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Role of the Siberian flying squirrel as an umbrella species for biodiversity in northern boreal forests

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ABSTRACT

One of the potentially useful indirect shortcut methods in biodiversity conservation is the umbrella species concept. An umbrella species can be seen relatively demanding for the size of the area and probably also for certain habitat types: conservation management for the umbrella species would thus encompass other species preferring similar habitats but with smaller area requirements. As such, it has a comprehensive spatial aspect for landscape planning. We tested the role of the Siberian flying squirrel (*Pteromys volans*) as an umbrella species for wood dependent species among red-listed and old-growth forest associated polypores, epiphytic lichens and beetles. Flying squirrels inhabit home ranges of several to tens of hectares, and prefer mature spruce-dominated (*Picea abies*) mixed forests, which often have high amounts of dead wood. We carried out species surveys and trappings during 1 year from 20 mature spruce-dominated forest stands (altogether 162 ha), of which 12 were occupied by the flying squirrel. The amount of dead wood was higher in occupied stands than in unoccupied stands. We also found a tendency for a higher number of species and number of records in occupied stands, a relationship mostly due to the polypore species. The presence of the flying squirrel may reflect the habitat availability for species depending on dead and living wood, and assist in site selection of conservation areas. We suggest that the flying squirrel has potential as an umbrella species to partly enhance maintenance of biodiversity in northern boreal forests in Finland.

1. Introduction

Several indirect shortcut methods have been introduced to describe biodiversity values and the occurrence of species to support landscape management planning (e.g., Noss, 1990; Ricketts et al., 1999; Andelman and Fagan, 2000; MacNally et al., 2002). Some of the commonly used indirect cues for the occurrence of a certain species or species groups are flagship, indicator, and umbrella species concepts. Public concern can be directed on a charismatic flagship species as a symbol of nature, which may increase funding for conservation (Caro and O'Doherty, 1999; Sergio et al., 2005). An indicator species reflects the quality of a certain habitat, or changes in populations of other species (Landres et al., 1988). An umbrella species is relatively demanding on the size of the area and probably also on certain habitat types (Roberge and Angelstam, 2004), and as such has the most comprehensive spatial aspect for landscape planning. Therefore, conservation areas planned for the umbrella species would include other species preferring similar habitats, but with smaller

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area requirements (Simberloff, 1998; Caro and O'Doherty, 1999; Fleishman et al., 2000; Suter et al., 2002). The umbrella species concept as an indirect shortcut method for conservation is thus tempting. However, it is not so straightforward in practice.

The umbrella species concept is suggested to improve the effectiveness of biodiversity conservation and field surveys (e.g., Simberloff, 1998; Caro and O'Doherty, 1999; Andelman and Fagan, 2000). It certainly would be faster and cheaper to survey the area for an easily recognizable species instead of conducting a survey for the majority of biota. Furthermore, population persistence is a positive function of population size (Hanski, 1999). From the long-term management perspective populations of an umbrella species should be viable (Berger, 1997; Martikainen et al., 1998; Caro and O'Doherty, 1999; Andelman and Fagan, 2000), when the population persistence of an umbrella species could assure also the population viability of the species under the umbrella. It has been argued that a single species can seldom be a surrogate for a variety of species, and thus the conservation areas based only on one umbrella species would create gaps in conservation (Kerr, 1997; Simberloff, 1998; Lindenmayer et al., 2002). Therefore, a concept of focal species (Lambeck, 1997) relies on many umbrella species: a taxon-based surrogate group of the most demanding species, each of which could be used to define different attributes of a landscape.

Roberge and Angelstam (2004) divided umbrella species to three groups: (1) area-demanding species, (2) species that are used in site selection, and (3) an extended umbrella species concept. Because the area requirements tend to be positively related to the body size of a species, the first group addresses mainly large vertebrates: mammalian carnivores (e.g., Noss et al., 1996; Carroll et al., 2001) or herbivores (Berger, 1997). In boreal forest environments, white-backed woodpecker (*Dendrocopos leucotos*) (Martikainen et al., 1998) and capercaillie (*Tetrao urogallus*) (Suter et al., 2002; Pakkala et al., 2003) have been studied for the umbrella effects to other forest species based on both their area and habitat type demands. The basis for the second group is especially the habitat type requirements of species. Studies on umbrella species assisting the site selection have focused mainly on bird (Fleishman et al., 2001; Poiani et al., 2001; Rubinoff, 2001; Sergio et al., 2005), butterfly (Launer and Murphy, 1994; Fleishman et al., 2000, 2001) and beetle species' (Bonn and Schröder, 2001) ability to provide umbrella for the larger species communities in the same habitats. Encouraging examples for the usage of umbrella species in the reserve site selection within large areas come from Africa, based on game reserves for large mammals (Caro, 2003), and on habitat suitability models for amphibians and mammals (Rondinini and Boitani, 2006).

The third group, an extended umbrella concept, emphasizes habitat connectivity, occurrence of certain ecosystem processes or the distribution of scarce resources at the landscape scale (Roberge and Angelstam, 2004). It has mainly been related to focal species. For example, Watson et al. (2001) used information on two focal species to identify the minimum patch size, habitat structural complexity and landscape connectivity to support the other 70 existing woodland bird species, and Bani et al. (2002) used several focal species to plan a habitat network to accommodate a larger community of forest birds and mammalian carnivores.

However, rigorous tests for the umbrella species concept are scarce (Andelman and Fagan, 2000; Roberge and Angelstam, 2004), and among the existing studies the effectiveness of the umbrella species has often been found limited (Roberge and Angelstam, 2004). The problems are related for example to the lack of intensive surveys of other species, or the study includes species that have ill-assorted habitat and area demands (Simberloff, 1999; Andelman and Fagan, 2000; Lindenmayer et al., 2002). Even several umbrella species (e.g., sensu Lambeck, 1997) do not necessarily remove the difficulties of identifying the most demanding species or the risks of excluding some important areas from conservation (Lindenmayer et al., 2002).

We address the site selection concept and test a possible role of an arboreal Siberian flying squirrel (*Pteromys volans*) as an umbrella for species dependent on dead and living wood in northern Finland. Flying squirrels prefer mature Norway spruce (*Picea abies*) dominated mixed boreal forests (Mönkkönen et al., 1997; Hanski, 1998), and the occupied forests are typically older and often characterized by higher amount of coarse woody debris (CWD) than unoccupied forests (Reunanen et al., 2002). Approximately one fourth of the forest associated species in Finland are dependent on CWD (Siitonen, 2001). In Fennoscandian boreal forests, these species have faced considerable habitat loss due to forestry practices, now being prominent among red-listed species (Rassi et al., 2001). Species associated with CWD are particularly common among polypores and beetles. We focus especially on red-listed and old-growth forest associated species in polypores (Basidiomycetes), epiphytic lichens (Lichenes) and beetles (Coleoptera).

The spatial patterns in the ecology of the flying squirrel matches with the rough spatial definition of an umbrella species: individual home ranges are rather large in size, on average 8 ha for females and 60 ha for males (Hanski et al., 2000). In addition, the breeding sites of the flying squirrel are protected since the species is categorised as a vulnerable species in Finland due to population decline and habitat loss (Rassi et al., 2001). Its occurrence is thus already taken into account in forestry planning, and the conservation effort would be even more effective if other species of concern were located at the same sites.

We surveyed mature spruce-dominated forest stands occupied and unoccupied by the flying squirrel, and compared the stands in terms of the number of species and records. From the practical perspective, the occurrence of the nocturnal flying squirrel in a forest stand is relatively easy to determine based on distinctive fecal pellets (e.g., Reunanen et al., 2000), compared with laborious surveys and identification of many polypores, lichens and beetles. Therefore, we evaluate the utility of the flying squirrel in the site selection for conservation, when the objective is to maximize species coverage in a hypothetical reserve network. In addition, since flying squirrels seem to be dependent on landscape connectivity (e.g., Reunanen et al., 2000, 2002) we discuss the extended umbrella species concept from the landscape planning perspective.