2.6 Managing for target species

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> *By focusing only on structural features we risk overlooking species with particular demands*

Forest conservation management often focuses on maintaining general habitat features such as natural tree species composition, uneven age structure, and perhaps most importantly, the presence of old and dead trees. The most widely used strategy for maintaining biodiversity is to emulate natural forest dynamics at the stand and landscape levels. For example, selective cutting or partial cutting can be used as alternatives to traditional clear-cutting, and untreated habitat patches, individual retention trees, and deadwood can be retained in the cutting area. The basic assumption is that by mimicking natural disturbances it should be possible to maintain the structural features and processes that are important for species. The general justification for focusing on structural features instead of species is that there are simply too many species to take into account the habitat requirements of each individual species. Therefore, it is often necessary to use structural features as surrogates for species (Figure 38).

Although this so-called coarse filter approach (*sensu* Hunter et al. 1988) probably captures the demands of many forest species, it may still not secure all aspects of forest biodiversity and risks overlooking some species with particular demands. It may even be potentially deceiving as the mere presence of particular structural features does not guarantee the presence of all species associated with the forest type in question. It is therefore advisable to include a set of target species in the management strategies to ensure that the more demanding species actually maintain viable populations, which also provides an evaluation of the success of the management. This is often referred to as a fine filter approach to conservation management. Including a set of well-selected target species may be an important complement to general measures and provides managers with a biological "receipt" on the outcome of implemented actions.

Box 24. The coarse and fine filter approaches

The concept of coarse and fine filter approaches dates back at least 25 years (Hunter et al. 1988). Originally it was related to the idea of securing particular habitat types by setting aside a representative network of reserves (coarse filter) while recognizing that this might be insufficient to secure viable populations of all species and that there is hence a need to complement the coarse filter with actions directed to individual species. In its development the concept has, however, expanded to include the identification and maintenance of general habitat features in management (coarse filter) as surrogates for species diversity as well as species-specific habitat requirements (fine filter) for those species that might not be secured by the general measures. It can be seen as a conceptual framework for conservation planning. When identifying how much of a particular habitat feature is needed, it is critical to consider its natural range of variability (Landres et al. 1999), while at the species level, the focus is on the individual requirements and population dynamics of each species. This is a broad starting point for conservation actions: for instance, the EU's Birds and Habitats Directives call for favourable conservation status of both the designated habitat types (based on structures and functions) as well as associated typical species and hence include both the coarse and fine filter approaches.

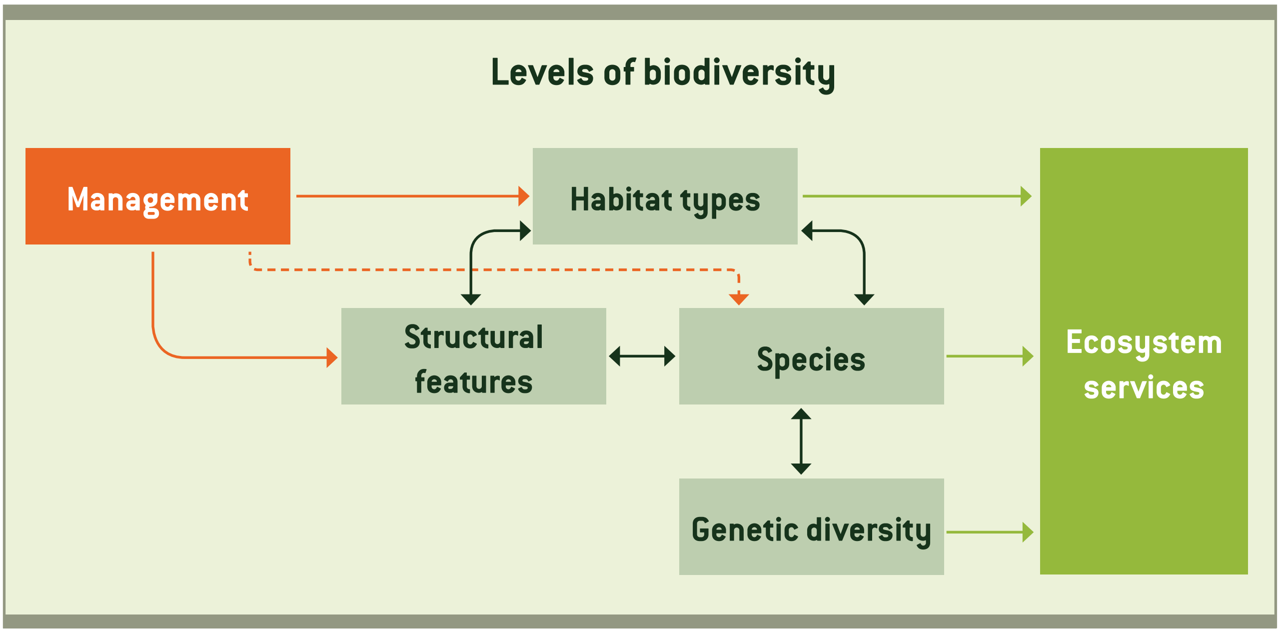


Figure 38. Components of biodiversity. In general, three levels of biodiversity are distinguished: genetic, species, and ecosystem diversity. From the management point of view, it is useful to add one additional aspect of biodiversity: structural features. The different components of biodiversity are interconnected, and together they produce ecosystem services. Management is practically always directed to either maintaining certain habitat types or structural features (the coarse filter approach). Even when the focus is on individual species (the fine filter approach), we actually manage particular habitat types or structural features that are needed to maintain their populations.

Careful selection of target species is a critical stage for complementing the coarse filter approach and evaluating management outcomes

As not all species can be considered, selecting representative target species is an important step. At least two different aspects should be considered to guide management. First, species to be selected should include those that are not covered by the general management measures, i.e. specialist species demanding particular habitat structures and substrates that are difficult to provide. Secondly, they should also include species that are easy to monitor and can be used as monitoring tools for assessing whether the chosen management results in desired outcomes.

In addition, the choice of target species also needs to consider what is actually limiting their occurrence in the forest landscape. The limiting factor is critical to address and can be used as a template to compare management options. For selecting target species we recommend that four types of species, limited by different factors, should be considered: **resource-limited**, **area-limited**, **dispersal-limited**, **and process-limited species.** As a framework for the selection of target species, we believe that this will allow us to better envision the range of habitat requirements that forest species exhibit. Basically, this is nothing more than dissecting into pieces the simple, general statement that all species need a continuity of the right kind of resources in sufficient amounts within their dispersal range. For an individual species, the four limiting factors are not mutually exclusive but can affect with different intensities (Figure 39). In the following, we will use species dependent on deadwood (saproxylic species) as examples. While many other substrates and habitat types are important for forest biodiversity, deadwood is one of the most critical habitat features in most managed forest types.

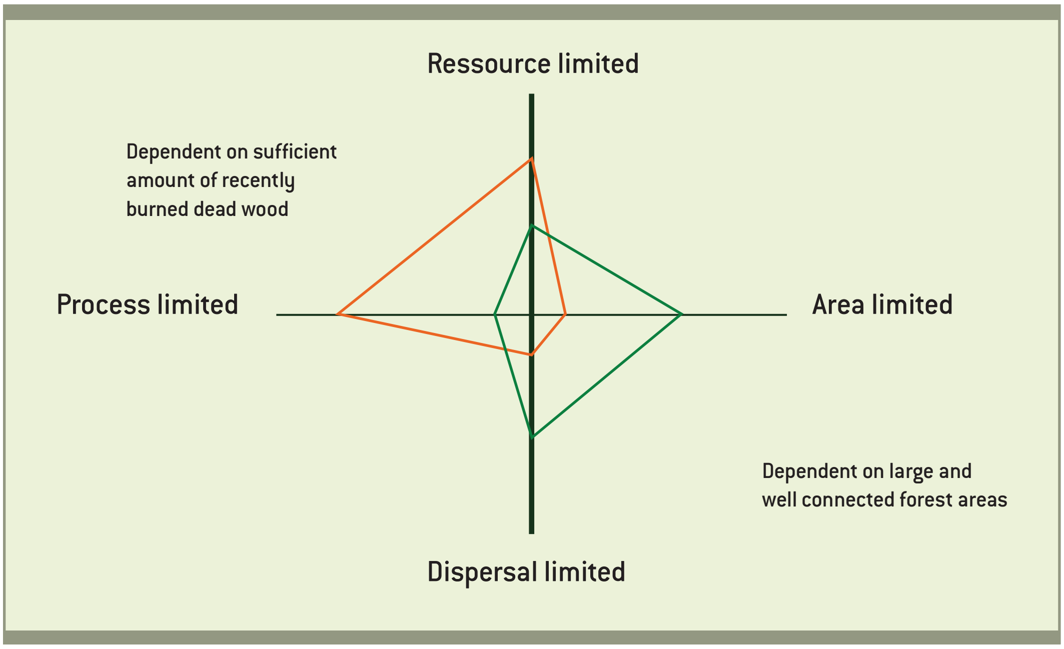


Figure 39. Species are limited by different factors, and by selecting target species representing these factors, management can secure suitable conditions for a wider range of species. This star-diagram includes an example of a species (red lines) dependent on recently burned wood (process and resource) and a species dependent on larger areas of well connected habitats (area and dispersal). The set of limiting factors in these two species is completely different.

> *Ideally, target species affected by different limiting factors should be selected since this will improve the general relevance of conservation management measures*

Resource-limited species. The simplest reason why a species may be missing from a forest stand or the entire landscape is that suitable resources are missing. Regarding saproxylic species, deadwood is not a homogenous substrate. It comes in many different forms, and even with apparently high total volumes, particular types of deadwood might still be missing. Different tree species, decay stages, tree diameters, causes of death, and combinations of these factors all potentially represent specific substrates for some target species. Management should ideally ensure that the full range is available (Figure 40.).

In intensively managed forests with relatively short rotation times, particularly large-diameter trees in advanced decay stages are scarce or missing. For instance, the majority of threatened polypore species associated with beech in Denmark were only recorded on logs that were > 70 cm in diameter (Heilmann-Clausen and Christensen 2004) – a truly rare substrate in managed forests. Another example of a rare substrate is large decorticated snags of pine. These so-called "kelo trees" were probably historically common in lowland forests with pine throughout Europe, but are among the first deadwood types to decline when forests are harvested. Nowadays they occur in higher numbers only in remote boreal areas and in a few remaining lowland sites, such as the Białowieza primeval forest (Niemelä et al. 2002).

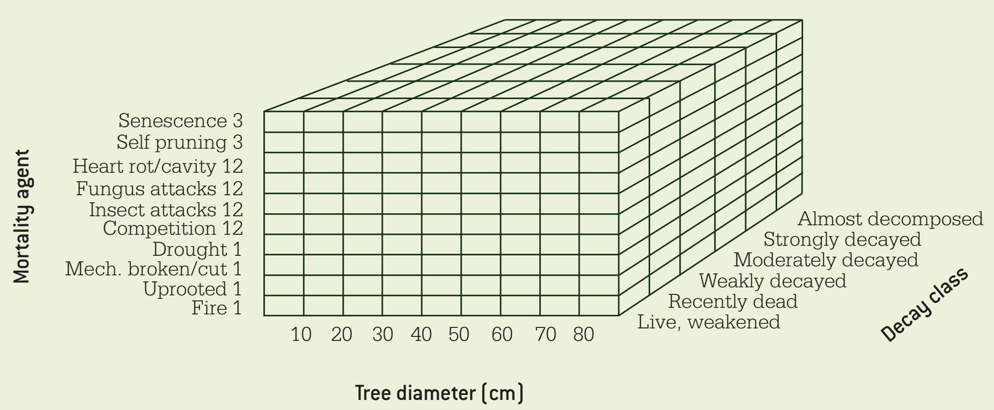
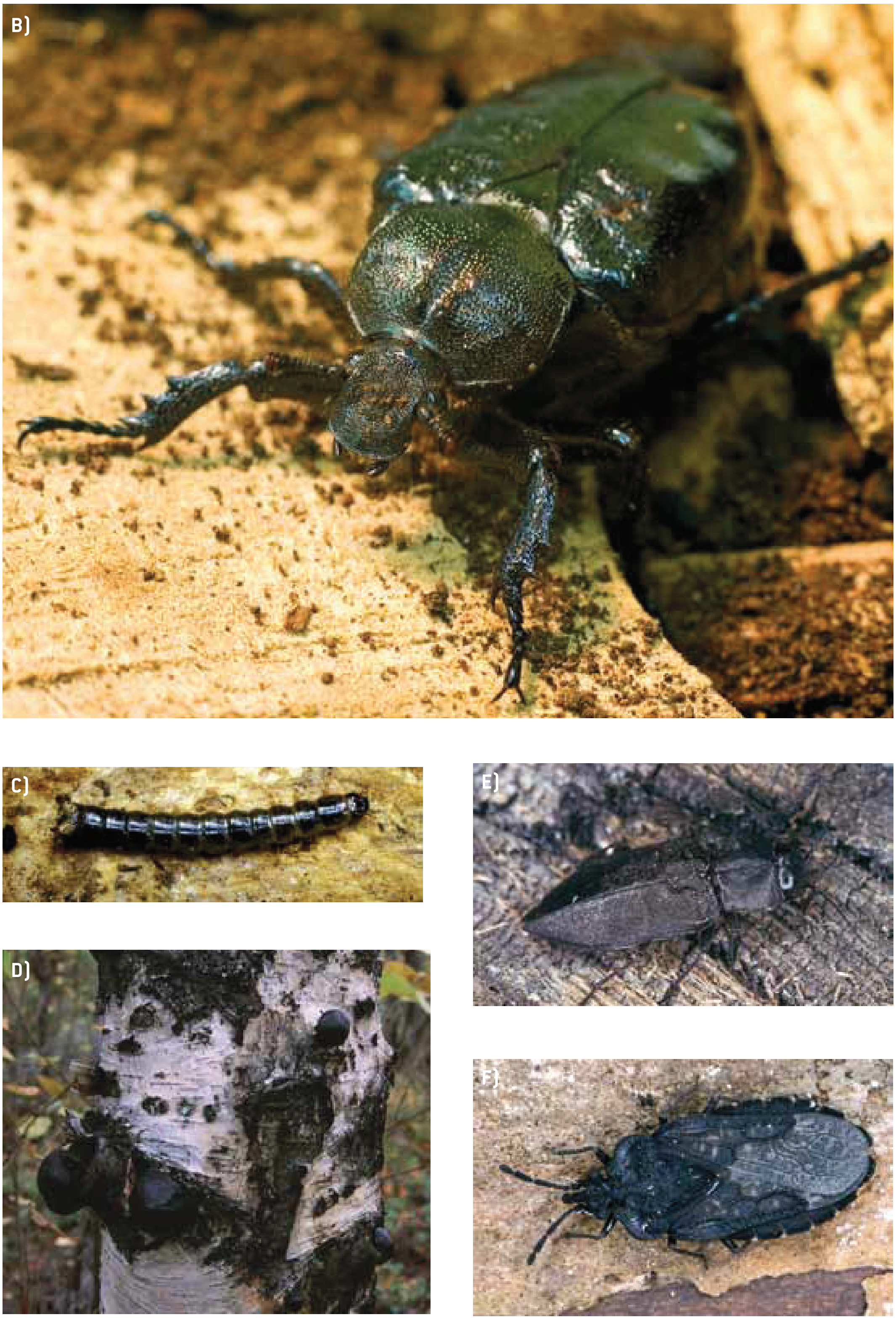


Figure 40. Deadwood is more than just total volume. It is critical to also consider different types of deadwood since many species are specific to certain deadwood qualities. The figure exemplifies for a single tree species the variability in three important factors; tree size, decay class, and mortality agent. All these, as well as different tree species, are required to provide the full range of substrate types. Source: Modified from Stokland et al. 2012.

Figure 41. A: The Middle Spotted Woodpecker (*Dendrocopos medius*) is a good example for an area-limited species (photo by Alain Saunier). B: The hermit beetle (*Osmoderma eremita*) is a dispersal-limited species inhabiting old hollow trees (photo by Heinz Bußler). C: The larvae of the beetle *Pytho kolwensis* live under the bark of fallen spruces in old-growth spruce-mire forests. The species is both dispersal- and process-limited and depends on continuous local tree mortality (photo by Reijo Penttilä). D: The ascomycete species *Daldinia loculata* grows on fire-killed birch trees in forest fire areas. Several insect species are associated with this fungus (photo by Reijo Penttilä). E: The jewel beetle (*Melanophila acuminata*) is a classical example of a strongly fire-dependent (pyrophilous) species. It has infrared sensors to locate ongoing forest fires (photo by Petri Martikainen). F: The flat bug species *Aradus laeviusculus* is one of the many insect species that colonize burned areas right after forest fires. Species associated with forest fires are process-limited (photo by Petri Martikainen).


B)
C)
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Area-limited species. Many rare specialist species require not only specific resources but also sufficiently large patches of habitat where the amount of the critical resource exceeds a species-specific threshold value. A range of studies focusing on woodpeckers illustrate how specialised woodpecker species need relatively large areas of forest with sufficient amounts of deadwood. For instance, the White-backed Woodpecker feeds its nestlings mainly with longhorn beetle larvae and other large larvae living in dead deciduous trees. For successful reproduction, one nesting pair needs at least 50 ha of deadwood-rich deciduous forest (Aulén 1988). At the landscape scale, the average basal area of deciduous snags should exceed 1.4 m^2/ha over an area of 100 ha for a high occurrence probability of this species (Roberge et al. 2008). Furthermore, in order to maintain a viable White-backed Woodpecker population comprising several nesting pairs within a certain area, this good-quality deciduous forest needs to cover at least 10–20 % of the landscape, otherwise the population will gradually disappear (Carlsson 2000). For the Middle Spotted Woodpecker (Fig. 41A), the minimum area of a breeding territory is about 15 ha (Kosiński 2006), and at the landscape scale, the occurrence probability of the species becomes high when the basal area of large-diameter deciduous trees exceeds 1 m^2/ha over an area of 100 ha (Roberge et al. 2008). Another example is the Three-toed Woodpecker: at least 1.3 m^2/ha of snags (corresponding to a volume of about 15 m^3/ha) over an area of 100 ha of coniferous forest is needed to sustain this species (Bütler et al. 2004). It should be noted that these examples concern conditions needed to host one or a few pairs of the species and not necessarily what is required to maintain a viable population over a larger landscape.

Dispersal-limited species. Species living on temporary substrates such as decaying trees are dependent on repeated dispersal. However, their dispersal ability varies in relation to the specific longevity of their substrate and habitat. Some may occur only during one summer on their substrate, as for instance most bark beetles utilizing the cambium of recently dead trees, while other species may utilize the same substrate unit for decades. The durability of substrate constitutes a strong selection pressure, and as a consequence, different species have widely varying dispersal capacities. The fragmentation of the forest landscape and the loss and growing isolation of specific habitats or habitat features pose a special threat to those species adapted to long lasting, but currently declining, substrates.

Species living in tree hollows serve as a good example. The hermit beetle (*Osmoderma eremita*) (Figure 41B) lives in hollows of large and old oaks and other deciduous trees. In Northern Europe about 85 % of the individuals remain in the tree where they were born. Of those leaving the tree, most disperse less than 200 m, which means that they usually remain within the same stand (Ranius and Hedin 2001; Hedin et al. 2008). The species has become threatened because of its low dispersal capacity, combined with the decline of wood pastures and other habitats with old hollow trees, and it is included into the Habitats Directive. To maintain species like the hermit beetle, it is important to secure local continuity of the critical substrate and, as far as possible, increase connectivity between suitable forest stands.

Process-limited species. Some species occur mainly or exclusively in particular successional stages. For these species the disturbance processes driving the succession need to be maintained. For saproxylic species these may include fire, wind, flooding, and other processes that generate dead trees. In some cases a species may be specifically dependent on the local continuity of its substrate, and although potentially characterized as dispersal-limited, it can also be considered as process-limited as it is strongly dependent on the processes generating its substrate. An example is the beetle *Pytho kolwensis* (Figure 41C) inhabiting fallen spruce trees that have died a few years earlier. Due to its low dispersal ability and its occurrence during a relatively short time span in individual logs, it is strongly dependent on continuous local tree mortality (Siitonen and Saaristo 2000).

In many forest ecosystems, fire has played a significant role. *Daldinia loculata* (Figure 41D) is a wood-decaying ascomycete that occurs in Northern Europe and with scattered occurrence also in Central Europe. It appears exclusively on fire-killed birch trees and is hence strictly connected to forest fires. In a study from central Sweden, Wikars (2001) showed a strong correlation between fire-dependent insects and the frequency of birch trees with *D. loculata*. The details of the interaction are not fully understood, but many of the fire-dependent insects were found to live inside the fruit bodies of the fungus, indicating a strong association. Another example comes from insects breeding in fire-killed trees directly after forest fire. Some of these are so dependent on fire areas that they have developed infrared sensors to locate ongoing forest fires, the jewel beetle *Melanophila acuminata* (Figure 41F) being a classic example. Other species, including several flat bugs (*Aradus* spp.) (Figure 41E), colonize the burned area directly after fire. These fire-dependent species often have remarkable dispersal abilities.

Analysis of thresholds can provide managers with quantitative target values, but there are limitations

A critical question in addressing the limiting factor is “how much is enough?” If a single answer could be given, managers would have a powerful tool and target to work with. However, given the large number of forest species and aspects to consider, this is a notoriously difficult question to answer. Searching for quantitative thresholds is a valid and important research challenge, and for some species and habitat features quantitative targets are available. Regarding how much of the original habitat that needs to be retained at the landscape scale, most empirical and theoretical studies point to a level around 20 % (e.g. Hanski 2011). There are also examples of quantitative targets for individual species, such as those presented for the woodpeckers above. Although these estimates provide guidance, care must be taken when they are implemented. Even if we can assume that thresholds in limiting factors do occur for the majority of species, they are likely to vary among species, species groups, and even for the same species that occurs in different regions (e.g. Ranius and Fahrig 2006, Müller and Bütler 2010). Translated to the *whole forest biota*, this suggests that for many factors we cannot give a single answer besides the general statement of “the more the better”. Yet, by carefully selecting target species representing a range of limiting factors, we can provide suitable conditions for at least these species, and by fulfilling their habitat requirements, we can expect to help many other species.

Box 25. Recommendations

There are indeed many species, even if we only consider threatened saproxylic species, and we cannot simultaneously take into account all of their habitat requirements. Careful selection of target species should include species of special concern (e.g. those included into Birds and Habitats directives, red-listed species), but also species suitable for evaluation of management outcomes. By recognizing that different species are limited by different factors, a link to a wider range of concerns can be made. This would also help to integrate the local stand level factors (enough resources in single stands) with landscape level targets (suitable habitats within dispersal distances and sufficient amount of habitat to sustain viable populations).

One possible solution is to reduce a larger set of species into a more limited number. This was done by Tikkanen et al. (2007). Originally their study system included about 140 species. They were grouped based on their preferred microclimatic conditions (sunny, indifferent, or shady), host tree species, decay stage, and quality of the tree (e.g. snag or log). Tikkanen et al. were able to form only 27 groups in which the habitat requirements of the species overlapped. This appears to be a promising approach that can be used in selecting a representative set of target species.

Identifying thresholds for critical habitat and landscape factors, as well as critical population sizes and the spatial requirements thereof, is needed in order to provide management with relevant quantitative targets. These are available for some species, but ideally we should have information for many other species with different limiting factors. Assessing threshold conditions is an important first step for implementing target species strategy in conservation management.

Management includes numerous trade-offs, and it is unlikely that all objectives can be met within the same forest stand. This includes not only conflicts between economy and species habitat requirements, but also among target species. Their requirements are likely to differ, making it impossible to provide suitable conditions, in any specific forest, for all target species. This suggests that explicit choices have to be made concerning what aspects should be emphasized in individual forest stands, and that conservation planning, including integration approaches, must consider the landscape scale. This is even more important as populations of many species utilize and need large parts of the landscape for their long-term survival.

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