

## **Insect diversity in green-infrastructure – and how to support it**

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Biodiversity is declining rapidly and the loss of species is today 100-1000 times higher than in previous times. The reasons for this decline are manifold. These include intensification and overexploitation of land-use in agriculture and forestry, land abandonment, fragmentation of habitats, climate change, and the spread of invasive species. Insect diversity has also dramatically declined. This has gotten especially attention in recent years due to the significant decline in pollinators, which have a key role in many ecosystems. To counteract these negative trends, international conventions, policies and strategies have been developed to preserve biodiversity. So far, these efforts have not resulted in a halt of the overall loss of biodiversity. Therefore, measures to support and enhance biodiversity including insect diversity are increasingly needed.

Green-infrastructure (GI) can be seen as a network of natural, semi-natural or other green areas that supports biodiversity and ecosystem services. However, green-infrastructure has been defined in many different ways and the concept has been applied in various contexts. Key principles that are mentioned in relation to GI are connectivity, multifunctionality and strategic spatial planning. The concept is seen as suitable in the context of this lecture, because it can be applied in both rural and urban landscapes, it is emphasizing multifunctionality and it includes landscape ecological aspects such as connectivity. Development of green infrastructure was also seen as one crucial target measure to support biodiversity in the previous Biodiversity Strategy of the EU.

In this lecture, examples will be given on how to study and support insect diversity in green-infrastructure in both agricultural and urban areas. The focus will be on butterflies and pollinators as bumblebees. Butterflies are good indicator species of habitat quality at site and landscape level. Bumblebees have been increasingly studied in the context of insect decline.

The establishment of sown wildflower strips is one measure to increase insect diversity in more intensively used agricultural landscapes. These strips are sown on agricultural land with mixtures of native wildflowers (and grasses). Sown wildflower strips are included in national or regional agri-environmental schemes. It has been shown that insect abundances (number of insects) and diversity increase by the use of sown wildflower strips not only at site level, but also at landscape level. Combining sown wild flower strips with for example greenways used for recreation has the potential to create multifunctional green-infrastructure intensively farmed areas.

Urban green space such as parks, gardens, ruderal sites and road verges can also be habitat for many insect species. Some research studies have shown that insect abundance and diversity in urban areas can be higher than in the surrounding agricultural landscape. For pollinators, especially the extent of semi-natural grasslands and ruderal sites are important in urban areas. Insect diversity and numbers can be increased by adapted management forms of green space, habitat creation and through the choice of plant material. Green roofs and green walls have been suggested to support biodiversity especially in city parts with a dense building structure. While certain insect species can live in this type of green-infrastructure, research has also shown that biodiversity in urban areas needs space.

Finally, I will present a vision for my future research and argue why further research in these fields are needed:

- implementation on multifunctional green infrastructure in different types of landscapes;
- ecological design of urban green space to contribute to support biodiversity, climate adaptation/mitigation and recreation;
- urban landscape ecology – How do insects move in cities? How can movement be supported?
- long-term studies on change in insect diversity related to landscape changes in agricultural landscapes.