:

- Types of butterflies and their habitat requirements in Milan.
- The current status, advantages, and disadvantages of green areas in the city of Milan.
- Attitudes and behaviors of residents in the city of Milan.

4.3.1 Methods of Data Collection

The field of user research encompasses a wide range of research methods. While employing the complete set of methods for a project is impractical, integrating multiple research methods and consolidating insights is advantageous for nearly all projects. To gain a clearer understanding of when to use specific methods, it is beneficial to categorize them within a 2-dimensional framework defined by the following axes (see figure 28) (*When to Use Which User-Experience Research Methods*, n.d.):

- Attitudinal vs. Behavioral
- Qualitative vs. Quantitative

The Attitudinal vs. Behavioral Dimension

This distinction can be succinctly expressed by contrasting "what people articulate" versus "what people enact" (frequently, the two are markedly different). Attitudinal research typically aims to comprehend or gauge individuals' stated beliefs, but it is confined to what individuals are conscious of and willing to disclose.

On the opposing end of this spectrum, methodologies primarily focused on behavior aim to comprehend "what people do" with the product or service.

The two most prevalent methodologies we employ fall within these two extremes: usability studies and field studies. They encompass a blend of self-reported and behavioral data and can lean towards either end of this spectrum, although a bias toward the behavioral aspect is generally advisable.

The Qualitative vs. Quantitative Dimension

This thesis employs the concurrent mixed methods, integrating quantitative and qualitative data to comprehensively collect, analyze, and interpret information related to the research question (Creswell, 2014).

Qualitative research, by its nature, generates data about behaviors or attitudes based on direct observation or firsthand accounts. Qualitative methods are suitable for addressing questions related to why or how problems are solved. On the other hand, quantitative studies gather data about behavior or attitudes indirectly. Quantitative approaches are better suited for addressing questions regarding numbers and types, aiding in resource prioritization (*When to Use Which User-Experience Research Methods*, n.d.).

The integration of various research methods contributes to understanding the challenges and obstacles faced by butterflies in the urban areas of Milan and the threats posed by human activities. Concurrently, citizen participation can better activate bottom-up actions to incorporate the survival needs of butterflies into the creation of urban green space.

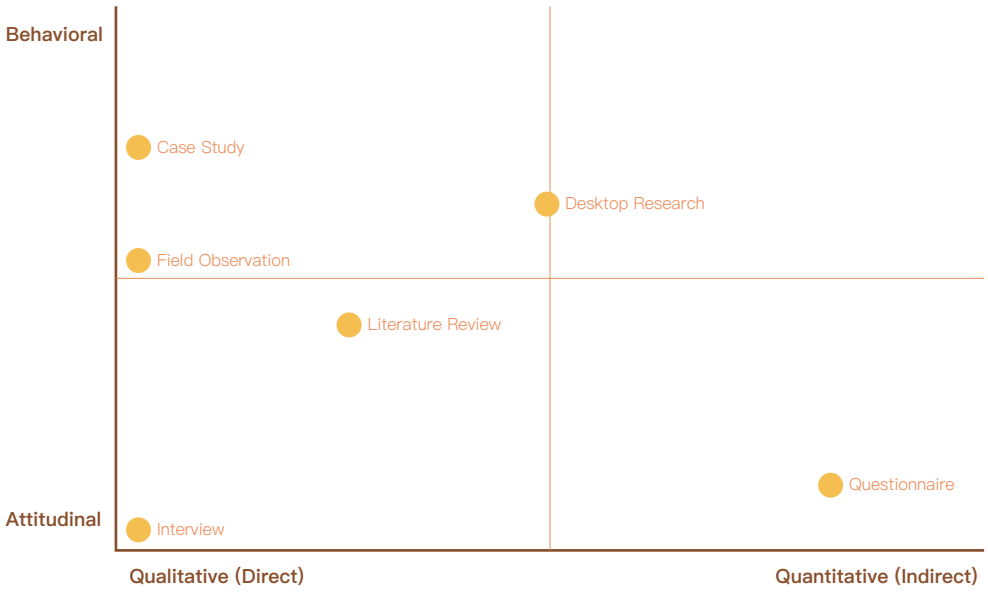


Figure 28. Adapted from The landscape of user research methods.

Among these methods, qualitative research serves as the primary source of non-human-related data. The research's structure encompasses field observations of Milan's urban environment and desk research on native butterfly species studied in the Milan region. The aim is to comprehend the current status of butterflies in Milan, the challenges they encounter in their growth process, and the threats posed by the urban landscape and human activities.

Social innovation for more-than-human beings is not entirely distinct from humans. Based on this theoretical standpoint, a bottom-up approach to design can facilitate the transformation and evolution of social innovation in design that transcends humanity. Some of the quantitative research data in this thesis were obtained from citizens in the city of Milan, with the purpose of collecting and analyzing citizens' attitudes, intentions, preferences, and insights. This information served as the foundation for planning and executing the action research project.

The design methods (See figure 19) used in the research process are:

Literature Review: This thesis conducted a comprehensive review of relevant literature, encompassing books, academic articles, and other pertinent sources in the field (Snyder, 2019). The literature review involved analysis, commentary, and insights, guiding the research in a particular direction.

Desktop Research: Desk research was conducted to identify specific and useful qualitative or quantitative data relevant to project requirements and to comprehend prevailing policy and business needs (March, 2023). This thesis employed desktop research to gain a thorough understanding of butterfly species and their ecological relationships. It identified potential threats to the survival of native butterfly species in Milan, synthesizing data to examine barriers to creating urban habitats for local butterflies.

Field Observation: Also known as unstructured observation, this research method involved gathering information about the research subjects through close visual observation. Observations and events were recorded as field notes (Academy, 2022b). This thesis used field observations to gather in-depth information regarding the use and current status of green spaces in Milan and the relationship between butterflies, citizens, and urban spaces. The field observations contributed to filling in data related to Milan's green spaces and facilitated qualitative research and analysis.

Case Study: The thesis employed case studies collection to comprehend action plans for local butterflies in other cities and to investigate coping strategies adopted in similar situations (McCombes, 2023b). These case studies provided insights into the current state of Milan's urban green spaces and landscapes.

Questionnaire: A quantitative study was conducted through a questionnaire to understand citizens' attitudes and actions towards non-human habitats in the city (Bhandari, 2023). The questionnaire served as a research foundation for co-design activities.

Interviews: One-to-one interviews were conducted with participants to delve deeply into their perspectives on the topic of interest (*Research Guides: Research Methods Guide: Interview Research*, n.d.). This thesis employed individual interviews with citizens residing in Milan to comprehend attitudes, willingness, motivations, and limitations of Milanese citizens concerning butterfly conservation in the city. There were no restrictions based on age or nationality, but participants needed to have permanent residence in Milan.

4.3.2 Methods of Data Analysis

Typically, in a planned research design following a classic project management approach, the data collection phase is succeeded by a period of data analysis. It is noteworthy that when researchers adopt an iterative research design with a visual synthesis and analysis process, they can avoid feeling overwhelmed by the volume of data. This is because the researcher goes through multiple iterations of data collection, synthesis, and analysis (Stickdorn et al., 2018).

Visualizing data can assist researchers in gaining an overview of the information volume, structuring complex data, identifying patterns, and revealing existing data gaps. It also enhances their understanding of a subject and fosters empathy with the individuals who were the subject of the research. There are various ways to work visually and present research; the choice depends on the researcher's objectives (Stickdorn et al., 2018).

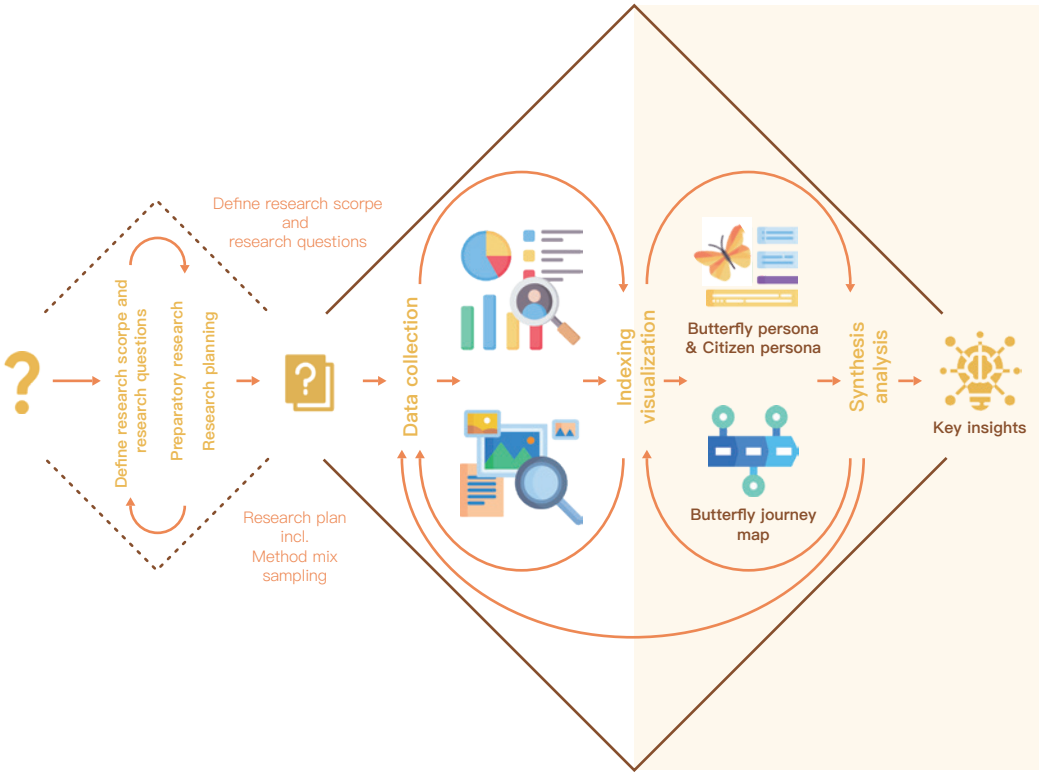


Figure 29. Design tools used in the research phase of this thesis.
Research activities are embedded in an iterative sequence with other activities of ideation, prototyping, and implementation.

This thesis analyzes insights and iterates on the collected data using visualization methods specific to research data in service design (see Figure 29). Furthermore, it presents research content and insights through pertinent design tools. Among the design tools utilized for data analysis and presentation are:

Key Insights: This thesis highlights potential issues through key insights from various facets of the city, landscape, plants, butterflies, citizenship, and more. They serve to summarize and iterate on the previously mentioned data collection content, as well as aggregate the final content analysis.

Butterfly Journey Maps: In traditional user/customer research, journey maps are employed to visualize customer experiences at different touchpoints (Stickdorn et al., 2018). However, due to the unique nature of social innovation for more-than-human (including non-human stakeholders), the journey maps in this thesis extend beyond human experiences to portray the experience from a butterfly's perspective. Challenges and obstacles in the city are visualized through the butterfly's journey map.

Non-Human Persona: This tool, used in Life-Centered Design, aims to establish an emotional connection with nature and non-human entities. Non-human personas aid in understanding the needs and perspectives of non-human actors, assisting researchers in creating designs that incorporate these actors. Developing a non-human persona involves scientific research, emotional narratives, and communication through various mediums. When done effectively, non-human personas help researchers comprehend nature or non-nature beyond traditional academic papers and statistical data (Spoelstra, 2023). In this thesis, they serve as a valuable tool for designing a world where all life can coexist harmoniously, accommodating nature, humanity, and an economy based on equality.

Personas: These exemplify different groups of individuals, such as customers or users, detailing their characteristics, goals, or tasks (Stickdorn et al., 2018). The thesis outlines the characteristics, needs, limitations, and visions of Milan residents willing to contribute to butterfly conservation through a citizen user profile.

4.4 Design Approach

4.4.1 Participatory Design

Participatory design is often used to facilitate the creation of collaborative ideas on a given topic, relying on the potential to generate new concepts by involving different perspectives non-hierarchically (Kensing & Blomberg, 1998). Co-design often builds on the tradition of participatory design (Schuler & Namioka, 1993). Co-design is a participatory design methodology. It emerged around the 60s in northern Europe and later acquired fame when IDEO rigorously described the process through design thinking. It is important to emphasize that this activity is done with people but not always for people (Toniolo, 2022). It has also been defined as an activity that combines the multiple visions and backgrounds of different people to solve the same problem (Scrivener, 2008) and is an activity that satisfies the need for collaborative and productive meetings between various stakeholders (Albisson, Lind & Forgren, 2008). Many innovation projects are currently organized as co-design processes (i.e., as processes of creative cooperation) (Steen, 2013).

Therefore, this thesis uses Co-design as a participatory design method, which organizes the creation and collaboration of ideas among stakeholders through Co-design workshops. This thesis follows the principles of Co-design in practice:

Principles for Co-design (*What Is Co-design? — Beyond Sticky Notes*, n.d.-c)

Share Power: Acknowledging and addressing differences in power are essential. In co-design, power is shared in planning, research (sometimes known as discovery), designing, and decision-making. Those with the most power should not solely influence decisions.

Prioritize Relationships: Co-design is not possible without relationships and trust. Building that trust takes time, especially when communities may not trust organizations or external consultants, often for valid reasons.

Use Participatory Means: Co-design is about people taking part. That means offering many ways for people to take part and express themselves, for example, through visual, kinaesthetic, and oral approaches. Co-design does not rely only on writing, slideshows, and reports. Participatory approaches facilitate self-discovery and move people from meeting participants to active partners.

Build Capability: With enough time and care, co-design can build new skills for all. Some people need support and encouragement to take on new ways of being and doing, learn from others, and have their voices heard. Designers can move from being perceived as 'experts' to coaches, enablers, or hosts to provide the necessary support.

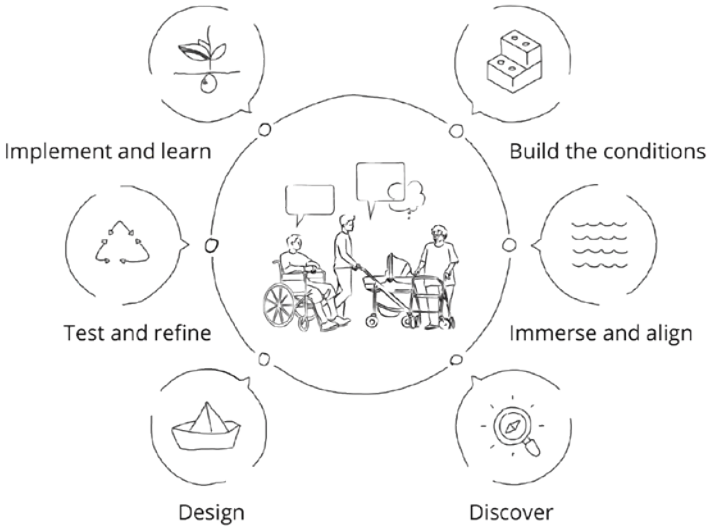


Figure 30. A co–design process (What Is Co–design? — Beyond Sticky Notes, n.d.–b).

4.4.2 Co-design processes

In the context of social innovation, transcending the complexity and criticality of the human world requires more extensive changes and practices beyond traditional methods to design for more-than-human. However, due to the inability of non-human actors to actively participate in the workshop as communicators, this thesis faces a fundamental question:

How can we effectively incorporate the perspective of non-human actors and evaluate solutions in the participatory design process?

Given the limited application of design practices involving non-human entities in existing co-design workshops and methods, the co-design workshop in this thesis is based on the traditional co-design process (See Figure 30). The co-design process is structured into six stages, namely "Building the Foundation," "Immersing and Aligning," "Discovering," "Designing," "Testing and Refining," and "Implementing and Learning" (*What Is Co-design — Beyond Sticky Notes*, n.d.).

This thesis chooses to explore, share, and expand the perspective of non-human actors during the 'Building the Foundation' and 'Immersing and Aligning' stages of this process. It leverages the understanding of non-human actors' behaviors, needs, and initiative as evaluation and reference factors during the 'Designing,' 'Testing and Refining' stages (see Figure 31).

The co-design process

Build the conditions: To select the right people for this Co-Design workshop, invite individuals whose interests are relevant or applicable. Since non-human actors cannot be present as participants, this thesis invites residents living in Milan to participate in the event. The perspective of the non-human actors (butterflies) is also presented through various media formats (slides, posters, etc.).

Immerse and align: Due to the participants' varying knowledge about non-human actors, the workshop first needs to help the participants understand the common goals and needs of the non-human actors and the challenges faced by them.

Discover: At this stage, the workshop focuses on listening to the voices and wishes of citizens, understanding the limits of citizen action, and the future vision that citizens expect with non-human actors.

Design: Collaboratively envision potential future scenarios and bottom-up action plans with participants. These design concepts and ideas aim to enhance survival opportunities, habitats, and shelters for non-human actors (butterflies) within the urban environment.

Test and refine: Organize participants to review, assess, and provide feedback on their solutions, selecting the most promising ideas through simple prototype testing or discussion. The evaluation criteria should consider the perspective of non-human actors while also taking into account the experiences of residents. This aims to facilitate improved coexistence between humans and non-humans in the city.

Implement and learn: Implement the design solutions as far as possible and reflect on and summarize their content.

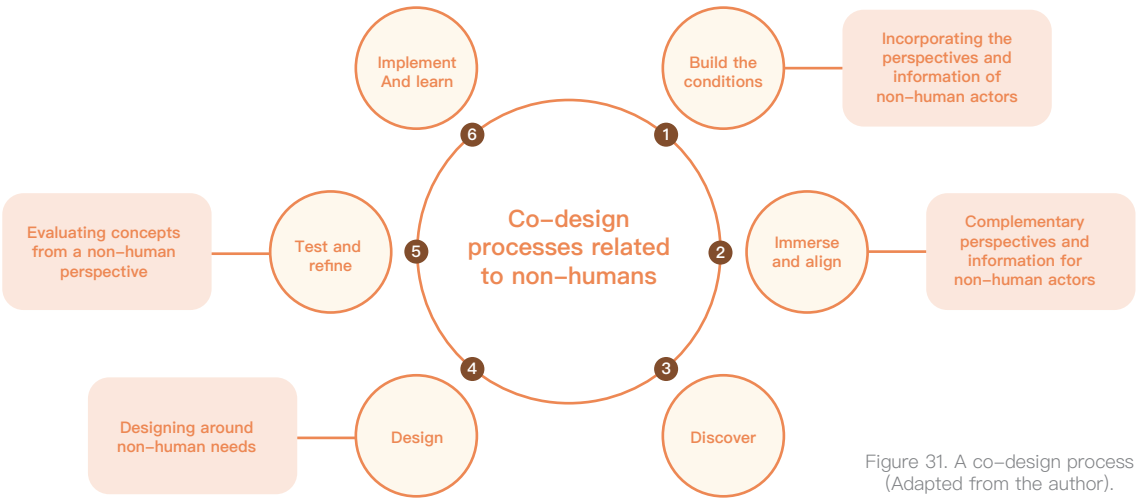


Figure 31. A co–design process (Adapted from the author).

4.4.3 Methods of concept iterations and outputs

This thesis plans to unfold further creativity, discussions, and iterative solutions for the question of 'How butterflies can coexist with citizens in Milan?' through two co-design workshops during the project implementation. The goal is to integrate and refine the final concepts.

Regarding the mentioned 'final concepts,' this thesis opts to evaluate and make final adjustments based on expert feedback. The aim is to strike a balance between the needs of butterflies and the experience of bottom-up actions by residents. Moreover, through expert feedback, a more professional understanding of non-human actors can be obtained, along with validating the feasibility of the concepts.

Finally, this thesis presents the final concepts through a narrative from the perspective of butterflies, a service blueprint from the perspective of residents, and a stakeholder map encompassing the interests of both humans and non-humans (see Figure 32).

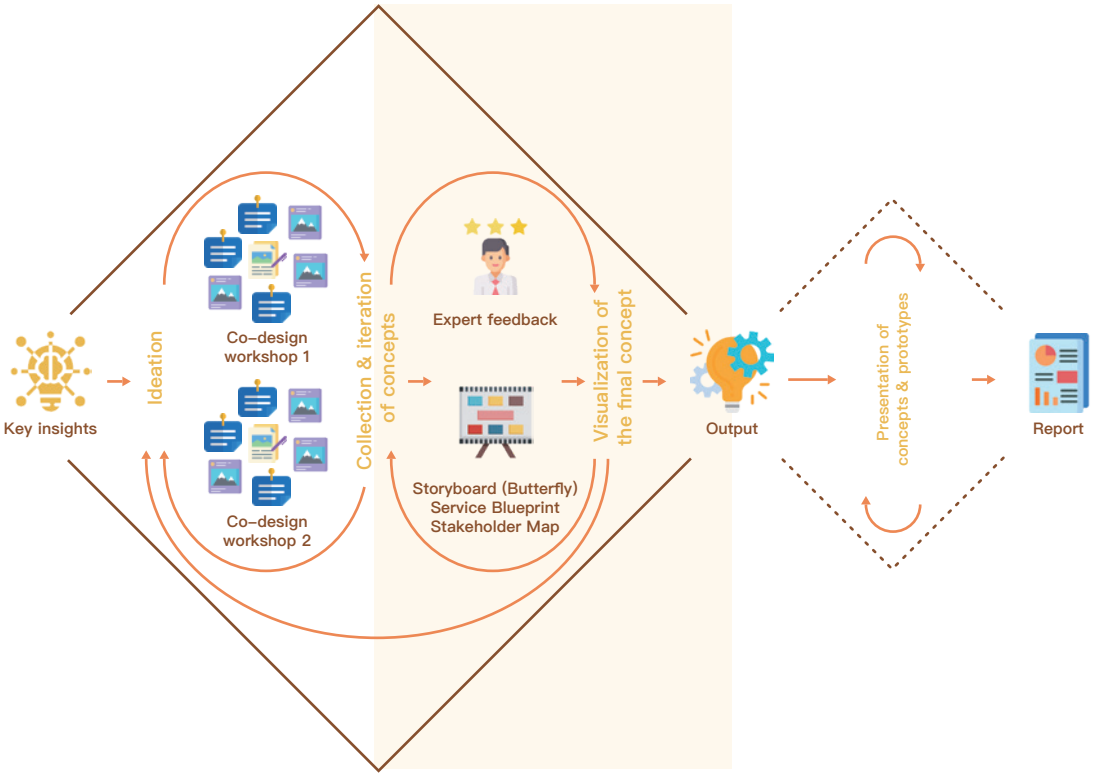


Figure 32. Design tools used in the design phase of this thesis.

4.5 Conclusion

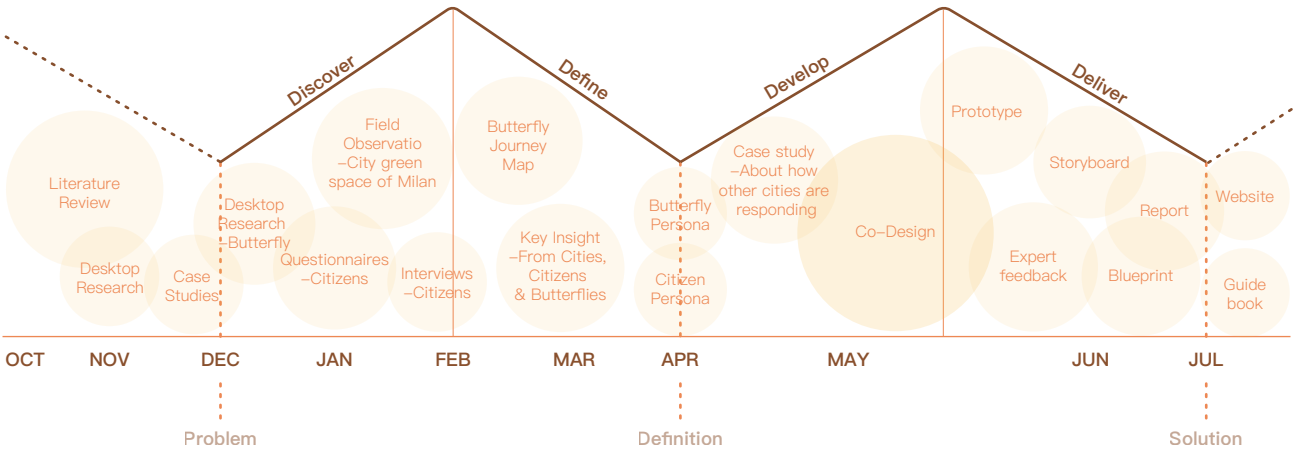


Figure 33. The project process for this thesis.

As depicted in Figure 33, this thesis encompasses all the design methods, tools, and the project's process.

The design methods used in this thesis still exhibit weaknesses in studying non-humans and presenting non-human perspectives. For instance, direct data collection methods for non-human data are lacking, and therefore, the majority of 'voices' from non-humans are derived from secondary research (specialized websites, reports, literature, etc.).

During the design phase, although this thesis aimed to provide participants with the non-human perspective (butterfly) as much as possible, participants had limited interaction with the butterfly actor and primarily empathized with the butterfly's experience. However, despite the limitations of these design methods, they were chosen for this thesis. Secondary data from non-human sources can offer specialized, intuitive, and comprehensive information about the species for this thesis. The future of more-than-human does not entail a complete disengagement from humans but rather the creation of new relationships for a co-living environment. Therefore, while the co-design workshop lacked direct human and non-human interactions, this study endeavored to prompt participants (Milan residents) to consider the butterfly's perspective while balancing the needs of non-humans with those of citizens as much as possible.

In summary, despite certain limitations in the design methodology and approaches employed in this thesis for non-human research, the service design framework sufficiently supports the systematic and comprehensive aspects of this study. The thesis looks forward to future research delving into more social innovation practices within the realm of the more-than-human, emphasizing the use and synthesis of methods in the design practice process, thus making design methods for the more-than-human or non-human perspectives more representative.

The following chapters will elaborate on the project's progress in this thesis. This includes a thorough exploration of the design framework, methods, and tools mentioned in this chapter, as well as the resulting outcomes discussed.

CHAPTER 5

BUTTERFLIES IN MILAN

5.1 Desktop Research
5.2 Field Observations
5.3 Butterfly Journey Map
5.4 Questionnaire
5.5 Non-human & Human Personas

5.1 Desktop Research - Butterflies in Milan

5.1.1 Butterfly species that may exist in the city of Milan

While macro-level challenges confronting butterfly species in Europe and Italy are outlined in Chapter 01, Literature Review, and Chapter 03, Background, this chapter specifically explores the threats and obstacles faced by certain butterfly species in the Milan area. This exploration is conducted through a thorough desktop study, involving the selection of butterfly species from the Italian Red List that might be present in the Milan area, both within the city and its surroundings. The study aims to identify the environmental challenges encountered by these endangered butterfly species. These species have been impacted to varying degrees by negative consequences of human activities and land use. In this thesis, the chapter analyzes the specific causes of these detrimental impacts. The primary source of information is https://www.iucn.org/.

Hence, the desk research process in this chapter is divided into the following five research steps (Villegas, 2021):

Identify the research topic: Before commencing the research, based on the topic and scope mentioned in the background of Chapter 03, this desktop research aims to investigate specific butterfly species in the Milan area and understand the reasons for their vulnerability.

Identify research sources: This thesis consults information from specialized websites related to butterfly species or from the websites of relevant animal or insect conservation agencies.

Collect existing data: Relevant information for this thesis's topic is selected from these research sources.

Combine and compare: The causes and findings of the specific research are studied in depth, combined, and compared with data from the study of Milan's urban environment.

Analyze data: The collected data is analyzed in this thesis, enabling a comprehensive exploration of the actual causes and their presentation.

Euphydryas maturna

Photo by Mauro Gianti
photo catalogue at www.leps.it

Red List Category: Critical risk (cr)
Cause: The species was on the brink of extinction. Over the course of eight years, the population declined by more than half. Currently, the species exists in only one population located in the Cuneo province. This population is excluded from the Natura 2000 network and is far from protected areas, with a count of less than 250 individuals. The effective occupied area is less than 100 km², and the actual occupied area is less than 10 km². This species is under severe threat due to commercial purposes and collection. There are additional concerns regarding the lack of management of ash trees (which serve as nurse plants) and overgrazing in the spring, which could adversely affect mature larvae feeding on psyllids. Consequently, the species is assessed as critically endangered (CR).

Present Distribution and Geographic Area:
Currently, the species is limited to a single population located in the Italian province of Cuneo. Former populations in the province of Turin became extinct around 1920.

Population and Trends:
The species faced a near-extinction scenario, with its population more than halving within eight years. The sole known population was identified in 2003 (Rooster & Gianti, 2003) outside the expanding Natura 2000 network. This sole population comprises fewer than 250 individuals.

Habitat and Ecology:
This species follows a univoltine life cycle. It relies on two distinct host plants (water hyacinth and plantain) before and after overwintering (Dolek et al., 2013).

Environment:
Terrestrial

Major Threats:
The species faces severe threats from extensive commercial collection. Additionally, concerns are raised regarding the lack of management of Ash plants, which can create an overly dense canopy, hindering oviposition and larval development. Spring overgrazing is also a significant concern, negatively impacting mature larvae that feed on Plantago.

Conservation Measures:
The species is yet to be included in the Natura 2000 network and remains distant from protected areas, complicating monitoring efforts. Urgent actions are required, including the designation of a site of community importance and the subsequent development of a comprehensive management plan. The imperative to conserve this population has intensified following recent work (awaiting scientific validation based on compelling data) designating it as an Italian endemic species (Euphydryas italica) (Back et al., 2015).

Source of Information: http://www.iucn.it/scheda.php?id=1178402857

Key insight

- Bulk collection for commercial purposes
- Lack of plant management and dense canopy preventing larvae from laying eggs and developing
- Overgrazing, with fewer parasitic plants needed by larvae

- Lack of detection and protection
- Lack of science education and civic awareness
- Lack of management of plants involved in the butterfly's growth period
- Lack of host plants and insufficient space and resources for larvae to breathe

Papilio alexanor

Photo by Paolo Mazzei
photo catalogue at www.leps.it

Red List Category: Endangered (EN)
Cause: The species has a limited range and is identified in fewer than 5 locations within the Ligurian and Maritime Alps. The distribution area spans less than 5,000 km^2. Not all populations are situated within protected areas, and the count of mature individuals is steadily decreasing due to severe harvesting, although quantifying this is challenging. Other potential threats include unregulated sheep grazing and reforestation. Due to these factors, the species is categorized as Endangered.

Present distribution Geographic area:
This species is found exclusively in Italy, particularly in the Ligurian and Maritime Alps. Some occasional sightings in Calabria and the Etna area pertain to migrating individuals of Balkan origin.

Population and Trends:
The southern population does not appear to be stable, consisting mainly of transient individuals. In certain areas, the species has become extinct in the North due to intensive harvesting.

Habitat & Ecology:
This species is a highly colonizing one and is polyphagous, feeding on various plants belonging to the Apiaceae family (e.g., Ptychotis, Opapanax, Trinia).

Environment:
Terrestrial

Major Threats:
The current major threat to this species is illegal collecting, which is challenging to control and quantify due to its extensive nature. Particularly, easily identifiable caterpillars are unlawfully collected. Controlled grazing can also have detrimental effects on Italian populations.

Conservation Measures:
The species is listed in Annex IV of the Habitats Directive and Appendix II of the Berne Convention. However, not all populations are encompassed and protected by the Natura 2000 network. Effective measures and surveillance are necessary to combat illegal collecting.

Source of Information: http://www.iucn.it/scheda.php?id=382569107

Key insight

- Adults are illegally collected, resulting in reduced spawning and mating populations
- Intensive logging and reforestation, natural reforestation leading to loss of habitat and plants they depend on

- Lack of regulation and protection of butterflies while they are growing
- Lack of science education and civic awareness
- Lack of replenishment of plants on which the butterflies depend during the process of natural reforestation

Araschnia levana

Photo by Paolo Mazzei
photo catalogue at www.leps.it

Red List Category: Endangered (EN)
Cause: The species is assessed as Endangered. In the past, it was present in Piedmont, Veneto, and Friuli; now it has a restricted area (actually occupied area (AOO) less than 500km²) and is known in only 2 locations, one North of Verona and one in the Tarvisio area. The reasons for the drastic decline of this species are not obvious. However, habitat reduction by humans is contributing to the effects of global warming. More studies are needed to understand the causes of the decline. More studies are needed to understand the causes of the decline.

Present distribution Geographic area:
The species is currently found only north of Verona and in the Tarvisio area.

Population and trends:
This species was once present in Piedmont, Veneto, and Friuli. All "historical" populations are currently extinct.

Habitat & Ecology:
It is a strongly colonizing species and a polyphagous feeder, consuming various species belonging to the Apiaceae family (e.g., Ptychotis, Opapanax, Trinia).

Environment:
Terrestrial

Major Threats:
The larvae of this species develop on some species of the genus Urtica.

Conservation Measures:
The reasons for the drastic decline of this species in the Italian peninsula are not obvious. Human activities have reduced the preferred habitat of the species. Additionally, they are affected by global warming.

Source of information: http://www.iucn.it/scheda.php?id=-390902479

Key insight

- Habitat shrinkage due to human activities
- Changes in associated habitat ecosystems due to climate warming

- Habitat loss and fragmentation due to human activities, lack of adequate habitat area and space for movement
- Lack of host plants and food needed for survival

Melitaea britomartis

Photo by Paolo Mazzei
photo catalogue at www.leps.it

Red List Category: Endangered (EN)
Cause: The species has a relatively limited range and is only known in 7 small populations, which are fragmented and isolated in the North East. The distribution area (EOO) is less than 5,000 km², and the actual occupied area (AOO) is less than 500 km². A continuous decline is projected mainly due to the threat of abandonment of mowing practices and conversion into cultivated fields. Moreover, recently, it has been highlighted that the species can be very vulnerable to meteorological anomalies (anomalous rainfall is quite frequent during the flight period). The species is assessed as Endangered.

Present distribution Geographic area:
The range of this species, now heavily restricted, once covered the hills of northern Piedmont (now extinct), western Lombardy (now extinct), and Friuli. At present, surviving populations are only found in the North East.

Population and trends:
Historically, only 31 populations were known in an agricultural-industrial matrix in the northern portion of the Po Valley. Among these, 24 became extinct before the 1980s. Currently, seven small, fragmented, isolated populations survive in the North East. These residual populations are currently not protected. The species is challenging to distinguish from its congeneric, so monitoring data must always be validated by expert personnel.

Habitat & Ecology:
In Italy, M. britomartis is a hygrophilous species found in marshy meadows, such as those of the Friulian Springs. The adults are not very mobile but relatively sedentary. They are polyphagous species, and the larvae develop on different plants belonging to the families Plantaginaceae and Scrophulariaceae (e.g., Plantago lanceolata; Veronica).

Environment:
Terrestrial

Major Threats:
The abandonment of mowing practices and conversion to cultivated fields pose a significant threat to the remaining populations. Recent work has highlighted the vulnerability of populations of this species to meteorological anomalies, particularly anomalous rainfall, which is quite frequent during the flight period.

Conservation Measures:
Residual populations should be safeguarded through appropriate management plans that apply agri-environmental measures to ensure the survival of occupied areas while maintaining traditional agricultural practices.

Source of information: http://www.iucn.it/scheda.php?id=-729600037

Key insight

- The species is vulnerable to unusual rainfall due to climate change during flights
- Impacted by human activities, changes in agricultural activities make the species lose its habitat
- Pollution from agriculture and industry
- Changes in the structure of the landscape due to natural recreation, the impact of climate warming on rainfall, resulting in a lack of shelter plants for the species
- Lack of host plants and habitats for the species due to changes in agricultural activities and farming practices
- Lack of control of chemical pollution leads to the extinction of populations in polluted areas

Maculinea alcon

Photo by Jens Christian Schou
photo catalogue at www.leps.it

Red List Category: Vulnerable (VU)
Cause: The species is confined to a portion of the Po Valley, representing the southern limit of its range (AOO less than 2,000 km²).Populations linked to habitat 6510 (Molinietum) suffer from habitat deterioration and abandonment of practices. Each population comprises only a few individuals, less than 1000, often not reaching 200 specimens. In the last ten years, at least four populations have become extinct, and the populations investigated with Capture Marking Recapture exhibit extreme fluctuations and reductions in the total number of individuals.

Present distribution Geographic area:
This species is limited in Italy to a small number of populations in Piedmont, Lombardy, Veneto, and Friuli.

Population and trends:
Due to severe habitat fragmentation, this species is present in 2-3 localities in Piedmont and Lombardy. There have been many recent extinctions, including the Biella area and the lakes of Ivrea (Casale).

Habitat & Ecology:
The species inhabits hygrophilous grasslands and is monophagous on Gentiana pneumonanthe. The larvae feed up to the IV stage on the host plant and subsequently live as obligate parasites inside ant nests of the genus Myrmica, where they are fed by trophallaxis.

Environment:
Terrestrial

Major Threats:
The species is threatened by habitat loss due to the intensification of agricultural practices and abandonment, which leads to reforestation and does not guarantee the survival of the nurse plant and the host ants. It also inhabits hygrophilous grasslands threatened by excessive water withdrawal from the aquifer. Climate change, particularly anomalous drought events, creates dangerous and documented temporal mismatches between the flight period and the flowering of the nurse plant.

Conservation Measures:
The species is not protected by national or Community legislation. However, some populations are located in Natura 2000 areas. It is necessary to keep the grasslands open to Molinia coerulea, which is inhabited by the species.

Source of information: http://www.iucn.it/scheda.php?id=-382512839

Key insight

- Fragmented Habitat
- Very dependent on specific parasitic plants and parasitic animals
- Agricultural practices lead to habitat reduction
- Climate warming leads to a mismatch between the flowering times of adult butterflies and nurse plants

- Lack of habitat or too small a habitat area
- Lack of host plants and parasitic animals during larval growth
- Lack of shelter and food/nurse plants

Maculinea teleius

Photo by Paul Tout
photo catalogue at www.leps.it

Red List Category: Vulnerable (VU)
Cause: The species is restricted to a portion of the Po Valley, marking the southern limit of its range. Populations associated with habitat 6510 (Molinietum) face habitat deterioration and the abandonment of agricultural practices. It is evaluated as Vulnerable (VU) since each population is isolated, consisting of only a few individuals, usually fewer than 1000 units and often not exceeding 200 specimens. Populations investigated using Capture Marking Recapture exhibit extreme fluctuations.

Present distribution Geographic area:
This species is limited to the Po Valley in Piedmont, Lombardy, and Friuli, with small isolated populations.

Population and trends:
Many local extinctions have been observed.

Habitat & Ecology:
The species inhabits hygrophilous grasslands and is monophagous on Sanguisorba officinalis. The caterpillars feed on host plants until the fourth stage and then live as specialized parasitoids in nests of Myrmica spp., where they feed on larvae.

Environment:
Terrestrial

Major Threats:
The species is threatened by habitat loss due to the intensification of agricultural practices and abandonment, resulting in reforestation that endangers the survival of the nourishing plant and the host ants. Additionally, the species inhabits hygrophilous grasslands threatened by excessive water withdrawal from the aquifer. Climatic changes, particularly anomalous drought events, disrupt the flowering patterns of the host plant.

Conservation Measures:
The species is included in Annexes II and IV of the Habitats Directive. It is crucial to maintain the meadows of Molinia coerulea, inhabited by the species, open through mowing or controlled cattle grazing.

Source of information: http://www.iucn.it/scheda.php?id=824924287

Key insight

- Fragmented Habitat
- Very dependent on specific parasitic plants and parasitic animals
- Agricultural practices lead to habitat reduction
- Climate warming leads to a mismatch between the flowering times of adult butterflies and nurse plants

- Lack of habitat or too small a habitat area
- Lack of host plants and parasitic animals during larval growth
- Lack of shelter and food/nurse plants

Plebejus trappi

http://www.farfalleitalia.it/sito/549/index.php

Red List Category: Vulnerable (VU)
Cause: The species has a restricted range and is known in fewer than 10 locations in Northern Italy. The distribution area is less than 20,000 km², and the effectively occupied area is less than 2,000 km². The habitat is in decline due to reforestation. For these reasons, the species is classified as Vulnerable (VU).

Present distribution Geographic area:
The species is present only in northern Italy (Val d'Aosta, Ossola, northern Alto Adige) and Switzerland.

Population and trends:
The species is found in small populations.

Habitat & Ecology:
The species is monophagous, relying on Astragalus centroalpinus. The larvae have a moderate level of association with ants.

Environment:
Terrestrial

Major Threats:
The species is threatened by reforestation.

Conservation Measures:
Efforts should be made to actively counter the natural reforestation of colonized sites.

Source of information: http://www.iucn.it/scheda.php?id=-1685951819

Key insight

- Threatened primarily by reforestation
- May lack host plants and shelter due to natural reforestation

Euphydryas aurinia

Photo by Paolo Mazzei
photo catalogue at www.leps.it

Red List Category: Vulnerable (VU)
Cause: The species has a restricted range and is known from a portion of the Po Valley, representing its southern limit. The distribution area is less than 20,000 km². Populations are highly fragmented, isolated, and in continuous demographic decline. They suffer from habitat deterioration and the abandonment of traditional agricultural practices, such as mowing, which is considered unprofitable for the grasslands dominated by Molinia. Overgrazing and intensification of agricultural practices, as well as water drainage, are also detrimental to this species, resulting in declines in mature individuals. For these reasons, the species is classified as Vulnerable (VU).

Present distribution Geographic area:
The species is restricted to a portion of the Po Valley, representing the southern limit of its range.

Population and trends:
Populations are highly fragmented, isolated, and experiencing continuous demographic decline.

Habitat & Ecology:
As a lowland species, it inhabits hygrophilous meadows and is linked to Habitat 6410 Molinietum. It is a polyphagous species, feeding on several species belonging to the Caprifoliaceae family (e.g., Succisa pratensis, Knautia arvensis).

Environment:
Terrestrial

Major Threats:
The populations suffer from habitat deterioration and the abandonment of traditional agricultural practices, such as mowing, which is considered unprofitable for the grasslands dominated by Molinia. Overgrazing, intensification of agricultural practices, and water drainage are also detrimental to this species.

Conservation Measures:
The species is listed in Annex II of the Habitats Directive and is within the Natura 2000 network. An ad hoc management plan should be developed and applied.

Source of information: http://www.iucn.it/scheda.php?id=749940127

Key insight

- Impacted by changes in agricultural practices
- Affected by overgrazing
- Affected by pollution of agricultural drainage

- Lack of management of agricultural and livestock activities
- Lack of parasitic plants with specific habitat requirements

Euchloe Tagis

Photo by Matt Rowlings
photographic catalog on www.leps.it

Red List Category: Near Threatened (NT)
Cause: The evaluation of the species is categorized as Nearly Threatened (NT), based on criterion B1. Even though its distribution area (EOO) slightly exceeds 20,000 km², the two populations (Ligurian and Southern Maritime Alps and Tuscany) are fragmented, lacking the exchange of individuals. The habitat is consistently declining due to reforestation and uncontrolled fires, especially in the Tuscany region.

Present distribution Geographic area:
The species is found in two distinct regions in Italy: the Ligurian and southern Maritime Alps, and Tuscany.

Population and trends:
The species is primarily prevalent in Monte Calvi, located in Tuscany. There is limited exchange of individuals between the populations in Tuscany and those in Piedmont/Liguria, resulting in two distinct groups of allopatric populations.

Habitat & Ecology:
The species is oligophagous, with larvae developing on specific species of the genus Iberis.

Environment:
Terrestrial

Major Threats:
The species is threatened by reforestation and uncontrolled fires, especially in Tuscany, which can eliminate suitable habitats.

Conservation Measures:
To mitigate the threat of reforestation, extensive cattle grazing should be promoted and maintained.

Source of information: http://www.iucn.it/scheda.php?id=-774845733

Key insight

- Habitat loss due to grazing and natural disasters
- Lack of land-use management

Iolana iolas

Photo by Daniel More
photo catalogue at www.leps.it

Red List Category: Near Threatened (NT)
Cause: The assessment of the species is Near Threatened (NT) based on criterion B2a, given the species' effectively occupied area, which approaches 2,000 km², and its severe fragmentation. The populations are notably isolated and transient, closely tied to the availability and disappearance of their host plant, Colutea arborescens. A comprehensive study of distribution and autecology is imperative to comprehend the rarity of this species.

Present distribution Geographic area:
The species is found in Italy, ranging from the Alps to the Pollino massif.

Population and trends:
The species exists in small, isolated populations across its distribution range. In Lazio, there are indications of population reduction.

Habitat & Ecology:
This species forms temporary populations linked to the expansion and disappearance of its nurse plant, Colutea arborescens (a pioneer plant on abandoned land). It is a weakly mycophilous species.

Environment:
Terrestrial

Major Threats:
The habitats it occupies are transitional and unstable, which poses challenges for the species. Monophagy, being highly specialized, makes it demanding.

Conservation Measures:
A comprehensive study of its distribution and autecology is imperative to understand the fate of this species and develop targeted management plans compatible with agricultural activities.

Source of information: http://www.iucn.it/scheda.php?id=-1649550047

Key insight

- Habitat is transitory and unstable → Lack of stable habitat
- Requires specific plants for food → Lack of specific plants needed for survival
- → Lack of management of agricultural activities

Polyommatus dolus

Photo by Matt Rowlings
photographic catalog on www.leps.it

Red List Category: Near Threatened (NT)
Cause: The species has a limited range and is known in less than 10 locations in the Ligurian Alps. The distribution area (EOO) and the effectively occupied area (AOO) are slightly above the limit for the Vulnerable category (20,000 km² and 2,000 km², respectively). The species is threatened by changes in traditional agricultural practices and their abandonment, leading to reforestation.

Present distribution Geographic area:
The species is confined to a few locations in the Ligurian Alps, situated between 90 and 1,200 meters in altitude.

Population and trends:
The population appears to be in decline.

Habitat & Ecology:
This species is widespread in hills and prairies. The caterpillars feed on sainfoin (Onobrychis viciifolia) and alfalfa (Medicago sativa). The larvae are moderately myrmecophilous.

Environment:
Terrestrial

Major Threats:
The species is threatened by changes in traditional agricultural practices and their abandonment, resulting in reforestation.

Conservation Measures:
Maintain suitable habitats through the use of agri-environmental measures.

Source of information: http://www.iucn.it/scheda.php?id=1979484349

Key insight

- Habitat threatened as a result of natural regeneration
- Habitat loss due to changes in agricultural practices
- Lack of management of agricultural activities
- Lack of parasitic plants and food

Polyommatus restarted

Photo by Teresa Farino
photo catalogue at www.leps.it

Red List Category: Near Threatened (NT)
Cause: The species has a restricted range, primarily found in the Ligurian Alps and possibly in the Cozies, known in less than 10 locations. The distribution area (EOO) and the effectively occupied area (AOO) are slightly above the limit for the Vulnerable category (20,000 km² and 2,000 km², respectively). The species is threatened by changes in traditional agricultural practices and their abandonment, leading to reforestation.

Present distribution Geographic area:
The species is present in Italy primarily in the Ligurian Alps and possibly in the Cozies.

Population and trends:
The population trend is stable.

Habitat & Ecology:
This species is an oligophagous species, and its larvae develop on certain species of the genus Onobrychis. The larvae display moderate myrmecophily.

Environment:
Terrestrial

Major Threats:
The species is threatened by changes in traditional agricultural practices and their abandonment, leading to reforestation.

Conservation Measures:
No specific conservation measures information is available.

Source of information: http://www.iucn.it/scheda.php?id=-1167958593

Key insight

- Habitat threatened as a result of natural regeneration
- Habitat loss due to changes in agricultural practices
- Lack of management of agricultural activities
- Lack of parasitic plants and food

Satyrium pruni

Photo by Paolo Mazzei
photographic catalog on www.leps.it

Red List Category: Near Threatened (NT)
Cause: The species has a very small occupied area (AOO) of less than 2,000 km², and due to its specific habitat requirements, it is severely fragmented. The habitat is experiencing a decline and is subject to human-induced transformation. However, given that there are more than 15 distinct locations, the assessment of the species is classified as Near Threatened (NT).

Present distribution Geographic area:
The species is exclusively found in the Po Valley.

Population and trends:
The species is rare and localized.

Habitat & Ecology:
The species resides in floodplain thickets, forming primarily small and isolated populations. It is a polyphagous species, feeding on various plants belonging to the Rosaceae family (e.g., Prunus spinosa, P. padus, Rubus, Sorbus).

Environment:
Terrestrial

Major Threats:
The species is threatened by the fragmentation and transformation of its inhabited areas.

Conservation Measures:
Ad hoc management plans are necessary to maintain the abundance of nurse plants (genus Prunus, Rubus, Padus, Sorbus) and establish connections between the currently isolated subpopulations.

Source of information: http://www.iucn.it/scheda.php?id=743045775

Key insight

- Affected by habitat fragmentation ---------- • Lack of sufficient habitat area
- Fragmented habitat leads to isolated populations ---------- • Lack of continuous habitat

Lasiommata achine

Photo by Paolo Mazzei
photo catalogue at www.leps.it

Red List Category: Near Threatened (NT)
Cause: The species is classified as Near Threatened (NT) based on the A2c criterion. Over the last decade, the population has experienced a decline of approximately 20-25%. Many populations have become extinct, particularly in Piedmont and the Po Valley. This decline is attributed to habitat loss resulting from intensified agricultural practices.

Present distribution Geographic area:
The species was extinct in most sites of Piedmont and all those in the Po plain area. It is currently well represented in the central and eastern Pre-Alps, ranging from 250 to 1200 meters.

Population and trends:
Healthy populations are known in Veneto, although not all are within the Natura 2000 network. Numerous populations have become extinct in Piedmont and the Po Valley.

Habitat & Ecology:
The species inhabits mesophilic woods of the pre-alpine belt. It is a polyphagous species, feeding on various species belonging to the Graminaceae family (e.g., Brachypodium sylvaticum, Brachypodium pinnatum).

Environment:
Terrestrial

Major Threats:
The species is threatened by the intensification of agriculture, abandonment, and consequent reforestation.

Conservation Measures:
The species is included in Annex IV of the Habitats Directive. Agro-environmental measures can be applied to counteract the intensification of agriculture and abandonment, which leads to reforestation.

Source of information: http://www.iucn.it/scheda.php?id=1450213955

Key insight

- Habitat threatened as a result of natural regeneration
- Habitat loss due to changes in agricultural practices
- Lack of management of agricultural activities
- Lack of parasitic plants and food

5.1.2 Findings

Through an analysis concerning the 14 butterfly species at risk as presented in the table, it becomes evident that the most significant threats faced by these species in Milan are associated with habitat reduction or loss due to natural regeneration and agricultural intensification. The direct consequence is the loss of specific food sources for some species or the loss of host plants for larvae. As mentioned in preceding points, the urban redevelopment process often inadequately considers the habitat needs of native butterfly species.

On one hand, the loss of many native plants in the process of natural regeneration leads to a scarcity of food sources for butterflies. This is the current situation faced by the city of Milan and its surrounding areas. On the other hand, shrinking habitats limit the range of local butterfly species and render their habitats vulnerable. Combining background studies with an analysis of local species in Milan, several reasons for this situation can be identified:

- Different butterfly species have varying preferences for food and habitat. The overly complex survival needs of butterflies have not been adequately considered in the natural regeneration process of the city, which predominantly prioritizes human living needs.

- Due to the complexity of butterfly growth stages—eggs, caterpillars, chrysalises, adult butterflies, and the subsequent stage of mating and spawning—each stage confronts distinct survival requirements, such as specific microclimatic conditions and interactions with parasitic plants or animals. These intricate needs are challenging to plan for precisely in a uniformly managed and planned natural regeneration process.

- Certain human activities are diminishing or eliminating habitats for local species. The detrimental effects of patchy habitats extend beyond the reduction of food sources and may render species vulnerable due to inbreeding.

In summary, the low quality of butterfly habitats and habitat fragmentation resulting from natural regeneration are the primary threats in Milan, Italy, and its surrounding areas. Enhancing butterfly habitats in cities and increasing species diversity and richness require the attention of local governments and authorities, including bodies such as the European Commission. The challenges faced by butterflies in cities are also pertinent to the citizens residing in these areas.

In the following section, this thesis will explore the specific challenges butterflies encounter in their survival within Milan by analyzing both the natural environment and the current urban situation in the Milan region.

5.2 Field Observations - Urban Environment Of Milan

5.2.1 Milan urban enviroment for butterflies

Field observation is a qualitative research method that enables a deeper understanding of communities and environments (Field Observation- SmartVillages, 2021b). This method allows for a comprehensive understanding of the issues discussed in this thesis.

Field observation encompasses diverse social research methods, including direct observation, limited participation, document and information analysis, informal interviews, surveys, etc. Although field research is generally characterized as qualitative, it often involves multiple aspects of quantitative research (Bhat, 2023).

Generally, field observations are designed to observe, interact with, and understand people in their natural environments. For example, environmentailsts observe the behavior of animals in their natural environments and how they respond to certain situations. Furthermore, it is used to help answer descriptive research questions, build theories, or generate and test hypotheses (Bhat, 2023).

Field research typically commences in a specific setting, aiming to observe and analyze the specific behavior of a subject in that setting. However, analyzing the cause and effect of a specific behavior is challenging due to multiple variables in a natural environment. Most data collection is based not entirely on cause and effect but mostly on correlation (Bhat, 2023).

In this thesis, due to the specificity of non-human roles, only direct observation in field research methods is used. In this method, data is collected via an observational method of subjects in a natural environment. The researcher does not interfere with the behavior or outcome of a situation in this method. The advantage of direct observation is that it provides contextual data on people management, situations, interactions, and surroundings. This field research method is widely used in a public setting or environment but not in a private environment, as it raises ethical dilemmas (Bhat, 2023).

In this field study outlined in the thesis, the selected note-taking format is Job Notes, primarily motivated by the unpredictable frequency of non-human entities (butterflies) appearing in the relevant environment. Data collection is conducted through observational methods applied to subjects within their natural surroundings. The notes are intentionally brief, concise, and presented in a condensed format, enabling the researcher to subsequently expand and build upon the gathered information (Bhat, 2023).

Meanwhile, the purpose of the research in this thesis is:

- Through on-site observation, this thesis aims to understand the use and current status of landscapes or green spaces within the city of Milan.

- In conjunction with the previous butterfly study, this thesis will analyze the potential challenges to the survival of butterflies in these green spaces and plant environments.

In addition, what needs to be emphasized during the field observation research process in this thesis is:

- Understand the study's background, helping to gain insight into the existing data.

- Improve the quality of data. This research method uses more than one tool to collect data, resulting in higher quality data from which inferences can be made.

- Make inferences from the collected data. Ancillary data puts the researchers in a position of localized thinking, opening new lines of thought. This method can help collect data that the study did not initially account for.

Therefore, this thesis focuses on characterizing the different types of sites in the city of Milan and their impact on butterflies, pollinators, and neighborhoods during field observations. This method will provide qualitative data from the urban environment as a basis for research and analysis for subsequent studies.

This thesis presents field observations of various urban green spaces and parks in Milan. It was observed that most of the green spaces in Milan have a low distribution of plant species that do not provide enough food and shelter for the butterflies, while managed lawns make it less conducive for the butterflies to breed. Additionally, Milan has many fragmented green spaces and large parks that are far apart. Fragmentation and poor quality of butterfly habitats are the main challenges faced by the city of Milan.

The following content describes and analyzes six different types of sites in Milan: community gardens/vegetable gardens, urban street green spaces, urban parks, and urban commercial green spaces.

Location 1: The Friends of "Il Miglio delle Farfalle" have planted flowers in three locations along Corso Lodi, covering an area of about one mile.

Description

Il Miglio delle Farfalle" is initiated by civil society organizations, and they regularly organize activities related to nature and pollinators. A Facebook group also disseminates information about events and answers questions for participants. Participants come from diverse age groups and races. The primary objective is to enhance urban plant diversity through volunteer seeding and taking care of flowers and plants to create more habitat for pollinators.

Figures 34, 35, 36: Posters and signboards are placed in cities to promote and publicize pollinator conservation activities. City residents can learn about pollinators and take action by scanning QR codes, viewing signs, and joining the online Facebook groups.

Figures 37, 38: The Facebook Group (online forum) allows residents to ask questions or provide answers. Additional event information is also posted here.

The organization's volunteer activities include:

- Nature and Land Initiative to combat environmental pollution
- Organizing planting events
- Providing science education for children and youth
- Sharing seed envelopes

Offline activity

Figure 34.

Figure 35.

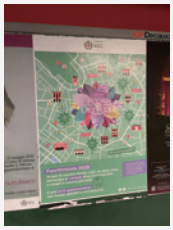


Figure 36.

Online community

Figure 37.

Figure 38.

Key insight

For butterflies:

While the organization actively promotes the protection of bees and butterflies, it's evident that "one mile" is insufficient. A sufficient area of habitat patches would be effective for butterflies in Milan. Also, due to the migratory nature of butterflies, direct and effective habitat-to-habitat connections are essential. Despite this organization's attention and focus on butterflies, it has initiated more planting activities, influencing the natural environment, bees, and other wild insects. However, it does not meet the survival needs of butterflies in their growth process. Given the complexity and variability of the butterfly growth process, organizations and participants need to be more focused on their actions.

For citizens:

The content in the Facebook group forum indicates that most participants have limited knowledge about plants and pollinators, particularly regarding how plants are grown or the types of plants preferred by pollinators.

Location 2: Community garden at the BOVISA campus of Politecnico di Milano

Description

The site is situated on the Milan Polytechnic campus. The participants primarily consist of community residents near the school. It serves as a community farm, and on November 20, 2022, in collaboration with the artist Claudia Zanfi, a hotel for bees was installed.

Key insight

- This collaboration between the artist and the community farm not only signifies an artistic endeavor but also underscores the necessity of targeted habitats for various species of pollinators. Hence, from a butterfly's perspective, providing them with a habitat in a community or urban green space becomes imperative.

- In the process of designing shelters for pollinators, consideration should be given to the physiological structures and survival needs of specific species. For example, there are significant differences in the physiological structures between butterflies and bees. Therefore, in conservation actions, it is essential to tailor the design activities based on the specific habits of butterfly species.

Photographed by the author

Location 3: Community garden at Via Guglielmo Pepe, 10, Milano

Description

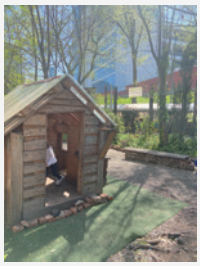
This is a community garden situated in Via Guglielmo Pepe, cultivating a variety of plants and offering the community plant-related resources like atlases and books, scientific growing methods and experiences, as well as designated growing sites. The garden is intentionally left uncleared of weeds to preserve wildlife habitats, providing shelters where diverse small wildlife, including pollinators, can thrive. Moreover, it acts as a hub for community activities, featuring a community center (equipped for projections and lectures), a simple basketball court, open spaces, and children's facilities. Typically, a community manager oversees the management of this community garden.

Key insight

- This garden that a rich plant diversity, ample plant acreage, and high-density plantings effectively attract pollinators and other wildlife. However, such high-quality habitat sites are scarce in Milan.

- Establishing such gardens necessitates bottom-up management and long-term maintenance. In contrast, one-off events or activities make it challenging to sustain the high-quality habitats vital for butterflies in the long run.






Photographed by the author

Location 4: Public Green Space – CityLife Park

Photographed by the author

Description

It is a vast and beautiful park, and surprisingly, the efforts of the Milan government for pollinators can be seen here. This park has a fenced-in area where native plants favored by pollinators are planted, and science is provided through signs and prevented from being destroyed by the public. This area not only provides a shelter for pollinators but also offers a diversity of plants to be planted (plants of different heights and growing seasons), which not only ensures a diversity of plants but also provides a more varied food for pollinators.

The QR code provided on the signage shares a botanical vision of Milan's future- a modern garden envisioned as an urban botanical library with an incredible botanical heritage: over 100 species of plants, 500 trees forming 22 circular forests, and 135,000 species of plants, including herbs, hedges, shrubs, aquatic and herbaceous plants, CityLife Park is also working towards this, and there is no doubt that this is a good start for the government to start acting for the diversity of animals and plants in the city.

Figure 39. Image source: https://bam.milano.it/the-park/collezione-botanica/

Key insight

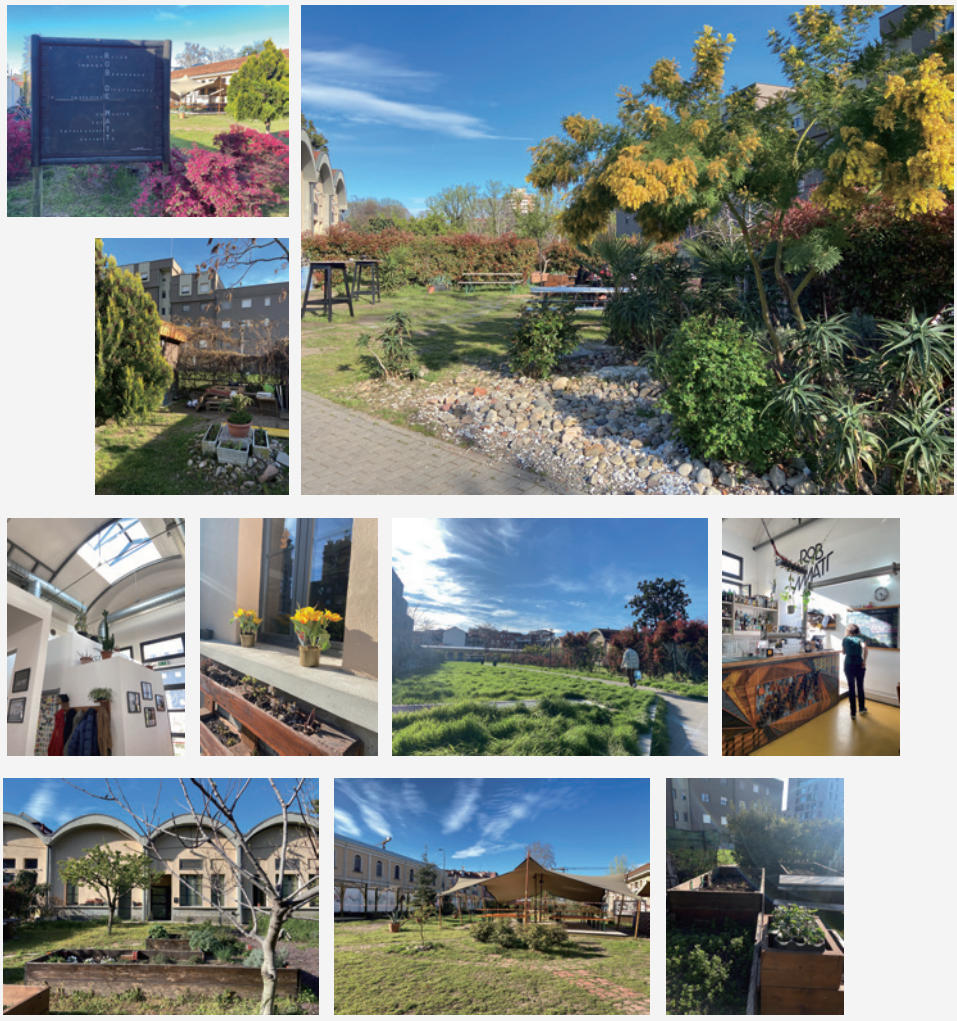
For pollinators/butterflies

- Despite the substantial efforts made by the park to enhance the diversity of animals and plants, as mentioned earlier, it falls short. Habitat fragmentation remains a significant issue for butterflies. More effective solutions and actions are needed to address questions about how to connect these high quality habitats.

For citizens

- The government in Milan is beginning to value ecological diversity and is working for it, yet there is not much citizen participation in the public space. There is not much science about the survival needs of pollinators. Citizens are aware of the diversity of plants through park planning. Although parks provide habitat for pollinators, it is also essential for citizens to learn about pollinators and ecosystems so that they can be more involved in nature conservation initiatives.

Location 5: Commercial area – Rob de Matt Restaurant, Via Enrico Annibale Butti, 18



Photographed by the author

Description

This is a commercial space imbued with natural elements, housing a restaurant and a bar. Abundant green spaces and a variety of plants are thoughtfully incorporated to cater to customers seeking outdoor dining experiences. While it may not be primarily designed for pollinators, the ample natural areas and diverse plants unquestionably create a pollinator-friendly environment within the city.

Key insight

- Commercial spaces with large green areas can still contribute to the diversity of plants. Providing some planting areas or habitats for the diversity of plants and animals can better interact with the surrounding residents or customers without conflicting environmental protection and commercial interests. However, land use and business models still need more integration and exploration.

- Surprisingly, the nearby residents have highly praised this space (rating information sourced from Google). This implies that residents appreciate such a space. However, such spaces are not common in Milan, possibly because they require long-term management by the operators.

Location 6: Public Green Space – Parco Nicolò Savarino

Photographed by the author

Description

A typical park near a residential area, characterized by vast grassy areas and children's facilities, is undoubtedly popular within the neighborhood. However, it also embodies a traditional garden, offering a space for recreation and proximity to plant life. The well-maintained lawn and relatively straightforward landscape structure are defining features of this traditional park.

Key insight

- In Milan, a significant portion of green spaces is underutilized. Similar to the description in "The State of Butterflies in Milan," the natural regeneration, managed parklands, and simplistic plant compositions deprive butterflies of habitat and host plants for breeding. Moreover, the flowers and shrubs in these areas do not adequately support the survival and feeding needs of adult butterflies.

- Nonetheless, these spaces constitute the majority of Milan's public green areas. From the perspective of butterflies, the few high-quality green spaces pose challenges in supporting their survival and migration needs, emphasizing the need for optimization.

5.2.2 Findings

This thesis, through the study of butterfly species and field observations of Milan urban spaces, by integrating and analyzing key insights, has uncovered the following information:

- Butterflies require high-quality and continuous habitats, which are crucial for their survival in urban environments.
- Some human conservation activities can spread awareness and encourage protective actions, yet maintaining high-quality habitats remains a long-term endeavor.
- Currently, there are many gaps in the protection of pollinators and butterflies in Milan's green spaces. A significant portion of the city's green areas still lacks plant diversity.
- Both the management of green spaces and citizen actions need to be planned. High-quality habitats are still a minority, necessitating the development of connections between habitats.
- Simultaneously, the approaches of citizens towards pollinators and butterfly conservation remain fragmented and limited. Presently, Milan city lacks specific bottom-up citizen engagement guidelines for protecting butterflies.

In the next section of the summary, this thesis will synthesize and organize the content of the research and analysis of butterflies and Milan's greenspaces in this chapter, and present it visually through a butterfly journey map.

5.3 Butterfly Journey Map

Generally, in a human-centered journey map, a synthetic representation describes step-by-step how a user interacts with a service. The process is mapped from the user's perspective, detailing what occurs at each stage of the interaction, what touchpoints are involved, and what obstacles and barriers they may encounter. The journey map often integrates additional layers representing the level of positive/negative emotions experienced throughout the interaction (*Journey Map | Service Design Tools*, n.d.).

However, due to the specificity of the non-human role and the lack of a rigorous method or standard for non-human-centered journey maps, this thesis has chosen to represent the challenges faced by butterflies growing up in the city in the form of journey maps. This visualization aids in understanding each stage of the butterfly's evolution and the obstacles they face while interacting with the city. In order to maintain objectivity in describing, analyzing, and speculating on the research, and due to a lack of scientific data support, this thesis omits descriptions of emotions and thinking attributed to butterflies in the journey map.

Based on previous research and the summary, as depicted in the figure, this omits divides the growth stages of butterflies into five stages: egg- caterpillar- chrysalis- adult butterfly- egg laying. Combined with previous studies on butterfly species and the urban environment in Milan, the challenges butterflies face at each stage to survive in the city are described separately (see Tabel 1).

Stage 1: Butterfly Egg

During this period, butterflies may choose not to lay eggs due to the lack of host plants in the city. This is not because the urban environment is unsuitable for butterflies but because the original green spaces in the city were not planted with the plants that butterflies need during the construction process, or uniform green space management activities remove the "weeds" that butterflies prefer. Especially for some butterfly species with specific preferences, suitable host plants are necessary.

The abundance of urban butterflies is also reduced by the loss of the moist, warm microclimate created by soil or leaf cover during the incubation stage of butterfly eggs, either through uniform green space management and "weed" removal or through the emission of harmful gases in the city (e.g., car exhaust).

Stage 2:Caterpillar

Similar to the first stage, caterpillars depend on parasitic plants and specific plants as their food. This is closely related to the location where they lay their eggs. Some specific butterfly species may not only depend on the plant where the eggs are laid but also need specific animals as food (e.g., ants). At this stage, the main reasons for their declining numbers continue to be the lack of plant species due to natural re-creation and the decline in abundance due to uniform green space management clearing the plants favored by butterfly caterpillars.

Stage 3: Chrysalis

At this stage, green space management remains a challenge for butterflies. A safe habitat and a suitable microclimate can help pupae develop better.

Table 1: Butterfly journey map in Milan.

Stage	Pre-adult			Adult	After adult
	BUTTERFLY EGG	CATERPILLAR	CHRYSALIS	BUTTERFLY ADULT	OVIPOSITION
Butterfly Action	Born parasitic on animals/plants A long developmental process Bite through the eggshell Hatch out	Eat parasitic plants/animals Multiple molting To the Metamorphosis stage Stop feeding Choose the right place (specific plants) prepare for pupation	Pupation The larvae shed their old skins Releases digestive juices The pupae contract and harden Into a variety of intrinsic forms	The adult develops and matures inside the pupal shell Out of the pupa shell The adult decapsulates Flutter and fly Find food	Fly to the spawning site mating Find parasitic plant Lay eggs
Touch point	Parasitic plants Parasitic animals	Parasitic plants Parasitic animals Habitat	Habitat	Habitat Foods Moving region	Moving region Parasitic plants
Pain Point	**Lack of host plants for eggs** Reasons: natural urban regeneration, uniform plant management, lack of specific plants **Lack of microclimate suitable for egg hatching** Reasons: natural regeneration, green space management such as weed control/pesticides	**Lack of specific plant/ animals as food for lepidopteran larvae** Reasons: natural urban regeneration, uniform plant management, lack of specific plants	**Lack of habitat for larvae to pupate** Reasons: natural urban regeneration, uniform plant management, lack of specific plants	**Fragmented habitats** Reasons: urbanisation of land use; too small urban green spaces; disconnected urban green spaces **Lack of sufficient plants for food** Reasons: lack of plants preferred by Lepidoptera **Lack of plants needed for habitat** Reasons: natural urban regeneration, uniform plant management, lack of specific plants	**Difficult access to breeding sites for urban lepidopterans** Reasons: some lepidopterans need to lay eggs in river valleys/grasslands **Fragmented urban habitats do not have access to suburban routes** Reasons: fragmented cities **Lack of parasitic plants in the city for laying eggs** Reasons: natural urban regeneration, uniform plant management, lack of specific plants
Opportunity	**Provide plants needed by butterflies in the city** **Provide undisturbed shelter for butterfly eggs and larvae**	**Provide plants needed by butterflies in the city**	**Provide undisturbed shelter for butterfly eggs and larvae**	**Reduce habitat fragmentation and provide continuous access** **Provide sufficient and diverse native plants as preferred food for butterflies**	**Reduce habitat fragmentation and provide continuous access** **Provide plants needed by butterflies in the city**

The challenges faced by butterflies in the city of Milan at each stage of growth

Stage 4: Adult butterfly

During this stage, butterflies can move freely due to their energetic nature, engaging in behaviors such as searching for food. However, they face significant obstacles in the form of fragmented habitats in cities, characterized by small habitat areas and a lack of connectivity between them. Additionally, their preferred plant species for food are not adequately represented in the city's natural landscape in terms of diversity. Some specific butterfly species require different plants for habitat during various seasons and at different times of the day (day or night), which may not be met by the available plants in the city.

Stage 5: Oviposition

The availability of host plants necessary for egg-laying is crucial for the species diversity and abundance of butterflies. Connected habitats are also vital for successful reproduction. This connectivity helps in avoiding inbreeding resulting from isolated habitats and is particularly important because some butterfly species must lay their eggs in designated locations (e.g., suburban river valleys).

In summary, the core reasons for the analysis are two fold:

- From a butterfly's perspective, habitats in the urban areas of Milan are of low quality and fragmented. It's important to note that for butterflies, the two factors—high-quality habitat and connected habitat (for butterfly migration and dispersal)—are indispensable and need to be simultaneously met.

- The growth and evolution of butterflies are complex, with different preferences for various species. Therefore, targeted planting and habitat creation require more specialized scientific guidance.

In summary, Milan's urbanization process in the past did not adequately consider the need for wildlife habitats within the city. For the non-human species studied in this thesis—butterflies—alongside the array of urban habitat challenges they face, the lack of flora diversity in the city pushes them into a survival dilemma. In this context, urban organizations or residents have begun to take action, with governments promoting initiatives and actions related to pollinator conservation. Additionally, some residents are spontaneously organizing and participating in "pollinator and biodiversity conservation" activities. However, this bottom-up engagement requires designers, residents, experts, and others to collaborate as guides and promoters. By promoting social innovation that encompasses not only humans but also non-human species through participatory design, this thesis aims to provide more opportunities for the survival of butterflies in Milan and to contribute to the vision of a sustainable city of the future- Milan- where humans and butterflies coexist.

5.4 Questionnaire: Attitudes of Urban Citizens Toward Butterflies

5.4.1 Approach

In cities, there is inevitably a direct or indirect interaction between non-human and human entities. Although literature and studies have outlined favorable factors for butterflies in urban areas, human activities consistently influence wildlife, including butterflies. This implies that a change in human action may have a positive impact on butterflies in cities. Consequently, this thesis gathered 110 responses from citizens residing in Milan through an online questionnaire concerning the integration of butterflies into urban or community life.

To gather more insights from Milan residents, this thesis employed a structured questionnaire to collect quantitative data, supplementing and validating previous information. The online format was chosen for its cost-effectiveness, time efficiency, and flexibility, allowing respondents to answer at their convenience, promoting more accurate responses without the pressure of immediate replies. The questionnaire utilized multiple-choice questions, where respondents could select one or more answers from a provided list of options. Additionally, recognizing the highly subjective nature of some questions, the questionnaire offered respondents the option to express their attitudes and opinions through an "other" category.

A total of 118 (110 valid questionnaires) questionnaires were gathered from citizens residing in the Milan area, encompassing both local and international residents. The survey participants were diverse in nationality, gender, and age, as the responsibility for butterfly conservation in the city is a collective effort, not confined to a specific group.

Through questionnaires, this thesis aims to investigate the attitudes, intentions, and actions of the inhabitants of the Milan area regarding the conservation of butterflies in the city. To enhance the survival of butterflies in the city, it is necessary to improve government policies, initiatives, and grassroots efforts from the residents. Therefore, comprehending the needs and intentions of the residents of Milan is crucial. Simultaneously, this data can also provide a foundation for subsequent design.

The questionnaire is intended to:

- Validate the insights obtained from preliminary research.
- Understand the feasibility of protecting butterflies in the city of Milan.
- Understand the willingness and attitude of Milanese residents to participate.
- Understand the level of acceptance among Milan residents regarding changes in green space content.

Furthermore, the questionnaire adhered to the key characteristics of survey questionnaires, as described by Bhat (2023b):

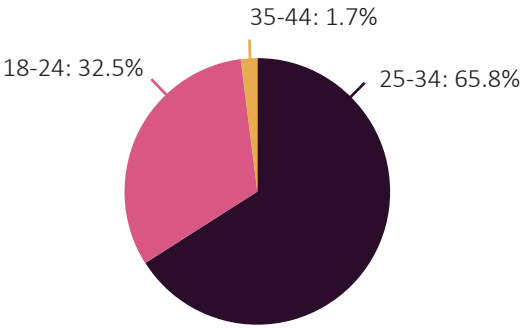
Uniformity: A uniform design and standardized format collect basic information, personal opinions, facts, or attitudes from respondents. Respondents see the same questions, aiding in data analysis and statistics.

Exploratory: The qualitative data collected should be exploratory, and there is no limit to the number of questions that can be included in the research questionnaire.

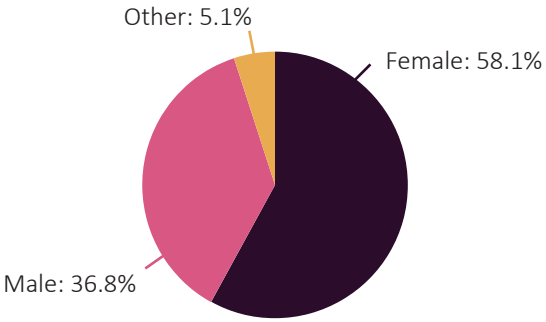
Questionnaire sequence: It typically follows a structured flow of questions to increase the number of responses. This sequence includes screening questions, warm-up questions, transition questions, skip questions, challenging questions, and classification questions.

5.4.2 Questionnaire content and data

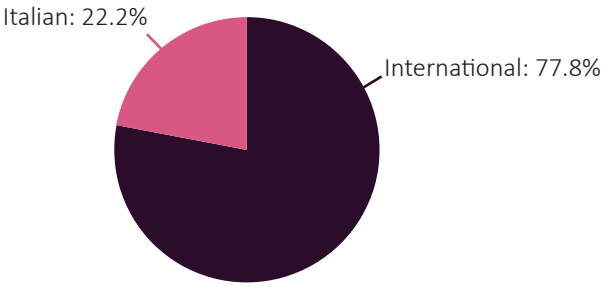
A total of 118 questionnaires were received, with data mainly from people of 25-34 years old, mostly females, with different cultural backgrounds. Probably due to the status of the author of this thesis as an international student and non-native speaker, this data has some limitations.



Age distribution

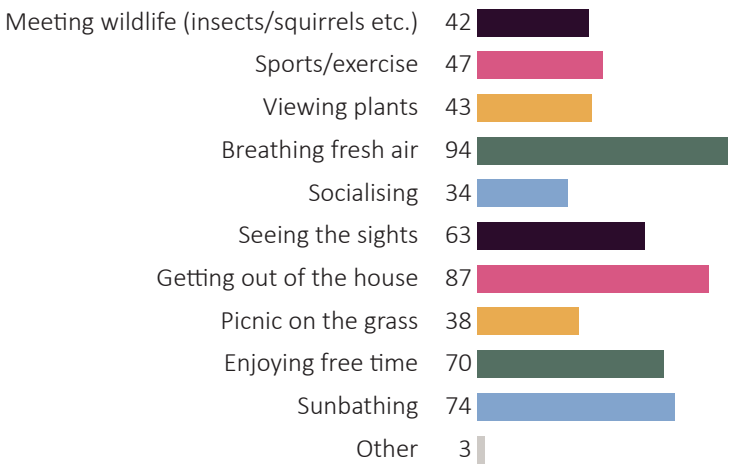


Gender distribution



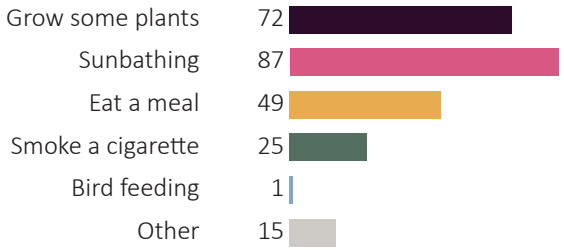
Nationality distribution

Most residents' current experiences with urban green spaces include, but are not limited to, "breathing fresh air," "enjoying an outdoor environment," and "interacting with natural plants and animals," among others.



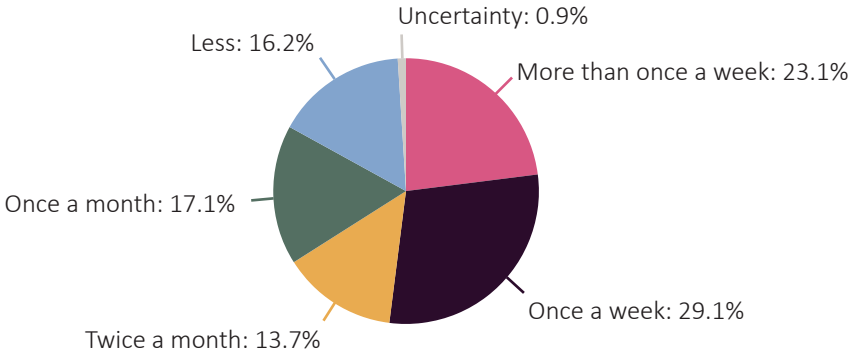
What are the aspects of public green spaces/parks that appeal to you?

The usage patterns for private spaces (such as balconies) include, but are not limited to, "planting plants" and "sunbathing." From this data, it can be observed that a majority of residents are receptive to animals and plants in green spaces, and are willing to engage in planting vegetation.

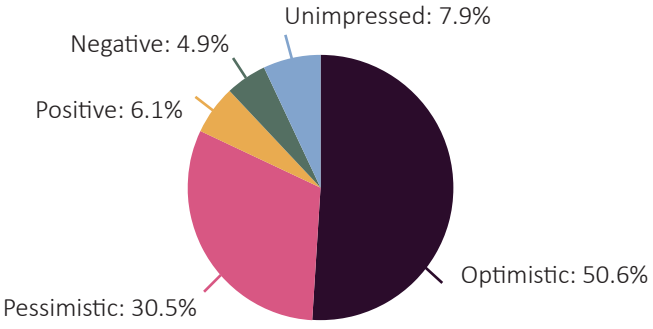


What do you usually do on your balcony?

The data indicates that over 80% of the residents enjoy engaging with green spaces. Simultaneously, they hold a positive attitude towards pollinator conservation, with over 50% of the residents willing to encounter butterflies in the city. Moreover, 82% of the residents are willing to support and take action for the city's butterflies. Surprisingly, 17.9% of the residents are even open to establishing a "friendship" with non-human characters in the city.

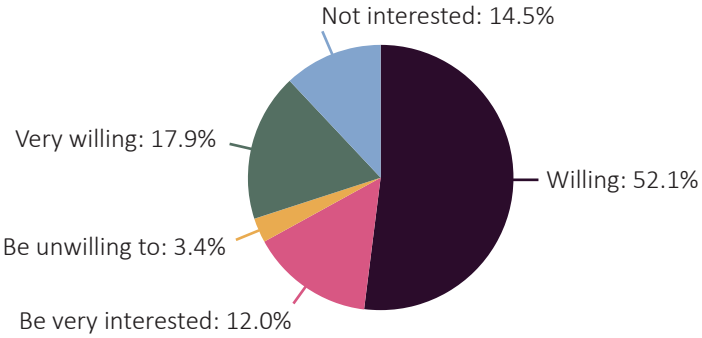


Frequency of visits to green spaces



Attitudes towards the inclusion of butterfly habitats in cities

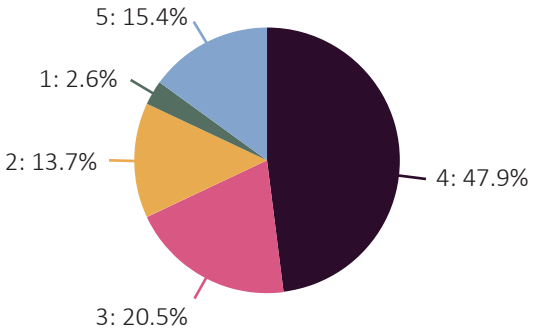
Optimistic (it is a sign of good urban ecology to encounter butterflies in the city) : 50.6%
Pessimistic (I don't want to see them in my life): 30.5%
Positive (I want them to be in the city and am willing to take action): 6.1%
Negative (I want them to be in the city, but this seems difficult): 4.9%
Unimpressed (I don't care about this): 7.9%



Willingness to help butterflies in the city

Very willing, I want to develop a friendship with wildlife: 17.9%
Yes, I am interested in how animals grow: 12.0%
I can help without causing me stress: 52.1%
No, I am not interested in butterflies: 14.5%
Very reluctant: 3.4%

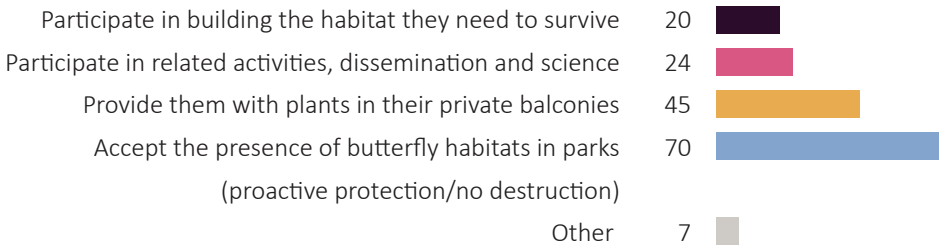
According to the questionnaire data, 15.4% of residents are accepting of changes in urban green spaces and are willing to take action to transform the space for the benefit of butterflies. About 47.9% of residents accept changes in their surroundings but are not willing to invest significant effort. Additionally, 20.5% of residents are accepting of the changes but are not willing to take any action. Despite varying levels of willingness to take action, fortunately, a majority of residents are accepting of urban spaces evolving in a direction beneficial to pollinators, particularly butterflies.



Acceptance of butterfly habitats in cities (e.g., spatial or object changes, landscape and plant changes, action and policy changes, etc.)

5. I accept the change of space (e.g. sharing some habitat with them) and am willing to put in the time and effort : 15.4%
4. I accept changes to my space, but I don't have to give much: 47.9%
3. I accept change in space but I won't do anything about it: 20.5%
2. I accept small changes in space, but I don't want pollinator plants to take up too much public space: 13.7%
1. I don't want the city to make any changes for pollinators: 2.6%

Regarding the content of bottom-up actions involving residents, the data demonstrates a positive scenario. The majority of residents are receptive to the presence of butterfly habitats in public spaces. A small portion of individuals are willing to construct habitats or shelters for butterflies. Additionally, there are some individuals willing to act as promoters for relevant educational content and actions.



What are the behaviors through which you would like to participate in the conservation of butterflies in the city of Milan?

5.4.3 Findings

In summary, the research results indicate that residents in the Milan area are inclined to actively engage with and adapt to the changes brought about by coexisting with butterflies in the urban landscape.

A majority of Milan's residents exhibit a positive disposition towards butterflies and plants within the city, showing a willingness to contribute in ways that are within their capacity.

However, integrating the findings from the previous sections, it becomes apparent that despite the prevalent positive attitude, residents may encounter challenges in the bottom-up action process due to a lack of professional guidance and a well-structured framework. This can result in errors, confusion, and inefficiencies.

5.5 Non-human and Human Personas

5.5.1 Non-human personas

Non-human personas are a tool used in life-centered design to establish emotional connections with both natural and non-human entities. They serve as a means to comprehend the needs and perspectives of non-human actors. The creation of non-human personas entails scientific research, emotional narratives, and communication through diverse mediums. Non-human personas can aid individuals in perceiving nature or the non-natural world in ways that transcend written papers and quantitative scientific research (Spoelstra, 2023b).

Designing for a sustainable future necessitates incorporating the voice of other species, with non-human personas playing a crucial role in achieving this goal. When embarking on a project to create non-human personas, biographies of natural beings, plants, animals, villages, buildings, or legal entities need to be developed while incorporating an emotional narrative. This approach delves deeper than a traditional persona, providing a wealth of scientific and emotional data. It enables individuals to connect with non-human actor themes and comprehend nature (Spoelstra, 2023b). Combining the user persona by Nielson Norman Group and Snezl's guidance on non-human personas, the purpose of a non-human persona could be defined as (lifecentred.design, 2023):

The diagram below illustrates (see Figure 40) the process of creating non-human personas. In the hands of designers, they represent an invaluable tool for designing a world where all beings can coexist on equal footing, allowing space for other species, humans, and an economy based on equality. Non-human personas provide companies and governments with insights into their negative and positive impacts, enabling the creation of opportunities to become more sustainable and inclusive, and potentially regenerative. They facilitate the creation of enhanced experiences for both people and nature (Spoelstra, 2023b).

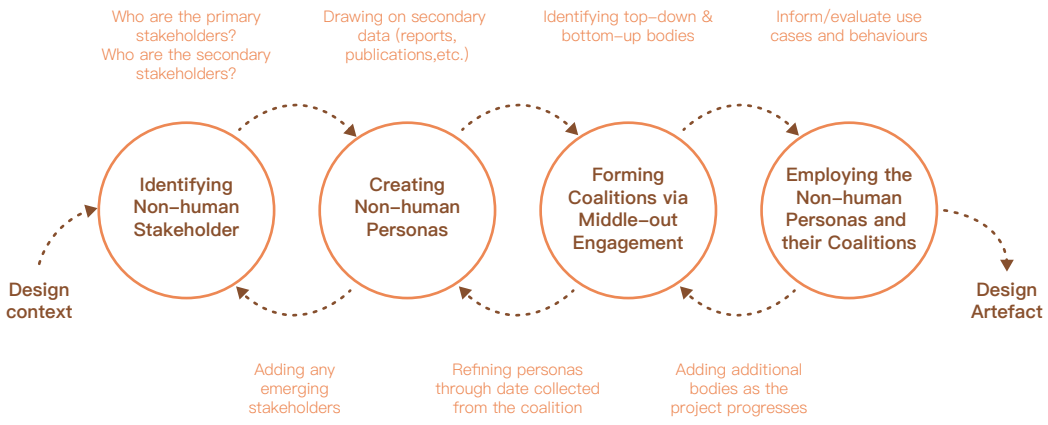


Figure 40. The four steps of the non–human personas framework. The diagram captures the fact that developing the fact that developing the personas is an iterative and ongoing process.

Drawing on the theoretical and practical support provided by the methods for non-human personas mentioned above, this thesis establishes non-human personas through the following five steps:

Step 1: In this thesis, non-human personas were created based on the content and data studied in the previous section and followed the following design framework. The data content was initially categorized following the radar chart in Figure 41.

Step 2: The qualitative research content covered in the previous section was analyzed and identified, focusing on the challenges and barriers faced by non-human personas, along with their existential needs and visions.

Step 3: A brief assessment of the non-human actors was conducted by combining the research information and secondary data.

Step 4: To help the participants/readers better understand the perspective of non-human actors, this thesis provides emotional characterizations and descriptions of non-human actors.

Step 5: Visualized and presented the non-human personas.

The personas in this thesis encompass non-human stakeholders and human stakeholders. Additionally, a distinction is made between primary and secondary stakeholders.

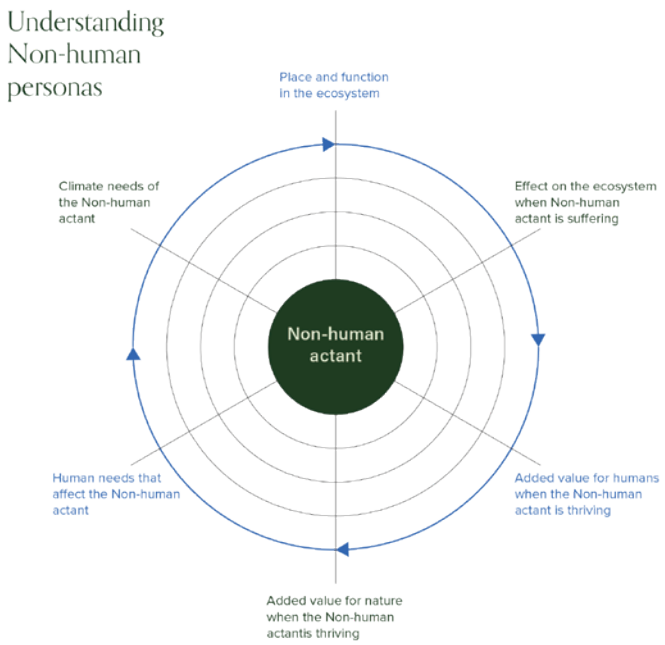


Figure 41. Information from the webpage:
https://www.unbeatenstudio.com/blog/why-do-we-need-non-human-personas.

5.5.2 Human personas

A persona is an archetype of a user that assists designers and developers in empathizing by comprehending their users' business and personal contexts. By basing personas on user research, designers and developers can steer clear of the pitfalls of designing for anecdotal, "fake," or extreme users (*IBM United Kingdom*, n.d.).

The residents of Milan are the main human stakeholders in this thesis, with the primary goal of utilizing human personas to depict the characteristics and needs of Milan residents interested in interacting with butterflies and other pollinators. It also provides a basis and guidance for the subsequent co-design process.

The information about the human characters is derived from the analysis of data related to Milan residents presented in the previous section. The definitions are visualized in the form of personas.

Butterfly

"City walker"

We initially thrived in and around the Lombardy region, but urbanization has transformed woodlands into towns and arable land. Urban development drastically altered the structure of our original habitat, leaving us with a fragmented environment where our preferred food sources disappeared due to natural regeneration. Our larvae now struggle to find plants on which they can parasitize. However, the impacts of fragmented habitats in cities extend far beyond these challenges. Racial isolation, inbreeding, chemical use, and reduced food and plant diversity makes our existence difficult.

In the present day, cities have become habitats we both love and dread. Urban environments are rife with destabilizing factors. Regular management of green spaces by people removes the parasitic plants we rely on; pesticides are used for beautiful flowers; people collect and harm us, and so on. Nonetheless, amidst these deteriorating habitats, urban landscapes still offer many plants and flowers that attract us for foraging...

Habitat

Currently, we move around the suburban areas of the city, particularly favoring gardens, woodlands, patios, and any locations where flowers are in bloom. While we relish a variety of flowers for sustenance, our larvae have specific requirements for host plants. Thus, we must select a habitat that offers these particular plants as our spawning site, and it should be easily accessible to us.

Need

As adult butterflies, we require flowers in bloom as they serve as our food source. A diverse array of plants is highly beneficial for us. While we have the ability to fly and move freely, an ample food supply is essential to sustain our journey and broaden our habitat.

Our larvae are highly reliant on specific host plants, so we kindly request to leave them undisturbed and provide them with the necessary time and space to grow.

Challenge

- **Lack of abundant and diverse native and parasitic plants**
- **Lack of high quality habitat**
- **Habitat fragmentation and need for more moveable space**

Pollinate

We function as pollinators, and blooming flowers entice us to visit. Our visits significantly enhance the likelihood of plant pollination and also supplement other pollinators, compensating for limitations in the pollination process.

Evolution

We are a unique insect in that we undergo four distinct forms of growth, each with different requirements. This also implies that we encounter distinct challenges at each stage of development. Specifically, we have a significant reliance on our host plants during the larval stage.

Moving

As adults, we possess the ability to move and seek out places where we can find food. However, fragmented habitats confine us to limited spaces. The lack of a varied diet due to continuous inbreeding has severely impacted our population.

I have been residing in Milan for 8 years now, where I both study and work. My affinity for everything related to nature, plants, and animals allows me to experience the allure of nature constantly. Milan, being a bustling city, lacks extensive natural landscapes and beautiful gardens. During weekdays, I enjoy running in the parks, and on vacations, I indulge in hiking in the nearby mountains. If I have free weekends, I gladly engage in activities related to nature themes.

Lisa

"Avid Nature Lovers"

Basic information

Milan residents
Age: 28
Gender: Female
Occupation: Designer

Hobbies

photography
Hiking
Reading
Planting

Everyday behavior

Morning jogging
Taking care of plants on the balcony
Enjoys visiting flower markets
Enjoys socializing and is willing to participate in activities related to nature topics
Wants to gain knowledge about all kinds of nature-related topics

Needs

- Our understanding of biological systems is still limited, especially when it comes to the specific behaviors of certain species or the cultivation methods of certain plants.
- Organized and guided actions can be effective in protecting the natural environment. But ecosystems are complex, and we need more professional guidance on how to respond to needs and changes in the course of action.
- The habitats of pollinators in the city require long-term maintenance, and this maintenance activity needs to be organized; otherwise, it is challenging to achieve long-term benefits.

Wish

Protecting nature is a long-term responsibility, and I hope more individuals or organizations can act on it.

Though the power of one person is insignificant, the actions of people working together will surely bring about positive change. The Earth is a common planet for all living beings, and we should be neighbors with animals and plants.

Secondary stakeholders

This part elaborates on the stakeholders that may be involved in the context of this thesis. They have a direct or indirect connection with butterflies in the city, and mutually influence each other.

Native plants of the Lombardy region

Role: provide pollen for pollinators (food for pollinators).

Needs: dependent on pollinators for pollination, need to maintain diversity of native plants.

Native pollinators (all pollinators, including but not limited to bees)

Roles: Butterflies have a complementary relationship with plants, mutually pollinating and enhancing the fruiting rate of the plants.

Needs: There is a need for active interspecies relationships to maintain species diversity and abundance.

Alien plants (some landscaping in the city)

Role: provide pollen for pollinators (food for pollinators)

As exotic plants, they affect the pollination and diversity of native plants to some extent.

Milan residents

Role: Resident of Milan

Needs: keep a positive attitude towards butterflies in the city and want to make conservation actions without pressure.

Green space managers

Role: The people who manage the green spaces in the city, they manage the landscaping and weeding on a regular basis. Regular green space management destroys the ecosystem on which butterflies depend.

Janitor of small gardens

Role: Managers of some small community gardens/vegetable gardens. These quality plant spaces provide opportunities for pollinators to survive in the city.

CHAPTER

6

PROJECT PROCESS

6.1 Case Study: Butterfly Conservation Cases In Cities

6.1.1 Approach

A case study is a comprehensive examination of a specific subject, such as an individual, group, location, event, organization, or phenomenon. A case study research design typically involves qualitative methods, although quantitative methods are sometimes used as well. Case studies are valuable for describing, comparing, evaluating, and comprehending various aspects of a research problem (McCombes, 2023).

The purpose of the case study in this thesis is to:

- Reference existing conservation actions for butterflies and pollinators in different cities and regions.
- Reference how different cases incorporate the perspective of pollinators in the action process.
- Pay particular attention to how citizens respond to policy initiatives through bottom-up actions.
- Understand the strategies adopted by citizens participating in pollinator conservation (including butterflies, bees, and other pollinating insects) in different countries and regions.

The data collection method for the case study in this thesis is structured into four steps.

Step 1: Select a case
Based on prior insights into the challenges faced by butterflies in urban environments, such as the absence of parasitic plants, habitat fragmentation, and reduced biodiversity due to natural regeneration, among other factors, this thesis seeks to identify cases that can offer insights, assumptions, or practical action plans for these themes through case studies.

Step 2: Collect data
The data for this case study are primarily gathered from secondary sources, such as articles, reports, and official records. The data are then analyzed.

Step 3: Construct a strategic framework
The objective of this thesis is to explore or summarize, through case studies, how existing theoretical foundations can be applied in urban settings. This is especially pertinent for projects that necessitate citizen participation in the conservation of butterflies in cities. The case studies also serve to introduce new concepts and ideas to guide the analysis and development of this thesis's project, as well as to assess the viability of future design strategies.

Step 4: Describe and analyze the case
In composing this thesis, the case studies are described in as much detail as possible concerning the topic under consideration. The focus of the case description is on the organization of citizen actions, from the bottom up, concerning pollinators, and the strategies to enhance pollinator survival opportunities.

In this context, this thesis has selected five relevant projects for case study.

Case study 1: Pollinator Paradise Demonstration Garden Inspires Pollinator Tourism

Contributed by Debbie Roos, North Carolina Cooperative Extension
(Pollinator-Friendly Parks | Xerces Society, n.d.)

Description

The Chatham Mills Pollinator Paradise Garden was started in 2008 as a demonstration site by the Chatham County Center of North Carolina Cooperative Extension. Chatham County is one of the state's fastest-growing and faces significant development pressure and loss of habitat for pollinators. Covering one-third of an acre, the garden includes over 220 unique species of perennials, shrubs, vines, and grasses, 85% of them native to North Carolina. The garden is managed organically and is maintained by a Cooperative Extension Agriculture Agent and a small group of volunteers.

As a demonstration garden, the Pollinator Paradise is an excellent and important tool for Cooperative Extension outreach efforts, continually inspiring residents to plant pollinator habitats at farms, schools, parks, businesses, and backyards. A multi-faceted outreach program includes all-day workshops and public and private garden tours.

Thousands of farmers, gardeners, beekeepers, Master Gardener volunteers, conservationists, green industry professionals, educators, and students of all ages have toured the garden. Guided tours highlight the diversity of plants and pollinators, the importance of emphasizing native plants, plant, and insect identification, the natural history and needs of native bees, nesting habitat, garden installation and maintenance, and organic management strategies.

High-quality photographs of flowers in bloom and pollinators visiting the garden plays a key role in extending the educational and inspirational impact of the garden. Social media is used effectively to excite, inspire, and educate: hundreds of photos and videos of the garden on Facebook, Instagram, and Twitter—as well as the garden's website, www.carolinapollinatorgarden.org—cultivate a high level of engagement and encourage viewers to visit the garden and attend educational programs. The website features recommended plant lists, workshop and tour schedules, a current "What's in Bloom" feature, a list of local nurseries that supply pollinator plants, and other resources. The garden staff surveyed its visitors and discovered the far-reaching impacts of the demonstration garden:

- the garden has inspired hundreds of visitors to plant their gardens;
- the garden attracts "pollinator tourists" from across North Carolina and beyond; 88% of visitors said they spent money eating out and shopping in Pittsboro when they came to see the garden, and 74% of survey respondents reported they bought plants from North Carolina nurseries as a result of visiting the garden; and
- many garden visitors take the recommended pollinator plant lists (developed by the Cooperative Extension Agriculture Agent) to local nurseries when they shop, prompting a few nursery managers to add new species for sale that are in the pollinator garden.
- Visitors to the Pollinator Paradise Garden have also shared how the garden has made them less fearful of stinging insects, inspired them to adopt organic management practices, and opened their eyes to the amazing diversity of pollinators and other beneficial insects and plant-insect interactions—all of which enable them to be better stewards of the environment and advocates for pollinators.

Strategy & process

Pollinator gardens managed by agricultural extension agents and volunteers

Continuously inspire community citizens and work with schools, organizations, parks, businesses, and backyards.

Engage green industry stakeholders to highlight the diversity and importance of local pollinators, learn about plants and insects, understand pollinator needs, and participate in organized management.

Social media to share, inspire, and educate

https://growingsmallfarms.ces.ncsu.edu/growingsmallfarms-pollinatorgarden/

The website provides specific materials, checklists, and resources to encourage participation in educational programs.

Incentivize visitors to plant their gardens.

Agricultural extension agents market new plant varieties.

Learn about

- Promote and organize pollinator conservation activities through increased stakeholder engagement. On one hand, this can boost the sale of relevant horticultural products, and on the other hand, it can provide citizens with specialized knowledge about planting and protecting pollinators. With the involvement of Agricultural Extension Agents, citizen activities can be managed and sustained in the long term.
- The online platform facilitates the dissemination of pertinent information.
- Simultaneously, this case illustrates that citizen engagement in pollinator protection is not only essential for a sustainable future but also for the economic growth of related industries.

Tiger swallowtail on ironweed in late August.

Photograph by Debbie Roos

One of the paths in the Pollinator Paradise Garden
.
Photograph by Debbie Roos

Farmers, gardeners, landscapers, nursery growers, beekeepers, and Master Gardener volunteers from 11 counties at a Pollinator
Garden Design Workshop.

Photograph by Debbie Roos.

Case study 2: Restoring Habitat for Monarch Butterflies at the Presidio of San Francisco

Contributed by Rebekah Berkov, Field Education Specialist, Presidio Trust
(Pollinator-Friendly Parks | Xerces Society, n.d.)

Description

Parks, yards, and natural areas along the California coast are crucial habitats for the western monarch butterfly. The Presidio of San Francisco, a 2.3 square mile urban park and historic site within the Golden Gate National Recreation Area, plays a vital role in providing overwintering sites for western monarch butterflies. Monarchs migrate to coastal areas of California for the winter, where they cluster on tree branches for several months in a state of semi-hibernation, migrating inland to breed as spring arrives.

Annually, researchers and volunteers conduct the Xerces Western Monarch Thanksgiving Count, visiting overwintering sites to count the butterflies in each cluster. These counts are summed to estimate the total population of Western migratory monarchs. Decades of counts indicate a severe decline in the monarch population, with a decline of over 99% in California's overwintering population—from over four million to less than 2,000 in 2020.

- **Monitoring at the Mexico overwintering sites shows that the eastern monarch population has declined by over 80%. Monarchs need good habitats to reverse these declines, and parks can provide that.**

- **Another significant way—besides restoring habitat and participating in community science—that parks can help monarch conservation is through public outreach and education about the decline in monarchs and other species.**

Conservation efforts in parks like the Presidio are crucial for monarchs. In the Presidio, specific tree groves and nectar plants are key habitats for monarchs. The natural resources staff has planted various species of native, flowering nectar plants, aiming to provide attractive overwintering sites and abundant nectar to fuel the butterflies. Regular garden maintenance events and invasive species removal projects help maintain and enhance these plantings.

Besides habitat restoration, public outreach and education are vital for monarch conservation. The Presidio engages in educational programs, community science initiatives, film screenings, and field trips to raise awareness about monarchs, their behavior, threats, and conservation needs. Their efforts demonstrate how conservation in dense urban areas can involve and educate residents and visitors, emphasizing the importance of monarchs and their habitats.

Strategy & process

Researchers and volunteers visit overwintering sites each year and count the number of butterflies in each group.

In addition to restoring habitat and engaging in community science, the park can help protect monarch butterflies and other species through public outreach and education.

Natural Resources staff plant different species of native flowering nectar plants for monarch butterflies.

Volunteer-run garden maintenance events ensure that plantings continue to flourish.

Forestry team launches a major invasive species removal program.

Park volunteers and staff planted more native nectar plants near wintering sites.

Movie screenings of relevant documentaries promote the spread of relevant culture.

Experts guide how individuals can contribute to community science in their own yards or neighborhood parks (e.g., reduce pesticide use by planting native nectar plants)

Learn about

- Combining top-down forestry team actions with bottom-up citizen volunteer actions.
- Plants act as a bridge connecting pollinators and humans. It is crucial to clear invasive plants and plant local flora that butterflies need.
- Public outreach and education are beneficial for advancing pollinator conservation efforts.
- Under expert guidance, citizen actions extend beyond protected areas to include private gardens and community parks.
- Diversified methods facilitate the promotion of culture, whether through organizing events or utilizing media (such as photography orvideo).

Overwintering monarchs clustered on a branch at Rob Hill site at Presidio.

Photograph by Liam O'Brien

Presidio Education interns are responsible for removing weeds from the native nectar plant habitat in the Central Magazine area of the park.

Photograph by Rebekah Berkov

California bee plants and California asters planted and mulched by volunteers along the main path that leads up to the Rob Hill Campground.

Photograph by Rebekah Berkov

Case study 3: Pollinator Week, a Community–Wide Celebration of Pollinators by Bee City USA — Hillsborough (NC)

Contributed by Sarah Meadows, Chair, Bee City Subcommittee, and Hillsborough Garden Club member; Phyllis Simon, Hillsborough Tree Board member and an Orange County Master Gardener; and Stephanie Trueblood, Public Space Manager, Town of Hillsborough. (Pollinator-Friendly Parks | Xerces Society, n.d.)

Description

Hillsborough, a small town in north-central North Carolina with approximately 6,000 residents, takes pride in being an affiliate of Bee City USA. The town has made a community-wide commitment to raising awareness, fostering appreciation, and conserving pollinators. These aspects converge during events and activities commemorating National Pollinator Week, observed every third week of June. Hillsborough's Pollinator Week endeavors are a result of close collaboration between the city council, local businesses, and organizations. Consequently, Hillsborough achieves a triple win: the community enjoys an educational and festive atmosphere centered around pollinators, participating local businesses receive promotion, and the significance and benefits of protecting pollinators and their habitats are emphasized.

The community recognized the wide-ranging benefits and wanted more towns to participate. The Hillsborough Garden Club, the Town of Hillsborough, and the Tree Board sent letters to the North Carolina Governor requesting that he declare Pollinator Week to be recognized statewide. The Governor issued the proclamation, and Hillsborough's mayor read it at an event in the town park. The mayor and town council also declared Pollinator Week for the Town of Hillsborough.

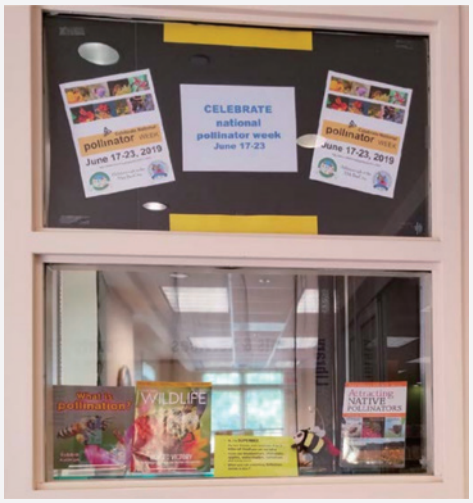
The city and garden club collaboratively promote the Pollinator Week theme and special events through their website event pages and Facebook posts. This content is shared and reposted by partners and other sponsors. Advance press releases ensured media coverage and publicity for the pollinator week activities. Furthermore, to promote these activities, the Bee City USA committee distributed free seed packets of mountain mint, an exceptional native pollinator plant from the NC Botanical Gardens, and created and circulated publicity materials, including stickers.

One of the Hillsborough library's pollinator week displays.

Photograph by Sarah Meadows

Presentation by Phyllis Simon about pollinators and monarch conservation.

Photograph by Phyllis Simon and Bruce Taggart

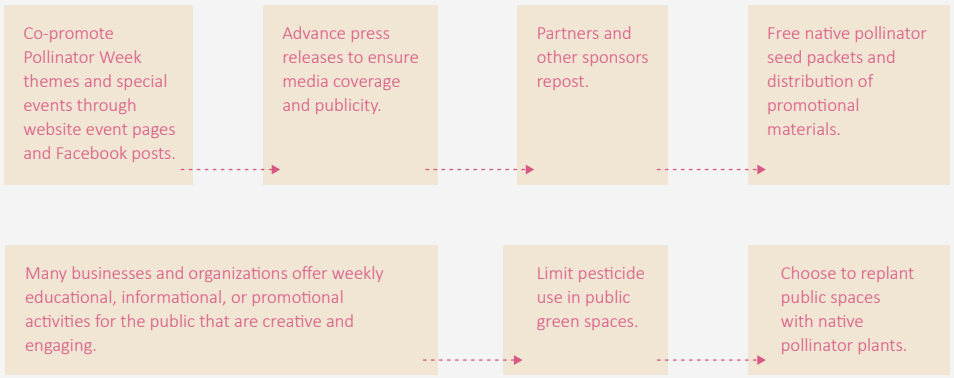


Numerous businesses and organizations offered weekly educational, awareness, or promotional sales activities. The activities offered were creative and engaging for the public. For example:

- A jewelry store offered a unique window display and bee-themed jewelry.
- The public library hosted local monarch conservationist Phyllis Simon to talk about flowers for pollinators and monarch butterflies, had pollinator story time, and showed the “Wings of the Butterfly” video.
- The Hillsborough Garden Club put up a display in the library lobby about the role of native bees as the “superheroes” of the pollinator world.
- The local history museum had a station for kids and families to learn about bees, butterflies, and beekeeping equipment, as well as an activity for children to decorate seed packets with the pollinator they would like to see in their yard.
- A co-working space held a pollinator art exhibit and interpretive signage.
- An art gallery organized a pollinator art exhibit and a reception to open the exhibit.
- The senior center had a pollinator art exhibit and honey tasting.
- A local bookstore featured books on bees and butterflies.
- A beekeeping supply company gave away free buckwheat seed (a cover crop rich in nectar) to people attending programs on bees and pollinators. They also donated a native bee hotel for a prize draw.
- A pizzeria and pub added several honey-infused cocktails and desserts to their menu. Patrons enjoyed a view of their pollinator garden.
- The frozen custard shop sold a honey sundae
- A pharmacy displayed honey-based products such as lipgloss and honey sticks.
- The plant nursery garden shop featured a display of pollinator plants.
- A hair salon offered honey-colored hair highlights.
- Orange County Master Gardeners gave a pollinator paradise presentation at the pollinator garden in a town park.
- A private pollinator garden hosted a tour and presentation about creating a pollinator garden.

Pollinator Week in Hillsborough unites the entire town in celebration of pollinators, providing both enjoyment and education. However, it's essential to note that Hillsborough's consideration for pollinators isn't confined to this specific week. Ensuring a high quality of life for both residents and pollinators is a year-round priority. For instance, Hillsborough has implemented town ordinances restricting pesticide usage in public green spaces. During the planning of a new playground, original designs suggested enclosing the play area with a chain-link fence and covering the downward-sloping land with riprap. However, the town opted to revegetate the slope with native pollinator plants and forgo the fence. This design enables children to play on the equipment and engage with the natural playground. Additional efforts are underway, including the development of policies to assist homeowners in establishing pollinator-friendly yards and landscapes.

Strategy & process



Learn about

- The various forms of citizen engagement in this case are highly valuable. Engaging different stakeholders in themed activities not only facilitates the dissemination of relevant education but also ignites citizens' interest and enthusiasm.
- Bringing together stakeholders with different roles can provide more possibilities for conservation efforts, especially by encouraging participation from local businesses.
- Actions to protect pollinators can establish neighborly relations and enhance connections among residents.

Case study 4: B–Lines

Swanscombe Marshes (c) Daniel Greenwood
(Buglife - The Invertebrate Conservation Trust, 2023)

Description

Motivation for Initiating the Project:

In the UK, bees, butterflies, and hoverflies have suffered significant declines over the past fifty years due to changes in land use resulting from modern farming methods, urban expansion, and the development of new transportation networks. Over 97% (an area equivalent to the size of Wales) of all flower-rich grasslands in England have been lost since the 1930s, a trend mirrored in other parts of the UK. This loss has drastically reduced pollen and nectar sources, leading to a severe decline in wildlife dependent on wildflower-rich habitats.

What are B-Lines?

B-Lines are a creative and aesthetically appealing solution to address the issue of dwindling flowers and pollinators. They represent a network of 'insect pathways' weaving through the countryside and towns, where efforts are made to restore and establish wildflower-rich habitats in the form of stepping stones. These pathways connect existing wildlife areas, functioning akin to a railway network that spans the UK landscape. By doing so, B-Lines create extensive new habitats that benefit not only bees and butterflies but also a diverse array of other wildlife.

B-Lines has the vision to help local native insect pollinators

B-Lines embodies a vision to support and enhance the well-being of local native insect pollinators. The 2014 National Pollinator Strategy for England initiated a 10-year plan to ensure the survival and flourishing of pollinating insects throughout England. Similarly, the Action Plan for Pollinators in Wales and the Scottish Pollinators Strategy have set forth comparable initiatives for Wales and Scotland. These strategies delineate actions aimed at bolstering and safeguarding the diverse array of pollinating insects that play a crucial role in our food production and environmental diversity. Additionally, they call upon collective efforts from all to contribute to the cause of supporting our pollinators.

This project serves as a demonstration of how a coordinated and holistic approach can effectively conserve our native insect pollinators. The initiative involves establishing a network of flower-rich pathways, known as The B-Lines, across the UK's countryside, towns, and cities. These pathways interconnect the finest existing wildlife areas, offering substantial benefits to pollinators, diverse wildlife, and the community at large.

B-Lines offer a multitude of benefits to wildlife, people, and agriculture, such as:

- Aiding in the conservation of our native pollinators and various other wildlife, contributing to Biodiversity targets.
- Assisting wildlife in adapting to climate change by facilitating easier movement across landscapes.
- Augmenting the population of insect pollinators, consequently enhancing the benefits they bring to the farming sector (pollination being a crucial 'ecosystem service').
- Connecting people with nature.
- Providing opportunities for everyone to actively contribute to and help establish the B-Lines network.

Creating B-Lines

B-Lines has set a goal to establish and rejuvenate a minimum of 150,000 hectares of flower-rich habitat throughout the UK.

Achieving this objective will require a concerted effort and collaboration involving farmers, landowners, wildlife organizations, businesses, local authorities, and the wider public. Together, they will need to work diligently to cultivate flower-rich grasslands in optimal locations.

B-Lines have been meticulously mapped across England, Wales, Northern Ireland, and Scotland. In partnership with conservation entities, land managers, businesses, and local authorities, this initiative is actively engaged in populating the mapped areas with revitalized and newly established wildflower-rich regions.

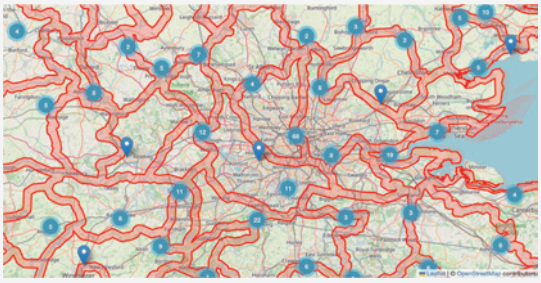


Image source: https://www.buglife.org.uk/our-work/b-lines/.

Strategy & process

It is mapping a rail-like network that will span the British landscape.

Working with conservation partners, land managers, businesses, and local authorities to help fill areas on the map with restored and new wildflower-rich areas.

Achieving this will take time and require farmers, landowners, wildlife organizations, businesses, local authorities and the public to work together.

Provide large areas of brand new habitat that will benefit bees, butterflies, and many other wildlife

Learn about

- "Landing sites" or "stepping stones" can provide pathways for pollinators to move.
- It connects fragmented habitats through paths that look like railroads. Furthermore, providing plants and food needed by pollinators along the way to broaden the range of habitat activities and break the limits of isolated habitats.
- Bottom-up resident action can be facilitated by giving active people the opportunity to participate.

Case study 5: CLEVER Cities' journey of urban biodiversity discovery comes to life with new cartoon and DIY pollinator guide

(CleverCities •• News, n.d.)
https://clevercities.eu/news/?c=search&uid=cMysUIbK

Description

To raise awareness about the significance of urban biodiversity, Eliante, a partner of CLEVER Cities Milan, introduced a new cartoon and DIY pollinator guide. This guide includes flower seeds and tips on how to attract pollinators, encouraging citizens to actively participate in biodiversity protection.

Urban nature manifests in various forms, providing a range of benefits, not only in terms of aesthetics but also in reinforcing ecological systems. Moreover, being connected to nature is synonymous with well-being and an enhanced quality of life for many individuals. Consequently, developing Nature-Based Solutions that augment urban biodiversity has a positive impact on both the environment and people's well-being.

Biodiversity can thrive right outside our residences, on balconies, terraces, and courtyards. By focusing on plants that offer nourishment and shelter to urban-adapted species like birds and butterflies, one can nurture biodiversity in the city. The CLEVER Cities pollinator guide assists in recognizing the diverse species that inhabit Milan's parks and green spaces, catering to people's curiosity about the city's environment.

Eliante is actively assisting the Municipality of Milan in designing the new Giambellino 129 park (CLEVER Action Lab 3). Their aim is to enrich elements of biodiversity by promoting trees, shrubs, native herbaceous species that attract birds and pollinators, and by creating appropriate habitats for foraging and shelter whenever feasible.

Image source: https://clevercities.eu/news/?c=search&uid=cMysUIbK.

Strategy & process

Get the public on board with conserving biodiversity through a pollinator guide with seeds and tips for attracting pollinators.

Actions that will protect pollinators can be carried out on and around balconies, terraces, and patios.

Learn about

- Provide residents with direct access to seeds and guidance to simplify civic engagement. They can utilize private spaces in the city, such as gardens and balconies, to cultivate plants favored by pollinators. This initiative enhances pollinators' chances of survival in the city.

- Private spaces in urban areas can also act as "stepping stones" to connect fragmented habitats. For instance, private balconies in the city are an excellent option. This vision necessitates active involvement from a substantial number of residents.

6.1.2 Summary

These case studies have provided a lot of inspiration for the project in this thesis and valuable materials for conducting the Co-design workshop.

In the developmental process of the project's design phase, ideas and concepts can be explored from the following dimensions:

Butterfly Perspective

- The "Landing sites" and "stepping stones" can extend the flight paths of butterflies in the city, providing more areas for diffusion and movement, compensating for the loss of fragmented habitats.

- In improving habitat quality, plants, as a bridge connecting humans and butterflies, need to focus on planting local plants and clearing invasive alien plants.

Resident Perspective

- Effective "stepping stones" and connected paths require the call from local authorities and the bottom-up participation of local residents.

- Interesting forms and clear, simple participation methods can provide more opportunities for active residents to participate, as well as facilitate the promotion and education.

- Establishing bonds between neighbors is conducive to the implementation and promotion of the bottom-up actions.

Policy Perspective

- Citizen participation in pollinator protection is crucial not only for a sustainable future but also for the economic growth of related industries.

- Combining top-down policies and initiatives with bottom-up citizen actions is essential.

In the preparation phase for the Co-design workshop, considerations can be incorporated for the following materials:

- The needs of butterflies in the city and the forms of "stepping stones" (touchpoints).
- Media of communication that showcases the butterfly's perspective.
- Stories and content derived from the butterfly's growth cycle and survival needs.
- Stakeholders from various industries, sectors, and organizations.
- Touchpoints or channels through which citizens are concerned about pollinators.
- Channels and processes for resident engagement.

Building upon these considerations, this thesis organized two Co-design workshops involving local residents in Milan, focusing on the perspective of butterflies and their survival needs in the urban environment. The aim is to facilitate interactions and connections between humans and non-humans in the city, providing butterflies with more urban living spaces and opportunities.

6.2 Co-design Workshops

6.2.1 Approach

As mentioned in Chapter 4 regarding the co-design approach, this thesis advances the implementation of co-design workshops for the project based on the process depicted in Figure 21. The following content describes the details of the two co-design workshops in more detail.

The co-design workshop for this thesis was conducted in two groups (as shown in Table 2), each comprising three participants, and took place at different times. In the first group, the participants were Milanese residents who provided ideas for this project from a citizen's point of view. In the second group, the participants were represented by experts who provided ideas based on the citizens' ideas and suggestions from the experts.

This project aims to incorporate the perspectives of key stakeholders—butterflies (non-human stakeholders) and Milan residents (human stakeholders)—simultaneously during the design process using a participatory design approach. Through Co-design workshops, this project aim to explore new concepts of co-living between butterflies and residents in the city.

Co-design workshops are typically divided into four main stages during the pre-preparation:

Defining Co-design Workshop Objectives: This involves setting clear objectives for the workshop, which is a crucial step across various disciplines, aiding in understanding the workshop's goals and facilitating the development of clear ideas (Lucenti, 2021).

The core users of this thesis are butterflies (non-human stakeholders) and the citizens residing in Milan. The objective is to create more living opportunities and space for butterflies and pollinators in the city through the bottom-up participation of citizens. The long-term goal is to enhance the diversity of butterflies, plants, and pollinators in the city through the actions of urban citizens.

Selecting Participants: Choosing individuals to participate in co-design workshops is essential to ensure representation of all stakeholders' views. No stakeholder should be excluded for the approach to be successful, preventing the loss of important potential (Lucenti, 2021).

Due to the specificity of the non-human stakeholders, butterflies (inability to communicate and participate in workshops), the participants in the co-design workshops were predominantly citizens. However, citizens lack specific knowledge about how to protect butterflies, pollinators, and related ecosystems, presenting a challenge for the participatory design process. In light of this, this project needs to present detailed perspectives from butterflies to participants at the beginning stage of the workshop.

Defining the Workshops: This involves structuring the organizational aspects of the workshops, determining the number, timing, duration, and location of the workshops. These details clarify the unfolding of the co-design workshop, followed by informing the relevant individuals and participants (Lucenti, 2021).

In this project, the table presents the time, place, and participant organization for the two co-design workshops. The workshops were held offline, and participants were invited via email.

Define the Workshop Agenda: Structuring the tasks to be performed during the workshop is crucial. Designing the workshop in a way that enables participants to comprehend the design goals and needs of various stakeholders through scenarios, touchpoints, behaviors, and experience descriptions is essential. The activity process can utilize various tools through a direct and simple approach (Lucenti, 2021).

Given the specificity of the non-human stakeholders' role, this project provides participants with the perspective and needs of non-human actors in the form of workshop Toolkits. The workshop toolkit materials are sourced from the previous research on butterfly species and their life cycles, the study of habitats in Milan city, as well as the materials mentioned in the case studies that may occur in this project. To explore more possibilities, this project provided some blank sticky notes during the workshops to allow participants to record additional ideas.

The process during the co-design workshop was divided into four stages:

Start - The designer provides participants with materials on non-human characters (slide stories, posters, scenario simulations, etc.), and the participants immerse themselves in the perspective of non-human characters to understand their needs through various pieces of information.

Exploration - Participants integrate their citizen perspective with the non-human perspective to generate a multitude of ideas. These concepts stem from the viewpoints and practices of Milan's residents whenever possible.

Concept - Participants consolidate the generated ideas and concepts. The designer and the participants collectively evaluate, discuss, and reach a final decision.

Test - Designers and participants simulate, reflect upon, and iterate scenarios through a desktop walkthrough.

Table 3 presents the specific information corresponding to these four stages, including the activity content, materials used, and the objectives of the activities.

Table 2: Workshop and participant Information.

Workshop 1

Date	March 22, 2023 3-6 p.m.		
Location	POLIMI BOVISA CAMPUS B7		
Participants	Oleksandr	29 years old Ukrainian	Residence in Milan for 9 years
	Huang longyue	26 years old Chinese	Residence in Milan for 3 years
	Luo xioaoyu	26 years old. Chinese	Residence in Milan for 3 years

Workshop 2

Date	April 11, 2023 2-5 p.m.	
Location	POLIMI BOVISA CAMPUS B7	
Participants	Vanessa Monna	PHD researcher about civic design in design department, polimi
	Tao Dong	PHD candidate about Urban ecological analysis at ABC department of polimi
	Irene	Researcher in design department, polimi

Workshop Process

Stages	Start	Exploration	Concept	Test	Closing
Activities	Take participants through the poster	Get to know, through the Butterfly Growth Stages Map, the specific obstacles that butterflies face to grow in the city.Through this workshop's Co-design toolkit, the designers organized participants to create and discuss ideas about the barriers that butterflies face in the city.	Participants summarize completed ideas and concepts. The designer evaluates and discusses with the participant to make a final decision.	With the Co-design toolkit for this workshop, the designer organizes the participants in a simple desktop walkthrough and evaluation of the design solutions generated in the previous stage.	When the two Co-design workshops are over, organize and summarize the content. Get final solution ideas and solutions.
Materials	Poster	Toolkits	Toolkits	Toolkits	Informational materials
Purpose	Learn basic information about butterflies and ecosystems Learn about the value of conserving butterflies and the challenges they face in cities Understand the process and purpose of this workshop	Due to the specificity of non-human actors, there are many unknowns and misunderstandings about them. The purpose of this stage was to provide participants with a clearer understanding of the butterfly's situation and needs and to empathize with the butterfly as much as possible. Collect ideas from participants. Find out what Milan residents wish and action to take to protect butterflies.	Designers and participants discuss together to get more feasible ideas from many ideas. Turn initial ideas into feasible solutions.	Simulate, reflect and iterate on scenarios through tabletop exercises. And test and validate the final scenarios.	Synthesize and analyze the information from the two workshops.

Table 3: Information on the four stages of the Co-design workshop.

6.2.2 Co-Design Workshop Toolkit Introduction

The toolkit, which was used in both co-design workshops of the project, consists of the following four main materials:

- A poster with information about butterflies
- A map of the city of Milan for observing the butterfly's movement paths
- A journey map to show the butterfly's growth process
- Cards to help the participants brainstorm

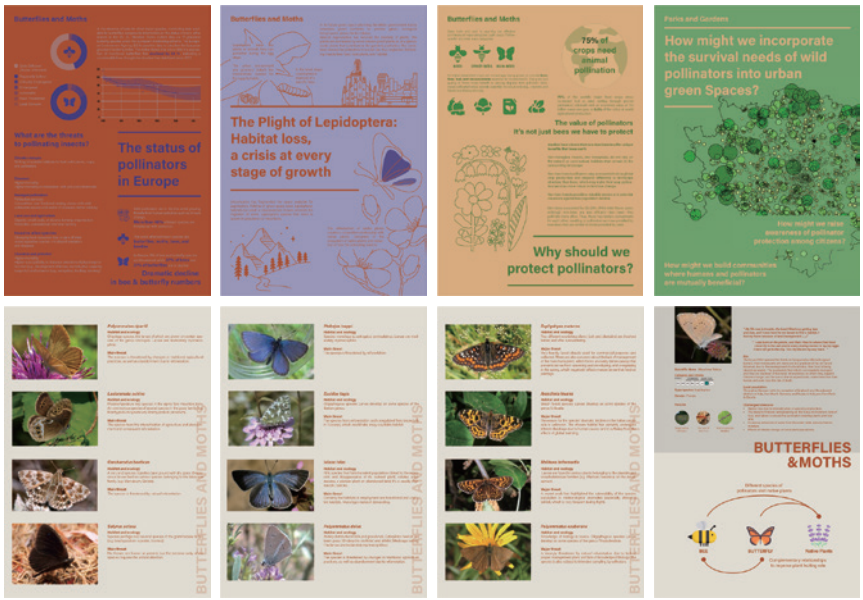


Figure 42. Posters from the co-design workshop toolkit.

Posters

The information presented in the poster is divided into the following 4 main categories (see Figure 42):

- Science related to pollinators
- Science related to butterflies in Milan
- Status of green spaces in Milan
- The needs of butterflies in the city

Aims of this workshop

Milan city map

Content (see Figure 43):

The map gives a macroscopic view of the distribution of green spaces and residential areas in Milan, through which the butterfly's movement path can be speculated.

Butterfly Growth Journey Map

Content (see Figure 44):

For participants to better understand the growth process of butterflies, this workshop divided the growth process of butterflies into five macroscopic stages and recorded the behaviors that may occur in each stage.

The workshop design process will also revolve around the timeline depicted in the butterfly journey diagram from the butterfly's perspective.

Figure 43. Milan city map from the co-design workshop toolkit.

Figure 44. Butterfly Growth Journey Map from the co-design workshop toolkit.

Figure 45. Butterfly Plight Cards from the co-design workshop toolkit.

Butterfly Plight Cards

Content (see Figure 45):

Used in the Butterfly Journey Map to mark the dilemmas that butterflies may encounter at different stages of the journey map in the city.

Figure 46. Butterfly Actor Cards from the co-design workshop toolkit.

Butterfly Actor Cards

Content (see Figure 46):

Different forms of butterflies as they grow。

Figure 47. Stakeholder Cards from the co-design workshop toolkit.

Stakeholder Cards

Content (see Figure 47):

Human stakeholders that may be involved in the process. The inclusion of different stakeholders may provide inspiration for new concepts. It can also be used as a prototype presentation in which the relationships between stakeholders can be more clearly represented. However, these cards are not a limitation and participants can make new cards.

Figure 48. Touchpoint Cards from the co-design workshop toolkit.

Touchpoint Cards

Content (see Figure 48):

Touchpoints that may appear in the design, may be for people, may be for butterflies, and the content of the existing cards may provide some inspiration for participants. However, these cards are not a limitation and participants can make new cards.

Figure 49. Plant Space Cards from the co-design workshop toolkit.

Plant Space Cards

Content (see Figure 49):

Shows the types of spaces in the city where residents or the public sector may be able to grow plants.

The Workshop Process.
Photographed by the author

6.2.3 Co-design workshop in detail

Stage 1 - Beginning： A small exhibition activity

Mini-poster exhibition——Poster topics include:

- The current alarming decline of pollinators in Europe, with a focus on bees and butterflies.
- The value of pollinators, reasons for their protection, and the adverse effects of pollinator decline on ecosystems.
- Challenges faced by butterflies in urban environments, including their vulnerability and the limitations of urban landscapes.
- Milan's current urban green spaces, showcasing the distribution and fragmentation of butterfly habitats.
- Butterfly species potentially found in the Milan area and the potential threats to their survival within the city.
- A non-human persona of butterflies, illustrating the needs and visions of butterflies in a humanized manner, aiming to enhance participant empathy with the butterflies' current situation.

Slide presentation

In the second co-design workshop, the experiences from the first workshop were summarized, supplemented by a PowerPoint presentation. The butterfly's journey through the city was portrayed as a story using slides to facilitate a deeper understanding and empathy for the butterfly's perspective.

Introduction of the Co-design toolkit to participants

The ideas and concepts of the workshop revolve around the Butterfly Journey Map within the toolkit.

Butterfly Journey Map: The re-designed chart is adapted from the Butterfly Journey Map created in the previous section. Based on the timeline of the butterfly's growth stages, the cards show the challenges that the butterfly may encounter at each stage of its journey. Different types of cards can be used in the butterfly journey map to help participants organize their ideas. These tools are used during the workshop's explore, concept, and test stages.

Milan city map: used to simulate the path of a butterfly moving through the city, helping the participant to understand the butterfly's perspective better.

Physical space cards: The physical space changes with the needs of the butterflies due to the different spaces they occupy at different stages.

Touchpoint cards: The touchpoints can change with the needs of the butterfly.

Stakeholder cards: Residents with different roles can take action as the butterfly grows.

Physical tools cards: Physical tools that residents may use in these actions.

Digital tools: Digital tools that residents may use in these actions.

Digital spaces: Digital platforms that residents may use in these actions.

The Workshop Process.
Photographed by the author

Stage 2 - Exploration

In both workshops, although much information has been shared about non-human actors in the exhibition. However, due to the fact that there are always limitations to what humans know about non-humans. Therefore, many specific questions about butterfly behavior still need to be answered at this stage. In this process, the design explained the butterfly's behaviors and needs on a case-by-case basis and organized brainstorming.

Participants recorded their ideas on sticky notes and could also use the cards in the co-design toolkit to introduce their ideas. Blank cards were provided in the co-design toolkit for participants to create needed materials.

This thesis results from an in-depth exploration, ideation, and testing with Milan resident participants in the first workshop. The second co-design workshop was carried out to collect some suggestions from experts to optimize and complement the content of the first workshop.






The Workshop Process. Photographed by the author

First Co-design Workshop

During the first co-design workshop, participants engaged in lively discussions around five potential questions:

1. What are the boundaries of interaction between residents and butterflies?
2. How can residents "notice" the butterflies that need protection?
3. What are the channels through which residents can get involved?
4. How to create contiguous butterfly habitats in urban areas?
5. How can the number of host plants needed by butterflies be increased in the city?

"I believe parks can be planted with a large number of host plants needed for butterflies. Particularly during the caterpillar stage, I would prefer to see them in public spaces."

"We can place signs in public spaces. These signs can inform passing residents that this area is a butterfly habitat and request them not to disturb it."

"Residents can use online platforms to learn which areas in the city need to have butterfly habitats created. Volunteers can then go and plant the necessary plants for butterflies."

"We could set up a temporary habitat in the city that's mobile, and volunteers can maintain it regularly."

"The signs in the park could display a QR code. Scanning the QR code can provide educational information related to butterflies. The online platform can also allow residents to register as volunteers, and it can provide information about habitat construction or maintenance tasks. Residents can take on these tasks and participate in the actions."

"Neighborhoods or communities can share some successful experiences through various activities regarding 'Becoming Neighbors with Butterflies'."

From the first workshop participants

During the discussions in first workshop, participants, as residents of Milan, observed the following points:

- Residents prefer butterflies to appear in public areas before they reach adulthood.
- Residents embrace multiple channels to protect pollinators, whether it's designed park spaces or online platforms.
- Residents recognize the importance of interconnected green spaces and are willing to take action to maintain continuous habitats.
- Residents need more accessible channels for science communication, and this information should be obviously displayed.

Table 4 compiles most of the ideas from the workshop, aiming to provide survival opportunities for each growth stage of butterflies. By integrating the perspectives of both butterflies and citizens, the concept of co-living between residents and butterflies was explored.

Table 4: First co-design workshop information collection.

	Pre-adult			Adult		After adult		
Butterfly growth experience	BUTTERFLY EGG Born parasitic on animals/plants A long developmental process Bite through the eggshell Hatch out	CATERPILLAR Eat parasitic plants/animals Multiple molting To the thermogenesis stage Stop feeding Choose the right place (specific plants) prepare for pupation	HRYSALIS Pupation The larvae shed their old skins Immediately The pupae contract and harden Into a variety of intrinsic forms	BUTTERFLY ADULT The adult develops and matures inside the pupal shell Out of the pupa shell The adult decapsulates Flutter and fly Find food		OVIPOSITION Fly to the spawning site mating Find parasitic plant Lay eggs		
Location	Public Green Space			Public green areas & balconies & connecting paths				
Touchpoint	Designated park space: specifically for pollinator habitat	Plants preferred by pollinators	Designing different habitat spaces for each stage	Designated park space: specifically for pollinator habitat		Designated park space: specifically for pollinator habitat		
Public park (Gov)	Provide relevant policy support	Provision of designated green space	Provision of butterfly habitat conservation areas and signboards to publicise areas that cannot be damaged	Provide educational content related to butterfly conservation in the reserve	Provide gardeners with conservation information and policies, such as signage, to avoid gardeners destroying tiny habitats.	Changing the flora of the park for pollinators	Entering habitat sites in the system	Building of greenfield habitats and temporary housing	Use as much green space as possible in the city (including rooftops, abandoned corners, etc.) to sow seeds
Family balcony	Designated park space: specifically for pollinator habitat	Plants preferred by pollinators	Designing different habitat spaces for each stage	Adopt a butterfly and provide some habitat for a butterfly in a private balcony	Residents in the community share their success stories with each other and spread their experiences. "How do you build friendships with butterflies?"		Entering habitat sites in the system	Provision of temporary space	
Community	Receiving government policies, appealing to residents to participate, spreading relevant science and activities	Create a temporary movable habitat that can be moved into the path of the green space that needs to be connected.		The community organises events to encourage residents to become neighbours with butterflies.			Entering habitat sites in the system	Raising civic awareness and promoting the " Become a neighbour with a butterfly" activity	
Signboard	Provide text information	Provide QR code							
Gardener	Provide regulation to keep habitats intact and available								
Residents	Engaging in communication and practice	Observing the growth of a butterfly	Creating an emotional connection with butterflies	Learn more about butterflies and where their homes are located through the notice boards in the park. And children's education		Engaging in communication and practice	Buy pollinators' favourite plants or seeds from a florist or trolley	Provide temporary shelter for pollinators where food is scarce	
Volunteer	Assist the government by protecting habitats in public green spaces (volunteers may come from relevant organisation/schools/community residents)						Through an open system, volunteers can discover the connecting paths of the fragments and participate in the construction of new habitats		Building mobile temporary sites
Website	Provides more and more professional information on how to care for butterfly larvae etc.	Access the website by scanning the code				Residents can share more success stories on the website		Residents can share more successful cases on the website	
Florist						Provide plants or seeds preferred by pollinators			

The Workshop Process.
Photographed by the author

Second Co-design Workshop

The second Co-design workshop served as a supplement to the first workshop. Participants in the second workshop emphasized the following three aspects:

1. Starting from the perspective of residents, provide more ideas on ways to involve residents.
2. Starting from the perspective of butterflies, explore more possibilities for the utilization of green spaces.
3. Starting from the perspective of experts, provide some related cases and conceptual recommendations.

"School libraries can be utilized to disseminate relevant educational information to students. For example, distributing seeds in the library."

"More practical activities can be organized for children and teenagers, such as constructing shelters for butterflies in the city."

"Different spaces within the city can be utilized, such as the tops of bus stations, abandoned city corners, green spaces near tram tracks. Seed sowing events can be organized, providing free seeds to attract more participation."

"Provide two maps, one belonging to butterflies and the other to residents. Through the maps, residents can understand the current status of butterfly habitats in the city."

"Reports related to butterflies can be provided, such as the survival status and population data of butterflies in the city."

From the second workshop participants

During the second workshop, participants provided numerous insights into the ways and channels for citizen engagement, emphasizing the use of spaces such as libraries, primary schools, and communities. The use of green spaces is not limited to just parks, communities, and balconies. More inspiration was offered on connecting fragmented butterfly habitats, along with discussions on various forms of spatial utilization.

Diverse educational formats on butterfly awareness, particularly targeting children and youth, and organizing more activities were deemed crucial. Volunteers can engage in specific ways, for instance, by accessing relevant tasks through a map showcasing the current status of butterfly habitats in the city.

Table 5 represents the information gathered in this project during the second co-design workshop. These ideas and innovations can optimizations of the concepts from the first co-design workshop, and providing specific guidance for the future development of this project.

Table 5: Second co-design workshop information collection.

	Pre-adult			Adult		After adult
Butterfly growth experience	BUTTERFLY EGG Born parasitic on animals/plants A long developmental process Bite through the eggshell Hatch out	CATERPILLAR Eat parasitic plants/animals Multiple molting To the thermogenesis stage Stop feeding Choose the right place (specific plants) prepare for pupation	HRYSALIS Pupation The larvae shed their old skins Immediately The pupae contract and harden Into a variety of intrinsic forms	BUTTERFLY ADULT The adult develops and matures inside the pupal shell Out of the pupa shell The adult decapsulates Flutter and fly Find food		OVIPOSITION Fly to the spawning site mating Find parasitic plant Lay eggs
Location	Public Green Space			Public green areas & balconies & connecting paths		
Touchpoint		Map of the city belonging to the butterfly		Bus station: Planting on top of the station as a temporary landing place for butterflies	Products that can be attached to buildings	
Public park (Gov)	Zoning of the green space. Provide areas for butterflies and plants	Statistics Butterfly Big Data	Garden design for butterflies	Involvement of non-profit/relevant organisations through a number of free events	Provide some information on how residents can maintain the butterfly's habitat	
Family balcony				Use of the roof to provide habitat for butterflies		
Community				Providing citizen science-related information through library		
Residents		Use different tools in different seasons For example, provide plants that butterflies like in the summer Provide habitat for butterfly eggs in winter	Butterfly Map of the city belonging to human	Sowing seeds in the corner green where residents can get some free seeds		
Volunteer	Building and protecting habitats	Providing a census for butterflies	Leading children's learning			
Website				Share some reports and see if you can use them	Share the situation at each site	
School	Education for a new generation of children through experiential activities	Organising the installation of a butterfly habitat for primary school children		Learn to organise student participation and sow seeds for green sites		
Urban planners	Provide planning on plant diversity					

The Workshop Process.
Photographed by the author

Stage 3 - Concept

The optimal solution was discussed in both co-design workshops.

In the first co-design workshop, approached from a civic perspective, participants emphasized the importance of protecting butterflies in both urban landscapes and community public spaces. They highlighted the necessity of designated areas for butterflies, providing parasitic plants and preferred food sources. Additionally, education through notice boards was seen as crucial to encourage more residents to participate effectively.

Participants aimed to connect fragmented habitats within the city by engaging more volunteers. Volunteers could share habitat locations waiting for creation on an online platform. Residents could then utilize this information to collaborate with volunteers in establishing butterfly habitats near their homes.

Educational initiatives focusing on science were identified as popular among families. By providing knowledge, more children and teenagers could be encouraged to participate in conservation efforts.

The second co-design workshop introduced exciting concepts building upon those from the first co-design workshop.

A city map could be designed for both butterflies and Milan residents. This map would serve to illustrate butterfly habitats and connecting paths, providing residents and volunteers with specific guidance on where to act and plan.

Furthermore, given the potential vulnerability of artificially created butterfly habitats, such as potential destruction or seasonal vegetation growth, observation and documentation of habitats were deemed necessary. The participation of more community residents and volunteers in these actions was encouraged.

The explorations, ideas, and discussions from the two workshops were synthesized. Concepts from both co-design workshops were integrated and optimized, leading to the final concept.

Stage 4 - Test

The Workshop Process. Photographed by the author

This thesis tested each of the two co-design workshops with a desktop walkthrough through the toolkit provided with the co-design toolkit. The materials in the tools used in the testing phase were butterfly actor cards, butterfly touchpoint cards, a city map of Milan, stakeholder cards, post-it notes, and so on.

During the desktop walkthrough, participants engaged in discussions, testing, and provided feedback on ideas generated during the conceptual phase. Subsequently, they collaborated to collectively refine and agree upon a solution. This process was reinforced through a tabletop exercise where ideas were further examined, tested, and feedback was offered. Ultimately, participants collaborated to reach a consensus on a solution.

Finally, the designer integrated the information from the two workshops and, through sorting through a wealth of information and ideas, arrived at the ultimate concept. Table 5 presents the storyboards from the butterfly's perspective, narrating the butterfly's experience of survival in the city under this concept. Table 6, on the other hand, illustrates the service blueprint from the residents' perspective, detailing the residents' engagement, interaction, and process in conservation actions under this concept.

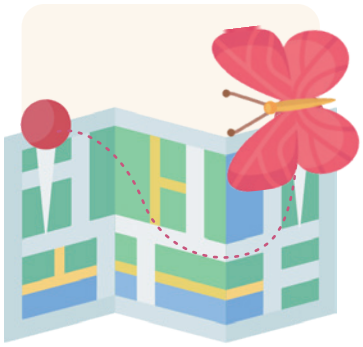
Table 6: Storyboards from a Butterfly's Perspective.

Two butterflies in love discover host plants in Milan and mate to lay eggs, finding a perfect shelter. Not only does this location provide a microclimate suitable for egg development, but it is also seldom disturbed.

The larvae emerge from their shells, and pesticide-free parasitic plants offer them a healthy environment for growth. Adequate local food and natural shelter are the basis for their success in the next stage of evolution.

The larva locates a space where it will not be disturbed and gradually undergoes metamorphosis into a pupa. For example, in a neighborhood green space in Milan, residents have safeguarded the area where the pupae are situated, ensuring they are not removed or disturbed. This protection provides them with a better opportunity to transform into butterflies.

The butterflies emerge from their chrysalises, and the community green space here offers them an abundance of native plants to feed on. The butterflies visit these plants one by one, and in the process, the plants are pollinated.



Butterflies can move and spread freely in cities through pathways planted with native plants. This movement pattern helps in avoiding isolation and promotes plant pollination within urban areas. The city roads are adorned with various local plants, visible in community gardens, street corners, private balconies, and building rooftops. These patch-like habitats act as stepping stones for butterflies, allowing them to transition from one green space to another. It is essential to ensure that butterflies have access to enough food as they traverse through the city.

A solitary butterfly roams the green spaces of the park, serendipitously encountering its compatible mate. They gracefully dance amidst the blossoms and discover a cluster of host plants ideal for their larvae. They carefully lay their eggs here ...The cycle of new life begins here.

Table 7: Service Blueprint for Milan's Resident.

		Aware	Join	Use	Develop	Promote
		KNOW IT	LEARN MORE	BUTTERFLY MAP EDITING	BECOME VOLUNTEER	EVENT PROMOTION
Residents' actions		-Residents walking in a neighborhood park. -Residents pass by native flora. -Residents see a signboard. -Residents scan the QR code to access the website "Becoming Neighbors With Butterflies". -Residents learn about the plight of butterflies in the city. or -Residents get seeds and learn about butterfly-related information offline through a number of community organizations	-Residents download "Guidebook To Butterfly Conservation In Milan City" from the website. -Residents use the guidebook to read about the species of butterflies that may be found in Milan, as well as information about their habitat needs, favorite foods, parasitic plants, and other scientific information.	-Residents browse the city's butterfly map -Residents learn about the current status of butterfly habitats in the city of Milan through an online map -Residents learn how to use Milan city maps -Residents find destroyed butterfly habitat in neighborhood public space -Residents mark details in the butterfly map on the website	-Residents working with other volunteers to organize builds butterfly habitat in the community -Resident discovers through a map that his neighborhood should be the habitat needed for butterflies to move around -Residents apply to become volunteers -Residents pick up tasks in the activity list -Residents participate in the building of a butterfly habitat in the community -Residents actively involved in urban butterfly habitat -Residents start specific planting actions through the guidebook	-Residents respond positively to activities in the community -Residents promote the website and butterfly conservation to a broader audience at offline events
Touchpoint		Native Flora, Signboard, Website	Guidebook PDF, Website	Online Map, Website	Online Community platform, Website, Guidebook PDF	Online Community platform, Website
Front-of-stage Interaction	Online Volunteers			Co-create a city map related to butterflies	Co-create a city map related to butterflies Be active in the online community	Co-create a city map related to butterflies Be active in the online community
	Community Manager			Co-create a city map related to butterflies	Organize community planting events now and participate in butterfly habitat management	Organize community planting events now and participate in butterfly habitat management
	Offline Event Participants			Co-create a city map related to butterflies		Participation in planting activities
Back-of-stage Interaction	Online Volunteers	Help build a butterfly habitat	Active on the website	Make active observations in life and record the content in the online community and the butterfly map	Organization and participation in valued activities	
	Community Manager	Organize residents and volunteers to build butterfly habitats			Organize residents and volunteers to build butterfly habitats	Organize residents and volunteers to build butterfly habitats
	Government public sector	Allow/provide use of public spaces in the city			Allow/provide use of public spaces in the city	Allow/provide use of public spaces in the city
Technical	Online platform		Provides information about butterflies Provides a guidebook related to the conservation of butterflies (PDF format)	Provides information about butterflies Provides an online map with information on butterfly habitats in Milan	Provides information about butterflies Provides a guidebook related to the conservation of butterflies (PDF format) Provide an online community platform	Provides information about butterflies Provide an online community platform

6.2.3 Co-design workshops summary

Through two co-design workshops, this project has culminated in a final concept that integrates the perspectives of both butterflies and Milan residents. However, this concept extracted from a plethora of ideas still requires multiple iterations and feasibility validation. Therefore, in the next chapter, this thesis invites experts from relevant fields to comprehensively assess and provide feedback on the outputs from the co-design workshops.

6.3 Expert Feedback

Tao Dong

PHD candidate about Urban ecological analysis at ABC department of polimi

In the final solution, I think it is easy and smooth to go from residents following the event to scanning the QR code to access the website and learn about the information. However, it might be challenging to engage the residents actively in the action of the public space, and the user experience breaks down there.

Nevertheless, there are few opportunities to see noticeboards in parks. Consider placing touchpoints in supermarkets as a scenario, such as complimentary seeds, selling or adopting some of the butterfly's favorite plants at a low price.

For me, the probability of going from 0 to 1 to grow a plant is not high. I think purchasing the plant directly for the resident/participant would be a much simpler experience, and the residents may be more likely to be active in the action.

At the same time, it is also helpful to give a "passport" about the plant when purchasing the plant. On the one hand, it is to let participants know where the plants come from (to prevent invasive species), and on the other hand, it can let buyers know how to plant them. Butterflies have mobility, and potted plants planted on the balcony will attract them to visit. By doing so, it is possible to gradually change the participants' attitudes towards non-human beings and the city's interaction boundaries.

As for the maps in the co-design solution, I think they could be enriched with more functions. For example, we can scan the code to locate the "butterfly's favorite plant" sold in the supermarket. This way, the plant's geographic location will also appear on the map. Participants may invite their neighbors and friends to participate to make the nearby paths continuous. The "social properties" of plants let more residents join in.

Potted plants can provide a good transition from learning about butterflies to engaging with community habitats. Through this step-by-step approach, participants can be better engaged in the action of public space.

Solution Optimization Analysis (see Tabel 8):

- Enhancing the action experience, this project introduced an additional stage where participants actively assisted the butterflies by planting them in pots. This was aimed at facilitating residents' connection with butterflies within the urban setting.
- Moreover, we included detailed plant growing instructions. From the residents' perspective, this project provided information about the plants, allowing them to learn about planting techniques specific to these plants and the butterflies' preferences.
- This project also incorporated social attributes into the initiative. Encouraging residents to engage with friends and neighbors helped raise awareness across a wider audience and paved the way for the next phase of community activities.

- This phase requires more stakeholder support. The purpose is to be known by a broader range of residents.

Table 8: Final concept iteration and optimization process.

Observation and verification of flowerpot plants:

Through the observation of potted plants, the author of this thesis has discovered that potted plants not only attract visits from butterflies (as seen in everyday life), becoming 'stepping stones' in the process of adult butterfly movement and dispersal but also provide a shelter for butterfly eggs (see Figure 50) and larvae (see Figure 51).

Figure 50. Lepidoptera eggs in a flowerpot.

Figure 51. Lepidoptera larvae in a flowerpot.

CHAPTER 7

OUTPUTS

7.1 Becoming Neighbors with Butterflies
7.2 Design and Details of Touchpoints

7.1 Becoming Neighbors with Butterflies

7.1.1 Final concept and outputs

The final output of this thesis is a set of service design solutions.

Expert feedback in the final design stages is beneficial for summarizing the co-design process. However, the information discussed during the design phase remains varied. Therefore, this thesis presents the final scenario of this approach with a storyboard from a butterfly's perspective, a blueprint of services from a resident's perspective, and a stakeholder map that includes both human and non-human actors. These outputs represent not only a synthesis of the project process but also the initiation of design for more-than-human engagement in the city.

The project's ultimate goal, "Becoming Neighbors with Butterflies," is to integrate butterfly habitat creation into urban civic action. During the participatory design process, workshops and interviews with residents and experts in the field provided valuable ideas and suggestions for the project. Finally, these insights were filtered and synthesized into several potential concepts. These "concepts" consist of key Touchpoints:

- "Butterfly Favorite Plants": Plants act as a bridge between humans and butterflies, making them a vital touchpoint in this project. Specific plants are crucial for the survival of butterflies, and given the prevalence of plant lovers and consumers in the city, plant native plants needed by butterflies is imperative to maintain the diversity of native plants.

- The Map of Butterflies in Milan: This touchpoint offers an urban space from a butterfly's perspective. It allows residents to observe the construction of butterfly habitats in the city, potential movement paths of the butterflies, and the continuity of those paths. Through the map, residents can gain a clearer understanding of where to initiate relevant actions, complemented by the guidebook, facilitating a smoother commencement of actions.

- The Map of Butterflies in Milan: This touchpoint offers an urban space from a butterfly's perspective. It allows residents to observe the construction of butterfly habitats in the city, potential movement paths of the butterflies, and the continuity of those paths. Through the map, residents can gain a clearer understanding of where to initiate relevant actions, complemented by the guidebook, facilitating a smoother commencement of actions.

- "Becoming Neighbors with Butterflies" Online Community: This touchpoint aims to foster bottom-up action and ensure the long-term conservation and protection of butterfly habitats through organized community activities. It provides a platform for wider dissemination of actions related to protecting urban butterflies.

Through a series of actions carried out by the residents, the touchpoints for butterflies such as "parasitic plants," "food," "undisturbed habitats," "the butterfly's perspective," "movement paths," and "diffusion paths" were created.

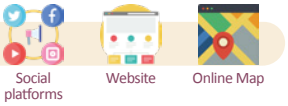
Based on these touchpoints, this thesis separately describes the experiences of human and non-human entities. For non-human entities (butterflies), this thesis presents a design prototype of the butterfly experience in the city through a storyboard (see Table 10). For humans (residents), this thesis outlines how residents transition from "paying attention" to "learning about" butterflies, then participating in concrete "action," ultimately becoming community volunteers and promoting relevant actions through a service blueprint with a timeline sequence. To effectively promote bottom-up resident participation, this thesis provides a detailed description of the "visible" and "invisible" parts of the participation process, presented through the service blueprint (see Table 9). The integration of background and foreground facilitates bottom-up actions by residents and responsiveness to policy initiatives. In this process, plants act as a bridge connecting residents and butterflies. Through a shift in citizens' attitudes, awareness, and usage behaviors towards plants, more habitats and survival opportunities are created for butterflies in the city.

Through this project, this thesis aims to provide habitats and shelters for butterflies within the city. Cities should be a home for both human and non-human lifeforms, and the participation of inhabitants can better advance the construction of a city inclusive of other lifeforms. As shown in Table 11 Stakeholder Map, These interlinked interspecies relationships are not solely for individual species but for the diversity and stability of the ecosystem, promoting a more diverse and sustainable vision for future urban living. Butterflies can be afforded more opportunities for survival through bottom-up actions by residents. Simultaneously, the abundant pollinator resources contribute to the diversity of the local ecosystem, ultimately benefiting humans. Designing for more-than-human lifeforms could not only provide more living space for non-human entities but also indirectly affect the health and well-being of human beings.

Table 9: Service Blueprint for Milan's Resident.

	Aware	Join	Use
Evidence	 Native Flora, Signboard, Website	 Online Map, Guidebook PDF, Website	 QR code, Potted plant, Plant Passport
Residents' actions	KNOW IT -The user walks in a neighborhood park. -The user passes by native flora. -The user sees a signboard. -The user scans the QR code to access the website "Becoming Neighbors With Butterflies". -The user learns about the plight of butterflies in the city.	LEARN MORE -The user downloads "Guidebook To Butterfly Conservation In Milan City" from the website. -The user uses the guidebook to read about the species of butterflies that may be found in Milan, as well as information about their habitat needs, favorite foods, parasitic plants, and other scientific information. -The user learns about the current status of butterfly habitats in the city of Milan through an online map -The user learns how to use Milan city maps	LEARN ABOUT PLANTS -The user looks at potted plants for sale in supermarkets/schools/neighborhoods -The user buys potted plants -The user finds Plant Passport, which records information about the origin of the plant, growing tips, and the way they attract butterflies. -The user scans a code to access the website and enters the home address (where the plant is grown) -The user's plant address is recorded in the website's butterfly map
Front-of-stage Interaction	Plant sales sites		Offer potted plants for sale or giveaway. May be supermarkets/-schools/community service, etc.
	Public green space	Providing space and management of butterfly habitats	
	Community Volunteers	Providing butterfly habitat construction and notice board displays	
Back-of-stage	Government public sector	Provide authority and planning for public land use	
	Online Community organization	Composed of volunteers. Provides planning and organization of various events	
Technical	Online website platform	the website "Becoming Neighbors With Butterflies". Includes butterfly maps, guidebooks and online community operations	the website "Becoming Neighbors With Butterflies". Includes butterfly maps, guidebooks and online community operations	the website "Becoming Neighbors With Butterflies". Includes butterfly maps, guidebooks and online community operations
	localization system		Provide location generation of potted plants on butterfly maps	Provide location generation of potted plants on butterfly maps

Use



JOIN BUTTERFLY MAP

-The User on the Butterfly Map finds that the coordinates for "Butterfly's Favorite Plants" do not appear near their friends' home
-The user recommends friends buy "Butterfly's Favorite Plants" at the supermarket.
-The user and friends enrich the butterfly map together

Offer potted plants for sale or giveaway. May be supermarkets/-schools/community service, etc.

the website "Becoming Neighbors With Butterflies". Includes butterfly maps, guidebooks and online community operations

Provide location generation of potted plants on butterfly maps

Develop

BECOME A VOLUNTEER

-The user sees green spaces near their home in the butterfly map, recruiting volunteers to participate in butterfly habitat creation
-The user signs up as a volunteer in the online community
-The user participates in a volunteer meeting in the online community and receives a task
-The user engages in butterfly habitat creation in the field

Providing space and management of butterfly habitats

Providing butterfly habitat construction and notice board displays

Provide authority and planning for public land use

Composed of volunteers. Provides planning and organization of various events

the website "Becoming Neighbors With Butterflies". Includes butterfly maps, guidebooks and online community operations

EDIT BUTTERFLY MAP

-The user passes by a community garden and notices that a butterfly habitat has been destroyed
-As a volunteer, the user marks the butterfly map and explains the details.
-The user has an online meeting with other volunteers and assigns tasks.

Providing space and management of butterfly habitats

Providing butterfly habitat construction and notice board displays

the website "Becoming Neighbors With Butterflies". Includes butterfly maps, guidebooks and online community operations

Provide location generation of potted plants on butterfly maps

Promote

More action

-Users invite friends who buy potted plants to co-construct butterfly habitats
-The user promotes "Become Neighbors with Butterfly" to more people during the action.

Providing space and management of butterfly habitats

Providing butterfly habitat construction and notice board displays

Table 10: The Butterfly's Story Board.

Butterfly Urban Oasis - "Landing Site"

Touchpoints: Pollinator Protected Areas, Local Plants, Host Plants
Space: Parks or Extensive Green Areas

The city provides undisturbed habitats for butterflies. Here, they can move, feed, mate, and lay eggs.

Butterfly Movement Paths - "Stepping Stones"

Touchpoints: Small Local Plants, Butterfly-friendly Potted Plants (food)
Space: Small Green Areas, Street Corners, Balconies, Community Gardens, etc.

Adult butterflies need a broader range of movement and dispersion. Although urban spaces may not provide ample area, scattered small local plants in the city can serve as adequate stepping stones and shelters for butterflies. Through these "stepping stones" connecting fragmented habitats, butterflies find the pathways they need for movement.

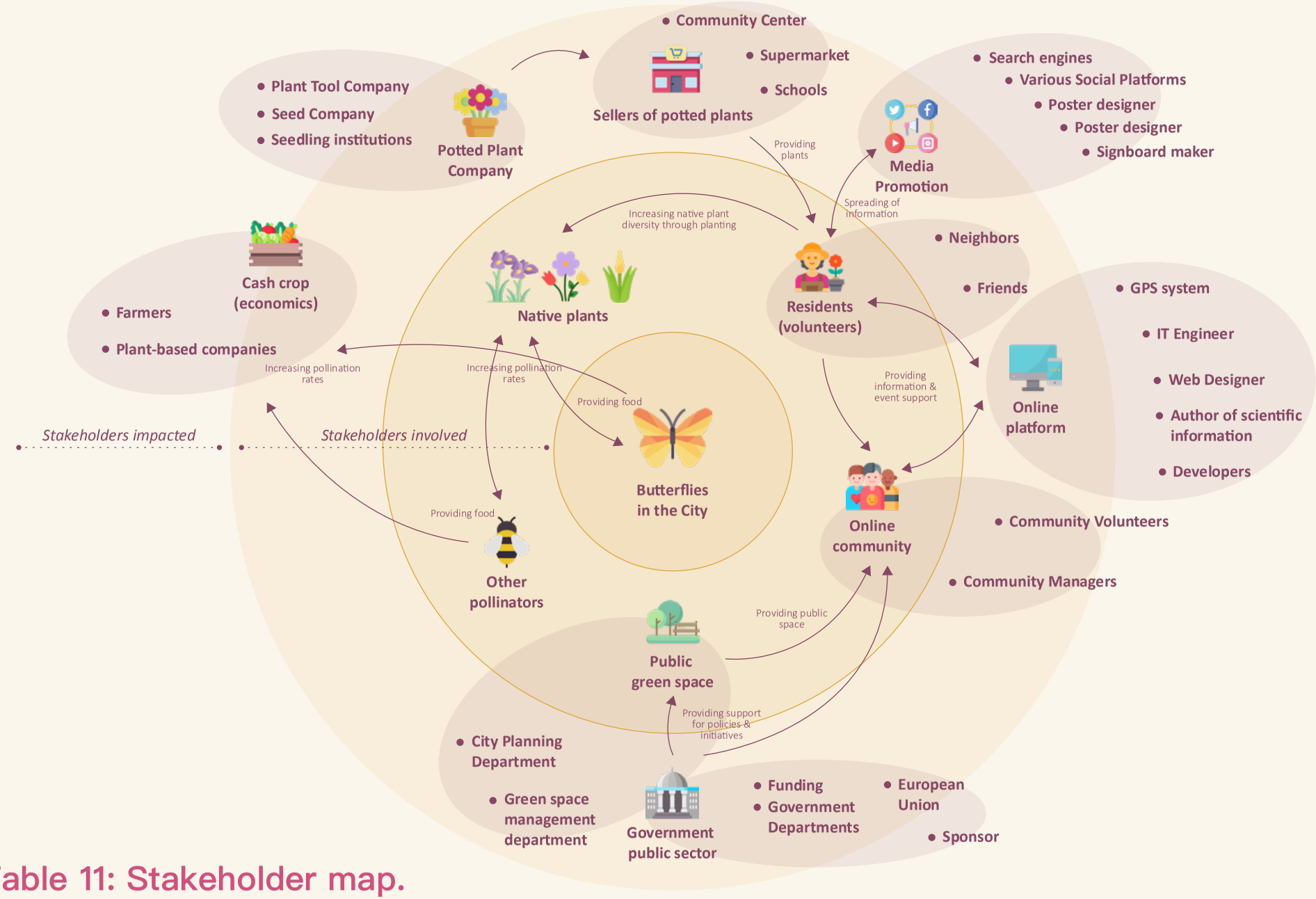


Table 11: Stakeholder map.

7.2 Design and Details of Touchpoints

Figure 52. The final concept of the web interface design.

"BECOMING NEIGHBORS WITH BUTTERFLIES" WEBSITE

Homepage (see Figure 52)

The website's homepage provides basic information related to butterflies, the current status of butterflies and pollinators, and the value of butterflies. On the homepage, you can explore the main functionalities of the website, with further details available upon clicking.

The website's purpose: To provide channels and guidance for citizen engagement in butterfly conservation in the city of Milan.

Key features of the website:

- Download the PDF Guidebook of "BECOMING NEIGHBORS WITH BUTTERFLIES."
- Explore the Butterfly City Map.
- Learn about community activities and actions related to butterfly conservation in the city.

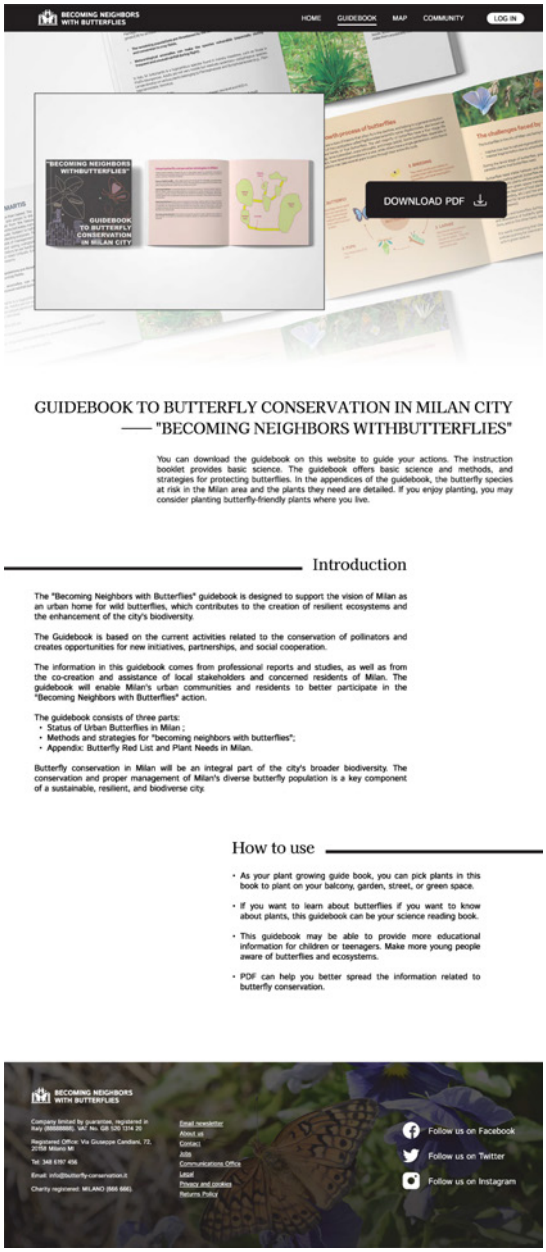


Figure 53. The final concept of the web interface design.

"BECOMING NEIGHBORS WITH BUTTERFLIES" WEBSITE

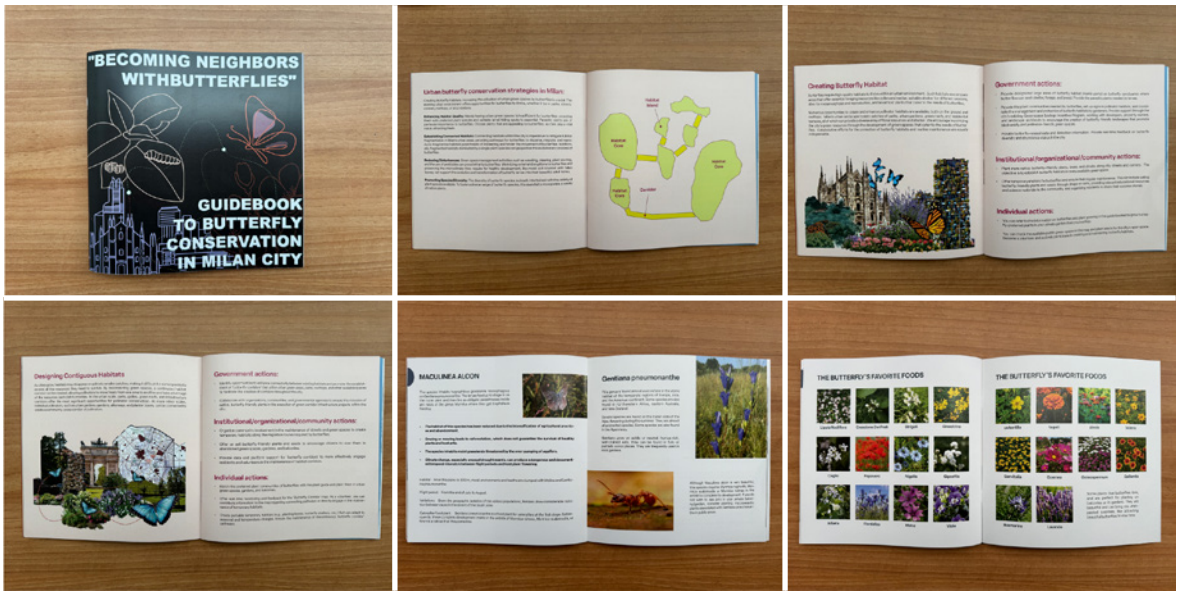
Guidebook (see Figure 53)

The guidebook offers detailed action guidance for residents in the Milan area who want to learn about butterflies. Readers can use the information provided in the guidebook to plant local flora that is beneficial to butterflies.

The guidebook (see Figure 54) is divided into three sections:

- The first section introduces the current status of butterflies in Milan. This section elaborates on the potential challenges butterflies may face in the urban environment of Milan, as well as the value of butterflies and the necessity of conservation efforts.
- The second section covers methods and strategies for taking action. It provides readers with strategies for taking action in different spaces and offers specific action recommendations for different stakeholders and interest groups.
- The third section provides an introduction to butterfly species in the Milan area and guidance on planting local flora. In this section, readers can learn about the plants that butterflies prefer and select their preferred plants for cultivation.

Figure 54. The final concept of the guidebook (paper version).



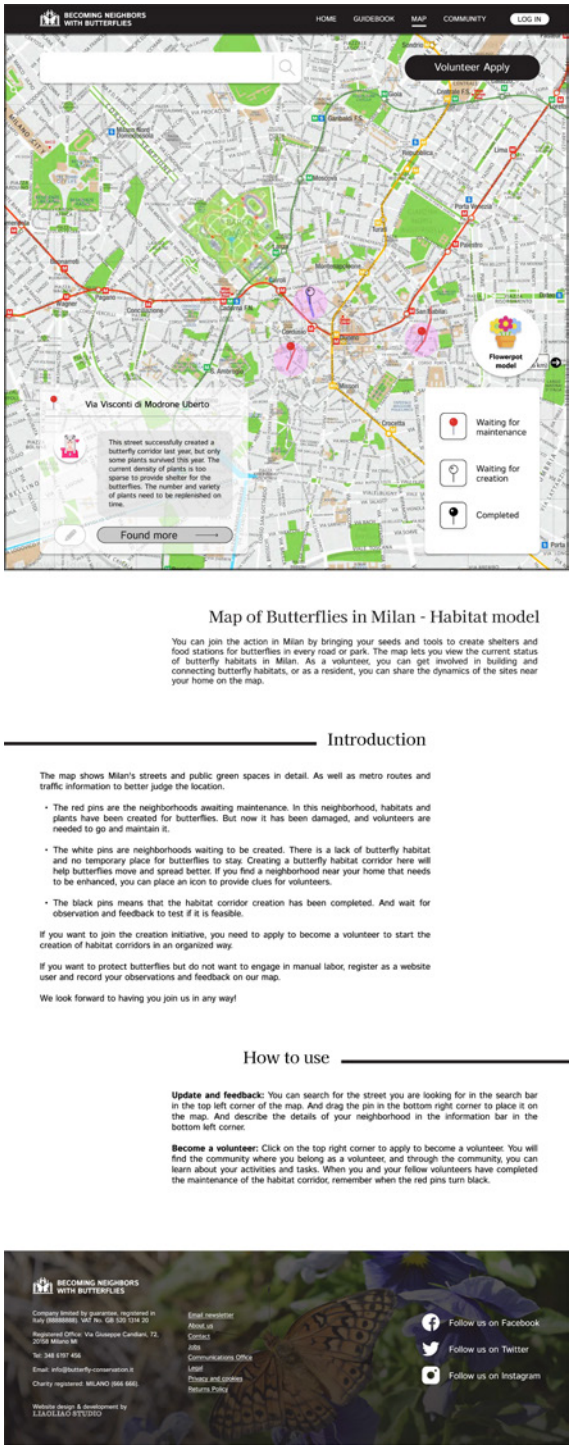


Figure 55. The final concept of the web interface design.

"BECOMING NEIGHBORS WITH BUTTERFLIES" WEBSITE

Habitat map (see Figure 55)

The habitat map displays the status of butterfly habitats in public spaces in Milan. Readers can use this map to understand the connectivity of butterfly habitats in the city, identify locations that need maintenance, and assist residents in initiating bottom-up actions.

Key functions of the habitat map:

- Classify public spaces in the city that could potentially serve as butterfly habitats into categories such as "established," "not yet established," and "in need of maintenance." This allows for a clear view of the status of each space and helps manage established habitats.
- Provide specific channels for resident engagement, allowing residents to understand the specific requirements for participating in actions through the map.
- Monitor the status of butterfly habitats to ensure the quality of these habitats and the continuity of migration paths.

Methods for map data updates:

Volunteers and website administrators collaborate in this effort. Highly motivated residents can apply to become volunteers and take on the responsibility of providing real-time updates on the status of public spaces near their residences.

"BECOMING NEIGHBORS WITH BUTTERFLIES" WEBSITE

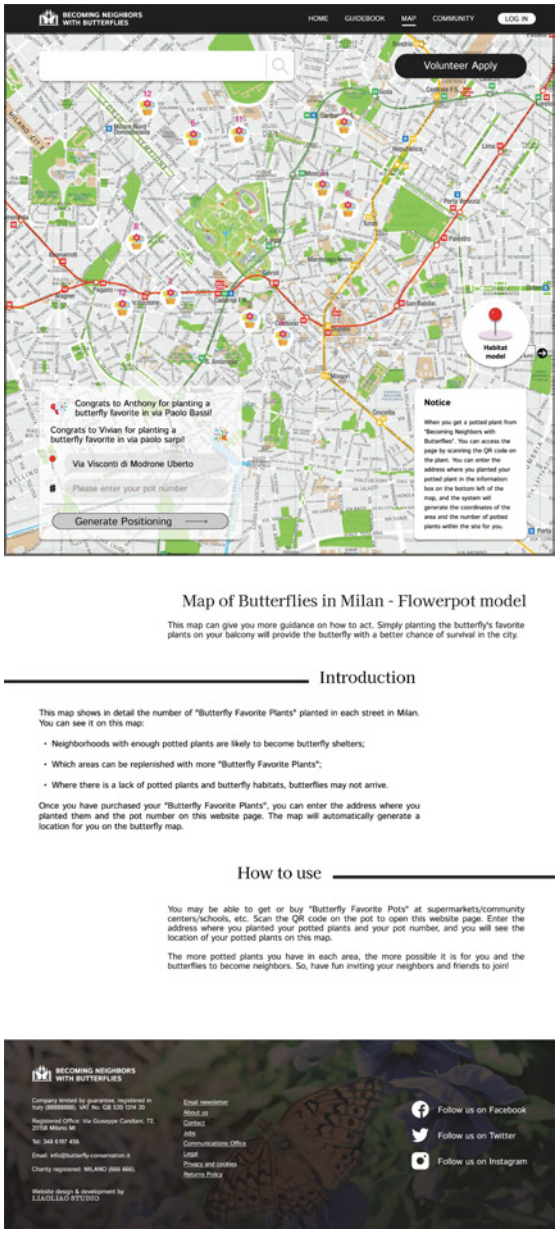
Flowerpot Map (see Figure 56)

The pot map displays the number of "Butterfly Favorite Plants" in different neighborhoods. Residents can purchase "butterfly-friendly plants" at various locations such as supermarkets, community centers, or schools. They can then register the number of potted plants by entering the plant's code and planting address, even if these pots are placed on private balconies and gardens.

The purpose of the Flowerpot map:

- Connect butterfly habitats and provide "stepping stones" on butterfly migration paths.
- Enable residents to easily participate in conservation efforts. Purchasing plants is a simple thing compared to becoming a volunteer.
- Visualize the number of potted plants of ""Butterfly Favorite Plants." Residents can invite friends from different neighborhoods to participate.
- Promote more active involvement. Leveraging social features, residents can easily invite friends and neighbors to join and participate. In familiar social networks, residents may be more motivated to engage in public space actions.

Figure 56. The final concept of the web interface design.



"BECOMING NEIGHBORS WITH BUTTERFLIES" WEBSITE

Online Community (see Figure 57)

Based on the butterfly habitat map, the Milan online community provides a platform for local residents to engage in online communication. This online community offers specific channels, activities, and tasks for residents and volunteers. Residents can share information related to butterflies within the online community, and they can also apply to become volunteers to participate in more active actions.

Key functions of the online community include:

- Community Introduction: Providing readers with an understanding of the community's purpose.
- Forums: Participants can share butterfly-related information in the forums, such as successful case studies, habitat locations that need maintenance, planting activities, and more.
- Action Events: Readers can browse habitat locations that require maintenance or creation, along with specific implementation tasks and information. They can apply to become volunteers and join event teams.
- Becoming a Volunteer: Residents can apply to become volunteers. Once accepted as volunteers, they can become editors of the butterfly habitat map, providing more dynamic information to other readers. They can also engage in more actions.

Figure 57. The final concept of the web interface design.

Figure 58. Butterfly Favorite Plants and Plant Passport.

Butterfly Favorite Plants (see Figure 58)

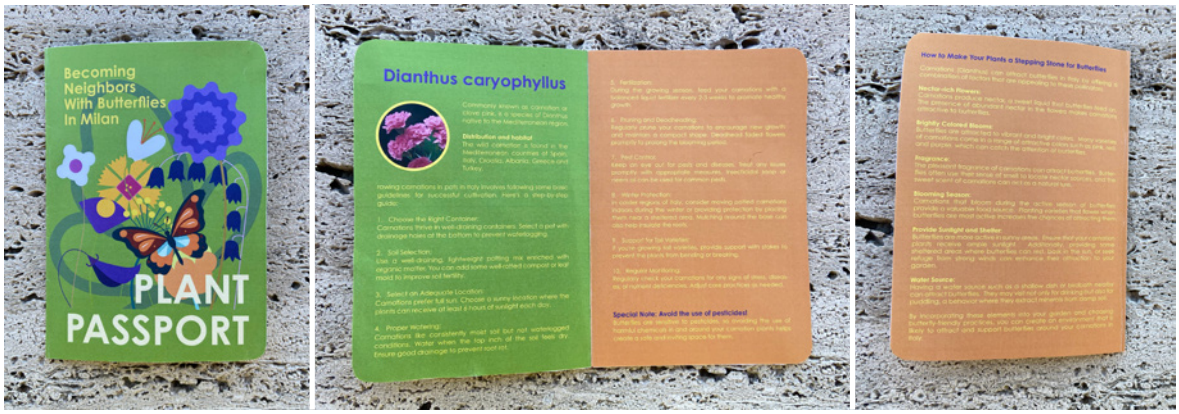
Location: Residents can purchase Butterfly Favorite Plants at supermarkets, schools, neighborhoods and other locations.

Purpose: Residents can create "stepping stones" for butterflies to spread and move in the city by planting Butterfly Favorite Plants. Residents can generate planting locations on the map by entering the plant ID provided on the flowerpot and scanning the QR code for the website 'Becoming neighbors with butterflies.' Additionally, users can find more action information and guidance on the website.

Plant Passport (see Figure 59)

The information card provided with Butterfly Favorite Plants provides detailed instructions on how to plant the species and methods to attract butterfly visits.

Figure 59. Plant Passport information.



CHAPTER

8

CONCLUSION

8.1 Future Developments
8.2 Reflections

8.1 Future Developments

In the discussions in the preceding chapters, this thesis have come to realize that incorporating butterfly habitats into urban spaces involves numerous complex factors. This process takes into account the needs and behaviors of non-human entities, as well as the changing urban environment, while considering government initiatives and the needs and expectations of residents.

This thesis aims to address the sharp decline in the population of pollinating insects in Europe, focusing on the ecosystem centered around butterflies, their species relationships, and habitat requirements. The project conducted a specific species analysis of butterflies in the Milan urban area and investigated the urban environment, citizen attitudes, and government actions. The primary research findings are as follows:

- Butterflies in the Milan urban area require high-quality and continuous urban habitats.
- Government initiatives struggle to garner bottom-up responses from residents.

As a result, this thesis integrates the frameworks and methodologies of service design and participatory design to approach the design process from a more systematic and inclusive perspective, presenting a set of service design solutions.

The objectives of this project are to explore more sustainable lifestyles for the future through design:

- Incorporate considerations for butterflies (non-human entities) into urban spaces, providing them with undisturbed habitats and pathways for dispersal and movement.
- Offer detailed references, guidance, and channels for residents to engage in actions.

While this study has explored various aspects in two co-design workshops, there remain numerous potential issues that require further refinement in design and resolution. Specifically, the following areas need to be considered:

More effective modes of cultural communication to shape the forms and content of resident engagement better. Additionally, more media, methods, and channels for residents to understand the butterfly's perspective should be explored.

Solutions with more interest and cultural characteristics should be optimized. Integrating local cultural features and customs from Milan and Italy can make residents' actions more engaging and increase civic participation.

Future research can extend to explore additional areas related to the connection between urban residents and butterflies. These areas could encompass the benefits of private spaces (such as balconies or gardens) for pollinators, the boundaries of coexistence between humans and non-human entities in cities, maintenance strategies for butterfly habitats in urban environments, and possibilities for other types of non-human entities and their habitats within urban living spaces. These ideas will form the foundation for future design activities.

It is worth emphasizing that to achieve a more sustainable urban society, further research and practice need to originate from specific locations (e.g., specific communities, spaces, or streets). Future research should delve deeper into the specific spatial environments of butterfly habitats within urban settings.

8.2 Reflections

During the research phase, this thesis heavily relied on desk research and observations to study non-human entities. This choice stemmed from the difficulty of finding representative individuals to articulate the viewpoints and needs of non-human groups. While deskt research provided detailed and specific insights into non-human habitat requirements, more emotionally enriched and comprehensive conclusions still require deeper research and analysis.

In the design phase, although various mediums were used to incorporate the non-human perspective through the co-design process, and essential information related to non-humans was actively provided during the exploratory process, the ultimate output served the non-human character of this study, the butterflies, and the local residents in the Milan area. However, in the existing co-design method, there is no clear stage or representative method model to introduce and elaborate on non-human actors. This was primarily due to the challenging task of getting participants to embody the viewpoint of non-human actors and empathize with them within the constraints of limited time. If more time were available for the workshops, this situation could potentially be improved.

In the final feedback collection phase, due to time and resource constraints, each touchpoint in this thesis has not received full practical testing. In the future, these touchpoints can be validated through more co-design workshops, and additional feedback from residents can be collected through surveys. If the opportunity arises, project development can take place within specific location.

Based on the Double Diamond model framework redefined by Selloni and Rossi (2018) that integrates human and non-human entity perspectives is proposed (see Figure 30). The aim is to build a bridge between humans and non-human entities through design practices, bridging the gap between human and non-human entities. In design practice, the perspectives of both humans and non-human entities are equally important. Therefore, the needs of different entities should be integrated at every stage of the design. This model framework can assist designers in incorporating the viewpoints of both human and non-human entities at each stage of the design process. Furthermore, it encourages designers to reconsider the processes of exploration, insights, definition, concepts, and outputs from a broader perspective of ecosystems and the diversity of species.

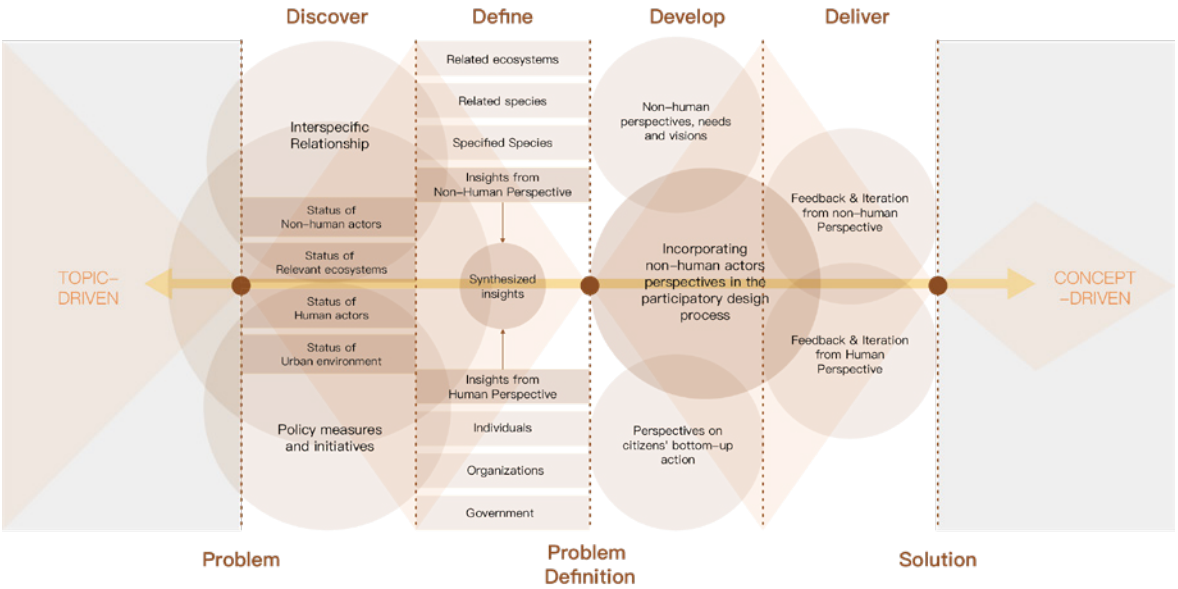


Figure 60. Service design model framework for incorporating more–than–human perspectives.

The model proposed core theoretical shifts in the following ways:

- In the "Discover" phase: The model emphasizes the importance of all material and entities interwoven. In the research phase, it is essential to integrate more-than-human perspectives and conduct detailed research and analysis of the associated species' ecosystems and interrelationships. Similarly, while including human perspectives, potential factors such as human behavior, activities, environment, and policies should be considered. A genuine understanding of facts related to more-than-human actors and interrelationships, interconnected ecosystems and environments, human interventions, impacts, and responsibilities, among others.

- In the "Define" phase: Designers should "see" the non-human entities and the ecosystems behind them, while considering insights into human activities from various stakeholders, such as individuals, organizations, and governments. Exploring potential connections interwoven in complex relationships.

- In the "Develop" phase: The participatory design approach helps in integrating more-than-humans perspectives and viewpoints into the design process. Through participatory design (approach), it reshapes the relationships between humans and non-human entities, offering more protection and support to non-human entities through bottom-up citizen action.

- In the "Deliver" phase: It is possible to invite representative experts or stakeholders, including non-human entities, to iterate on the design concepts. Given the intricate ecosystems and inter-species relationships, feedback from experts in relevant fields is highly important. The final output and implementation aim to inspire greater protection and support for more-than-human actors in urban environments, with 'mutual care' between humans and non-human entities.

This thesis project develops research and design around service design for more-than-human world. While existing design frameworks still have limitations in addressing non-human lifeforms, human-centered design thinking and frameworks lack consideration and inclusivity for non-human lifeforms. Thus, further research and practice are required to optimize existing theories and research methods for non-human entities. As a designer, it requires stepping out of the traditional anthropocentric mindset and shifting towards a broader non-human perspective. In this process, designers need to delve deeply into the complex ecosystems related to non-human lifeforms, understanding their viewpoint through extensive research and observation. Simultaneously, designers must remain attentive to the potential relationships between non-humans and humans, as well as the boundaries between non-human and human living spaces. The ecosystem crucial for human survival is intricately intertwined with the ecosystems inhabited by non-human lifeforms. Therefore, continuing to advocate for society's attention to non-human lifeforms becomes of paramount importance.

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