**Bee communities and pollination networks in planted pine forests compared to adjacent shrublands**

**M. Sc. Thesis**

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**2017**

**Abstract**

Forest ecosystems harbor high biodiversity and provide a wealth of ecosystem services. Israel’s coniferous forests, which span across the Mediterranean landscape, are mostly the result of human plantation that followed the disappearance of native forests and maquis. In view of the increased development pressures, and the worldwide recognition of the importance of preserving forest ecosystem services and functions by sustainable forest management, a new management plan that promotes these principles was developed by Keren Kayemeth LeIsrael (KKL- Jewish national fund which acts as Israel’s forest authority). This plan set the goal to sustainably manage Israel’s forests, combining ecological, social and economical targets. On the ecological aspect- conserving forest biodiversity, productivity, regeneration capability and vitality, basing on natural regeneration of the vegetation.

Bees play a key role increasing the diversity and stability of terrestrial ecosystem, being the principal pollinating group of wild plants and crops. Their survival depends upon the presence of suitable floral and nesting resources within flight range. Evidence accumulating from recent decades, indicates that honey bees and wild bees have declined in their abundance, diversity and geographical range around the world, and raise concern of a “pollination crisis” in agriculture. Causes consist of several drivers; habitat loss and fragmentation being the principal. Hence, it is important to understand the extent by which planted coniferous forests, that form semi natural habitat once understory has regenerated, can support diverse pollinator communities and the provision of significant pollination services. However, only few studies have examined bee communities and pollination network in planted forests and in Mediterranean forest ecosystems, particularly in Israel.

The current study aims to explore the contribution of planted coniferous forests undergoing natural succession and re-growth of the understory, to wild and honey bee communities. Three aspects were examined: habitat characteristics- microclimate conditions, availability and diversity of floral and nesting resources, indicating the habitat’s suitability and quality for bees; bee community- richness, abundance, community composition and ecological functional traits; pollination network- bee-plant interactions, indicating community functionality and robustness. The study was conducted in the Judean Foothills region, characterized by a mosaic of landscapes and high species richness. Two main habitats were compared: 50 years old planted coniferous forest plots, with significant understory regeneration, and nearby open maquis. In the second year a secondary habitat, which provided qualitative data, was added: planted coniferous forest plots with sparse understory. During field work, bees were sampled and at the same time plant and ground cover surveys were conducted, along the spring of 2015-2016 from March to May. Since many plots were slightly repositioned on the second year, data analysis was done for each year separately.

I found that habitats differed in their microclimate, species richness and abundance of flowers and diversity of nesting resources. Radiation reaching the understory of the forest was low in comparison to the natural habitat, and so nesting and foraging resources were lower in their quantity and diversity. Accordingly, differences were found between habitats in bee abundance and species richness as in community composition. Bee abundance and species richness found in the regenerating forest were low in comparison to the natural habitat, throughout the sampling season, in both years, except for the first sampling round in 2015 then values were similar. Blooming plant species richness (2015) and flower abundance (2016) best explained bee abundance (both years) and species richness (2016), and in several times annulled the effect of the habitat on this measures. Bee communities differed between habitats both in species identity- about 2/3 of the species were found only in one of the habitats, and in their relative proportion, in both years. However, much similarity in the dominant species was found between habitats, also no difference was found between the habitats in the distribution of the ecological traits related to diet, nesting, sociality or body size of the bee communities. Pollination network analysis reveals different trends; alongside similarity between regenerating forest habitat and natural habitat that was shown by different measures at network and species level, results shown by several measures have an inverse effect on network stability. In 2015 regenerating forest habitat showed lower levels of nestedness, functional complementarity and partner diversity on species level, compared to natural habitat. In 2016 regenerating forest habitat showed lower levels of nestedness, functional complementarity, interaction diversity and specialization on network level, as opposed to a higher level of niche overlap, compared to natural habitat

The results indicate that even though the regenerating forest habitat supports a bee community of lower richness and abundance, and of altered species composition compared to the natural habitat, they still hold high importance in the conservation of bee diversity, complementary to natural habitats. Furthermore, results indicate that the regenerating forest habitat provides divers floral and nesting resources that support high functional trait diversity in bee community, that does not fall short of that exist in the natural habitat. Bee community in the regenerating forest habitat found to be overall stable similarly to the natural habitat. In terms of management practice, results imply on the high importance of initiated management in forests to enhance bee community in it. It seems not enough to base solely on natural regeneration process of the vegetation in order to encourage bee diversity, as they are very much influenced by light availability. So, the combination of creating canopy gaps, parallel to natural regeneration process of the understory, is likely to contribute very much so to increasing the quality of regenerating forest habitat for bees and strengthening bee community that may exist in it.