GREEN INFRASTRUCTURE ALLIANCE

BRINGING BACK BIODIVERSITY IN OUR CITIES: THE ROLE OF GREEN ROOFS

JUNE 2022

Evidence shows that natural spaces and habitats are disappearing due to human impacts. Atmospheric CO2 concentrations are at their highest in more than 3 million years, triggering unprecedented droughts, fires, and floods across the continents. Rapid Global urbanization puts severe pressure on green spaces with destructive impacts on biodiversity and ecosystem services. Furthermore, millions of acres of tropical forest are cleared every year, decimating a few of the most diverse ecosystems on Earth. However, also here in Europe, our agriculture has created vast monocultural biodiversity deserts. Hence, it is not hard to see why most biologists agree that the world has entered its sixth mass extinction event (Wagner at al, 2021).

What is biodiversity and why does it matter?

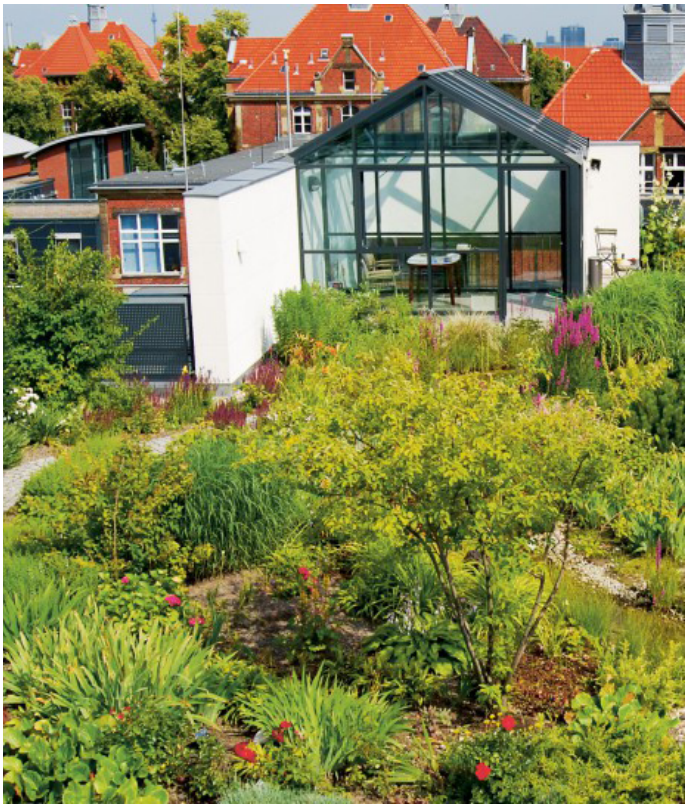
The term "biodiversity" means the variability within a biological system. It can describe inter- or intra- genetic, species, or ecosystem variability ranging from the deepest ocean to the highest mountaintop. Biologic variability is critical due to its positive correlation with system stability. This is partly due to functional redundancy. In short: if several species co-exist that can carry out a specific ecosystem function, a temporary species decline of one of those species will not significantly perturb the system. However, if you only have one species that can carry out a critical function, its decline might lead to an ecosystem collapse resulting in considerable ecological, economic, health, and societal damages.

Many studies suggest that biodiversity may be particularly important for **ecosystem multifunctionality**, because different species can contribute to different functions (Wagner at al, 2021). Biodiversity has a decisive impact on Earth's environment; it provides essential ecosystem services such as oxygen production, air, and water purification, flood and drought mitigation, increased soil fertility, pollination, and food security. But we should not forget that we also have the diversity of nature to thank for most of our medicines and materials. Hence, **biodiversity is critical to human survival as it also ensures health and food security.**

Insect pollinators provide an essential ecosystem service, but they are under threat. This is a severe cause for concern because pollinators are an integral part of healthy ecosystems. Without them, **many plant species would decline and eventually disappear with the organisms** that depend on them, which would have serious **ecological, social and economic implications** (NIB, 2019). For example, pollinators are vital in agriculture and are instrumental in 35% of global crop production (Willige, 2019). The net worth of insect pollination is estimated to be around 10% of the total value of the agricultural output. That adds up to approximately €153 billion globally and up to €22 billion in Europe every year (Helmholtz Association of German Research Centres, 2008)

In addition, high biodiversity has been linked to an increase in h**uman health and wellbeing** while many different businesses and jobs are connected to biodiversity whether by being dependent on nature or fighting against biodiversity decline. There is great potential for the **economy to grow and become more resilient by ensuring biodiversity**. Last but not least, **biodiversity provides livelihoods, protects us, and makes Earth habitable** (Quinney, 2020).

What are the benefits of urban green infrastructure for biodiversity



Intensive green roof

Extensive green roof

There is growing evidence that urban green infrastructure, including green roofs and walls, can contribute to mitigating the loss of biodiversity.

Urban green infrastructure can improve the natural conditions needed to sustain thriving pollinator habitats and renaturing urban and industrial areas. Green roofs and green walls form a green network of refuge habitats for, e.g., numerous arthropod species. This network allows many species to move and disperse within urbanized areas, thus increasing their genetic diversity. The Urban green roof and wall network also connects parks and other green areas, linking otherwise isolated city areas (Bevk et al., 2019). Green infrastructure may thus form a "green street" linking urban and rural populations leading to a substantial positive impact on biodiversity.

The Slovenian National Institute of Biology has monitored two green roofs located in an industrial and urban area. The study investigated their potential as high-quality habitats for pollinators and whether they could improve biodiversity.

The results of the study showed a considerable positive impact of urban green infrastructure on biodiversity and for pollinators. It shows that green roofs are essential not only for domestic and wild bee species or beekeeping but also for nature and biodiversity conservation. The range of insects found on the roof included wild bees, bumblebees, hoverflies, wasps, butterflies, flies, ladybugs, beetles, and moths. Pollinator density was also surprisingly high. **The highest recorded density of pollinators investigated was 11 pollinators / m2, which adds up to 2.750 pollinators on a small private green roof and almost 92.000 pollinators on a large commercial green roof in France.**

How can green infrastructure adapt to enhance urban biodiversity?

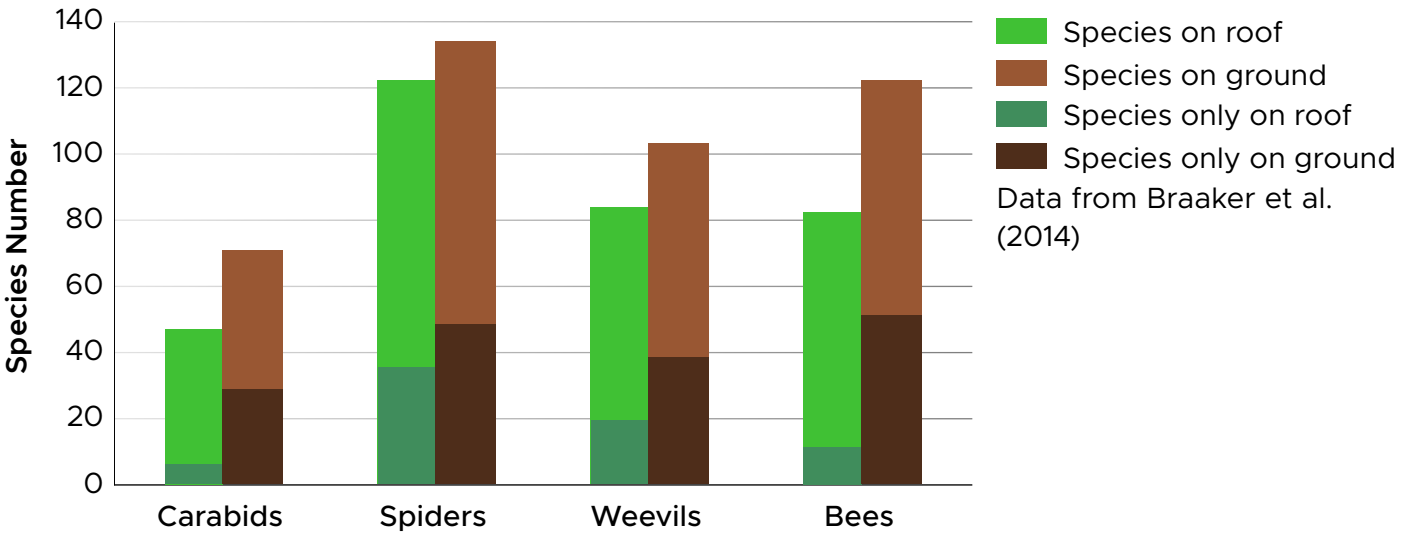
Generally, urban green infrastructure like green roofs and walls significantly contribute to biodiversity: not only do they comprise a wide variety of plant species, but they further provide habitats for a large number of animal species including insects such as beetles, bees and butterflies (MacIvor et al., 2011), arthropods like spiders (Madre et al., 2013), or even earthworms (Steiner & Schrader 2002) and birds (Coffmann & Waite, 2011). Green walls are valuable for snails, insects, and birds, as more than **6000 individuals belonging to over 230 species** were sampled on 29 vegetated walls (Chiquet, 2014), while green roofs throughout the city of Zürich sustained over **40 ground beetle species, more than 110 spider and 80 weevil species as well as over 75 bee species** (Braaker et al., 2014). Of the insect groups sampled on the rooftops, on average, 17 % of the species exclusively occurred on green roofs and were not present on sites at ground level. Particularly intensive green roofs displayed very close to ground-level habitats in the surroundings (MacIvor et al., 2011). The high species abundance and quantities found clearly illustrate the critical role of vegetated roofs and walls in urban areas.

The design and creation of **biodiverse green roofs** aim to further enhance the value of urban green infrastructure by actively supporting and attracting wildlife through providing food resources and shelter possibilities. As most species are adapted to specific environmental conditions, providing numerous ecological niches and creating a heterogeneous space can enhance species diversity (Knapp et al., 2019). Research results have shown that the most effective approach to improving biodiversity on roofs is to combine different types of green roofs, namely extensive, semi-intensive and intensive green roofs. This combination supports (a) the diversification of the growing media depth, (b) the expansion of plant species selection, (c) the use of several growing media types, and (d) the increase in vegetation cover, while for green walls (e) the choice of the wall-systems matters the most (Gabrych et al., 2016).

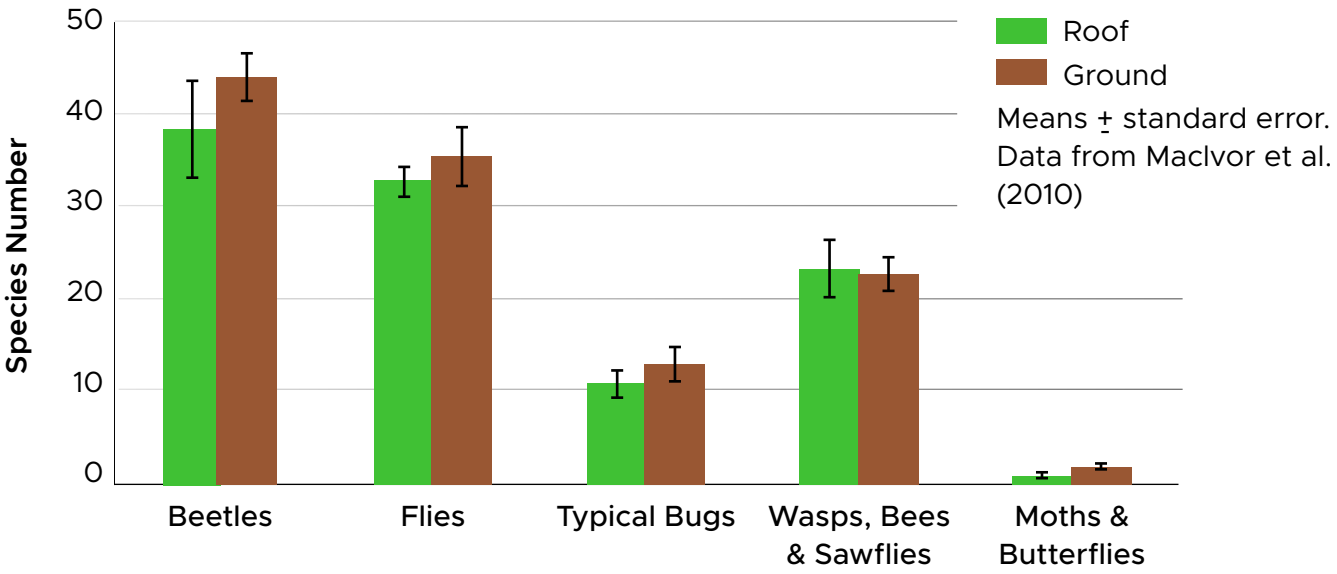
Extensive green roofs with shallow growing media are ideal for Sedum species, which can thrive in the various climate conditions and can be put on a variety of buildings (including lightweight structures). On the other hand, intensive and semi-intensive green roofs can boost a variety of grasses and herbaceous species but, due to the higher weight, are not suitable for all types of buildings. Sedum and herbs provide an essential food source for bee species. A **greater diversity of flowering plants** to a longer flowering season and, thereby, to higher abundance and diversity of bees (Kratschmer et al., 2018). Woody plant species require at least 40-60 cm of rooting media (Gabrych et al., 2016) and provide habitat for net-building spiders (Madre et al., 2013). At the same time, these deeper soils even allow earthworms to thrive on green roofs (Steiner & Schrader 2002). The **diversification of growing media types** such as creating vegetation-free, sandy or clayey growing media spots, is a prerequisite for many wild bees (Westrich 1996). Especially ground-nesting bees, which comprise 75 % of wild bee species in Europe, have been found nesting on green roofs (Brenneisen et al., 2014). Other insects like roove beetles occur in high species numbers when the vegetation cover exceeds 90 % (Breitenbach, 2003), and especially arthropods living below the surface benefit from a protective and dense **vegetation cover** Schindler et al., 2011). Insects and other arthropods may serve as a food source for birds, which have also been observed on green roofs (Coffmann & Waite, 2011). Lastly, Madre et al. (2015) showed that the type of **greening system** also affects biodiversity; beetles and spiders were more diverse on green wall-systems made from growing media modules, providing more

stable moisture conditions than other systems as climbing plant facades. Birds, on the other hand, were commonly found on climbing plant facades (Chiquet et al., 2013).

Biodiversity on Green Roofs



Insect Diversity on Green Roofs and Ground



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The Green Infrastructure Alliance (GIA) was established in 2019 and brings together 6 multinational companies from across the world. Each of them has extensive knowledge and experience in designing and developing natural based solutions that help cities become greener, resilient to new climate challenges and that improve residents wellbeing.

Our goal is to disseminate information and knowledge and promote research and uptake of nature-based solutions in urban areas as a way to address modern challenges. In that sense, we believe that green roofs and green walls are crucial elements for the enhancement of biodiversity in cities.

Indeed, the fact that they provide habitats for a great number of animal species is of major importance considering the increasing growth of urban areas and the limitation of available space at ground level. Simple measures like the creation of heterogeneous spaces through diversification of roof characteristics can meet the needs of a wide variety of animals with diverse habitat requirements and therefore effectively enhance urban biodiversity.

Ultimately, high quality green spaces, vertical or horizontal, play a decisive role in the connection of habitats. Green roofs and walls can become the missing stepping stones in a wildlife-friendly urban green infrastructure network, creating the biodiverse cities of tomorrow.

GREEN INFRASTRUCTURE ALLIANCE

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