Abstract

Oak-rich forests – a species rich but threatened habitat

Oak-rich temperate forest is a species-rich forest type, which mainly occurs as more or less isolated remnants. The area of oak forest has decreased dramatically during recent centuries due to overexploitation and changed land use. In addition, during the last century the few remaining oak forests have become denser and darker due to ceased hay-cutting and grazing by domestic animals. Fragmentation and succession are probably the main threats facing biodiversity in this forest type.

In this thesis, I study oak-rich forests and examine how different species (organism) groups respond to habitat fragmentation, and to partial cutting with the combined goals of increased biodiversity and biofuel extraction. I also examine how well different species groups indicate one another with respect to their species richness, and how these correlations may be related to the dispersal ability and habitat requirements of the species groups. For these purposes, I study four organism groups – vascular plants, bryophytes, lichens and wood-inhabiting fungi – in 25 old oak-rich forest stands in southern Sweden. In addition, I carry out a theoretical landscape ecological study to complement the empirical studies.

Lichens and bryophytes need large landscapes, while vascular plants and wood-inhabiting fungi responded to small landscapes

Species may be affected negatively by losses of their natural habitat, both directly by the loss of habitat patches, and indirectly in the remaining habitat patches due to limited dispersal resulting in insufficient recolonisation of empty patches. However, few studies have shed light on at which spatial and temporal scales the habitat amount is of practical importance for species and their conservation. Using a metapopulation model, I showed that species superior at dispersal generally were affected by the amount of habitat in larger landscapes compared to species inferior at dispersal for which habitat in smaller landscapes had a stronger impact. This means that the minimum landscape size meaningful for conservation of a species is larger for species with long average dispersal distance compared to species with short-distance dispersal. The empirical study showed that the density of lichens and bryophytes (of conservation concern) increases in a local forest stand with increasing amount of current deciduous forest 1–5 km from the study stands. In contrast, the current number of vascular plants and wood-inhabiting fungi (of conservation concern) increased with increasing amount of deciduous forest at a smaller spatial scale (0–1 km). These results may indicate that lichens and bryophytes are superior at dispersal compared to vascular plants and wood-inhabiting fungi. In addition, the two latter organism groups were affected more by the habitat amount 120 years ago than by the current amount of habitat. In other words, vascular plants and wood-inhabiting fungi showed a delayed response to changing landscapes, which is consistent with an extinction debt since the amount of habitat has decreased recently in the landscape.

After partial cutting the vascular plants and lichens on dead wood increased, while the wood-inhabiting fungi decreased

Many species in oak-rich forests are adapted to semi-open conditions, but the oak-rich forests have become darker. Large-scale restoration to grazed pastures would be desirable but may be too costly for large-scale implementation outside existing nature reserves. Therefore management with combined goals of biodiversity conservation and forest management could be a good complement to core forest conservation. A partial cutting experiment was started to evaluate the effect of sunnier conditions for species expected to gain from such cutting, as well as for other species groups. Old oaks were retained and some of the thinner trees were cut for biofuel. At each of the study sites, one experimental and one control plot, each 1 ha, were surveyed before and after the cutting. The short-term response to partial cutting varied among organism groups: the species density of vascular plants and lichens on dead wood increased; bryophytes on dead wood were not significantly affected; and wood-inhabiting fungi decreased. If also the responses of species groups studied within the same project but not included in this thesis (forest floor bryophytes; beetles; fungus gnats) are taken into account, the majority of the organism groups were positively affected or not affected at all, while only one organism group (wood-inhabiting fungi) was negatively affected.

Species with similar ecology covaried weakly

Species groups with similar ecology may covary in richness across landscapes. However, the species densities of four organism groups (only species of conservation concern considered) were weakly correlated or not correlated at all ($n = 25$ study sites; 2 ha study plots). Weak pairwise correlations (bryophytes with lichens; and vascular plants with wood-inhabiting fungi) were related to similar substrate requirements and dispersal ecology, while no correlations were found between species with large differences in their ecology. Possible explanations to the lack of strong correlations among species groups may be that the species groups are heterogenous and rarely have same substrate requirements and dispersal ecology.

Indicator species were weak predictors of Red Data Book species in oak-rich forests of high conservation values

In Sweden and other Nordic countries, Indicator (or 'signal') species have been used to find forest stands with Red Data Book (threatened) species. Such data could potentially also be used for prioritising forests for conservation purposes, e.g. establishment of nature reserves. I evaluated the relationships for three cryptogam groups (lichens, bryophytes and wood-inhabiting fungi) and found that the total number of Indicator species was not correlated with the total number of Red Data Book species in oak-rich forests. When only deciduous forest lichens were considered, the Indicator species and Red Data Book species were weakly correlated. Thus Indicator species, when treated collectively as a group, are not very useful in prioritising oak-rich forests for conservation. Indeed, they may still work for prioritising forest of high conservation value from production forests without conservation values.

Landscape scale conservation of oak-rich forests

In conclusion, the Indicator species may not be useful to find the *most* valuable oak-rich forests for conservation among oak-rich forests of high conservation value, with the exception of lichen indicators species. The amount of habitat at landscape scale may be a better indicator of Red Data Book species than are Indicator species used at local level. I suggest that conservation in oak-rich forests should preferably be focused on landscapes rich in deciduous forests instead of selecting individual forest patches rich in Indicator species. An appropriate minimum size of a landscape suitable for conservation may be 300 km^2 if the target group is lichens, 80 km^2 for bryophytes and 3 km^2 for vascular plants and wood-inhabiting fungi. In these landscapes the aim should be to maximize the amount of oak-rich deciduous forest. My suggestion is that grazing in oak woodland pastures and restoration of dense oak-rich forests to oak woodland pastures should be concentrated to these core conservation areas, while partial harvesting in oak-rich forests may be a good complement to this type of conservation, and should be applied elsewhere in the landscape. My suggestion is to carry out partial harvesting (or pure conservation actions) in 80–90 % of all oak-rich forest in southern Sweden, and leave 10–20 % of the forests for natural succession. However, it is important that the partial cuttings are done carefully, and the cuttings are evaluated in long-term perspective. The recommendation to cut such a high proportion of the oak-rich forests is based on the assumption that many of the wood-inhabiting fungi, that decreased due to cutting, also can be found in naturally closed deciduous forests without oak, while species confined to open oak-rich forests (many lichens and beetles) to large extent lack suitable habitat in current forests.