

Bird communities in distinctively mixed alpine forests of the Ennstal Alps in the Gesaeuse National Park

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Abstract

Bird communities as an important component of many ecosystems and their special characteristics, such as the good detectability (NIPKOW 1995) or the high autecological state of knowledge (NOWAK 1982), led to considering the following question for this work: which forest inventory parameters (for example the composition of tree species or the amount of deadwood) have an influence on the avifauna of the Gesaeuse's alpine forests? Starting from this question, twelve research sites were spatially set along a gradient of closeness to nature, differentiated by two components: the amount of deciduous wood respectively coniferous wood, and the size of the forest complex. Three bird inventories have been executed by using two different methods (point stop count and line transect count) on these research sites between mid-April and mid-June. The bird data obtained from these surveys were initially analyzed with principal components analysis and subsequently, in combination with forest parameters, in multivariate analysis. Based on the insights gained in these analyses about the effects of forest structure on ornithocoenosis, indicator species for three different characteristics of the Gesaeuse's mixed alpine forests could be derived. After that, the transferability of the results to the practical work in the Gesaeuse National Park, especially the differences between the two mapping methods, were examined. The comparison of the two mapping methods revealed that the line transect count provided significantly more reliable and more descriptive results than the point stop count and that the latter may cause an underestimation of biodiversity in near-natural mixed alpine forests. In addition, targets have been suggested to preserve and promote precious forest structures for ornithocoenosis of the mixed alpine forests in the Gesaeuse National Park.

Keywords

bird communities; ornithocoenosis; avifauna; mixed alpine forest; forest inventory; Ennstal Alps; Gesaeuse National Park; point stop count; line transect count

Introduction

The birdlife is an important component of many ecosystems. Their particular suitability as an indicator with regard to conservation-related planning is partly due to the following characteristics:

- good detectability (NIPKOW 1995)
- high autecology and faunistic state of knowledge (NOWAK 1982) at a manageable species richness
- close relationship to habitat and spatial structures (NIPKOW, 1995) and thus good comparability of population density studies in similar landscape units (STEIOF 1983)
- high sensitivity to environmental changes (STEIOF 1983; RUTSCHKE & KALBE 1980)

This high performance indication of the birds was the decisive reason for using avifaunal studies for the development of the Gesaeuse National Park. Thus in 2000, the breeding bird communities in montane and subalpine regions of the Buchsteingebiet (in the north of the Gesaeuse National Park) were mapped (ZECHNER 2001). Issues related to the change of bird communities along an altitudinal gradient were part of a thesis prepared in 2008 (KLOSIUS 2008). There are also monitorings of selected, for the European nature conservation particularly important breeding bird species (such as *Tetraourogallus*, *Ficedulaparva* or different woodpeckers) as part of a LIFE project (LIFE05NAT/A/78) as well as numerous works on various species (especially to *Tetraoninae*). However, studies regarding the most dominant forest community in the Gesaeuse National Park area, the mixed alpine forest with their locally very diverse characteristic forms, and the ornithocoenosis in these characteristic forests are missing so far. Even natural mixed alpine forest are "refuges of many endangered bird species", such as *Tetraourogallus* or *Dendrocoposleucotos*, attribution to the structural diversity of these forests "caused numerous ecological niches" (SCHMIDT 1997). Therefore this work is dedicated to the Gesaeuse's mixed alpine forest and especially considers the following question: which forest inventory parameters (for example the composition of tree species or the amount of deadwood) have an influence on the avifauna of the Gesaeuse's alpine forests? Therefrom indicator species were derived for certain characteristics of mixed alpine forests. Finally, it was considered which bird mapping methods are both feasible for the national park's work/staff and can provide useful results (point stop count or line transect count), taking into account that the areas are difficult to access and completely closed for the public.

Methods

Research sites

Four regions in a potential distribution area of the mixed alpine forests in the Gesäuse National Park were selected as test areas. First, they are different in actual vegetation as a result of silvicultural use (gradient from near-natural forest to heavily silvicultural used forests). Second, the embedding of the test areas into the alpine landscape was considered (gradient from embedded in large forest complexes to interdependent small forest complexes with other small forest habitat and land use types). The concrete specification of the twelve research sites, the mapping points (100 m radius for the point stop counting) respectively the walking line (200 m belt for the line transect count) was set with special consideration of accessibility and walkability. The numbering of the sites 1 - 12 follows a gradient of closeness to nature which is substantially based on the tree species composition of natural mixed alpine forest. Comparability was ensured by keeping the defined conditions: all areas are at altitudes between 500 and 850 meters above sea level and at southeast facing slopes.

- Area 1 Hagelwald (Sites 1 - 3):
Fairly inaccessible and thus also by the forestry marginally influenced areas in the northeast of the national park. Characterized by a near-natural mixed alpine forest, which forms an largely closed, continuous forest complex of approx. 190 ha (Fagussylvatica 53 %, Piceaabies 22 %, Acer pseudoplatanus 9 %, approx. 10 % woodless).
- Area 2 Gesäuse-Eingang (Sites 4 - 6):
A near-natural mixed alpine forest in a small forest complex (70 ha), isolated by spruce forests, in the west of the national park (Fagussylvatica 55 %, Piceaabies 33 %, other conifers approx. 5%; other parameters similar to area 1).
- Area 3 Scheibenbauer (Sites 7 - 9):
Close to the first, very natural area, a mosaic-like textured area of semi-natural mixed alpine forest and silvicultural used forests (260 ha). Deciduous and coniferous tree species as well as the age of wood are roughly balanced. The stocks are mainly closed and the area is comparatively poor on the amount of deadwood.
- Area 4 Gstatterboden (Sites 10 - 12):
The Gstatterbodener caldron is one of the formerly intensively used areas in the center of the national park. The proportion of the non-natural, non-native spruce forests (coniferous about 70 %) is accordingly high in this approximately 140 ha forest complex.

Bird inventories

For detecting the bird communities of the different research areas, the point stop count and line transect count method were applied. The principle of the line transect count is to traverse a transect along a predefined route with normalized step speed and to record all acoustically and visually perceived birds (BIBBY et al. 1995). For this work, a continuous route of 900 meters (divided into sub-sections, each 300 meters) was specified in each of the four research areas. In contrast, for the point stop method, all individuals are acoustically and visually counted at defined points. The counting points were directly located on the walking route of the line transect count. This way it was possible to combine both surveys. Each of the twelve research sites was committed three times between April and June. To ensure the comparability of the data collected, all surveys were proceeded in the early morning and only on days without strong wind, fog or rain (according to BILCKE 1982; BIBBY et al 1995).

Forest inventory parameters

A large part of basic data for creating the parameter data set to describe the forest habitats could be drawn from existing data sets. Forest data collected by the Steirische Landesforste and the Gesäuse National Park for a forest management plan represented the central part of the parameter data set. Key parameters were for example: tree species composition, growth class, stage of forest development, tree heights, overall structure, wildlife ecological parameters, deadwood. Data from the Alpine Habitat Diversity project (HABITALP interpretation Key II, see BfN 2002) were used to refine the composition of tree species. In addition, the coverage of the herb and shrub layer on the study areas was recorded with a standard sample method according to CYR & OELKE (1976).

Statistical analysis

The statistical analysis can be divided into three phases. In the first phase, the forest inventory parameters of the twelve study sites were compared. Exploratory and descriptive tests were executed. The H-test according to Kruskal-Wallis resulted in a list of parameters that are significantly different from each other. With the U-test according to Mann-Whitney, the significant differences of the research sites were analyzed. In the second phase, the bird data were examined for similarities. Therefore cluster analysis and correspondence analysis (PCA – Principal Component Analysis) has been executed. To determine significant differences between the research sites, also H- and U-tests were executed. In the third phase, both data blocks were analyzed together to question the relationships between birds and habitat. For this purpose, first the previously executed principal component analysis has been overlaid with the forest parameters and the Spearman correlation to the axes was calculated. Subsequently the bird data was merged with the forest parameters by multivariate analyzes (CCA - Canonical Correspondence Analysis). These three analysis phases were executed separately for both the point stop count data and the line transect count data.

Results

Bird inventories

During the line transect count 42 bird species composed of 887 individuals were mapped. As expected in mixed alpine forests, the most common type was *Fringillacoerebs* with a share of more than 16 % of the total sum of the individuals, followed by *Parusater* (14.88 %) and *Erithacus rubecula* (11.61 %). Especially in area 1 a significantly higher density of individuals was observed (32 species, 263 individuals). Area 4, as the formerly intensively used research area, was about 16 % lower in species richness (30 species) and 7 % lower in individual richness (220 individuals). The least differences were found between area 3 and 4. The point stop count resulted in 29 bird species and 412 individuals. The most common species were as in the line transect count *Fringillacoerebs* with a share of almost 20% of the total sum of individuals, *Parusater* (15.29%) and *Erithacus rubecula* (10.92%). However, comparing the individual research sites, the results of the two mapping methods differ significant. The biggest difference was between the areas 1 and 4 (species turnover of 31%) and 2 and 4 (species turnover of 33%). The cluster analysis confirms the limited precision of the point count data. Only the coniferous dominated areas 3 and 4 were successfully clustered. Also the principal component analysis of the point count data resulted in significantly worse separation of the areas compared with the results of the line transect data (especially in the deciduous woods).

Bird inventories and forest parameters

An overlay of the results of principal component analysis with the forest inventory parameters revealed significant correlations of both mapping methods (e.g. deciduous wood, coniferous wood or the amount of deadwood). The canonical correspondence analysis with the line transect bird data and the forest inventory parameters of research sites resulted in a very plausible outcome: bird species such as *Parus caeruleus*, *Pyrrhuloxia pyrrhula*, *Carduelis chloris* or *Sitta europaea*, with a main distribution in area 1, were unique to the near-natural forests. *Turdus viscivorus*, *Parus palustris* and *Dendrocopos leucotos* were completely limited to area 1 (single counts). *Dryocopus martius* and *Phylloscopus bonelli* were only counted in area 1 and 2, and also point to near-natural conditions. Other species such as *Bonasa bonasia*, *Turdus philomelos*, *Regulus ignicapillus* or *Scolopax rusticola*, with the main distribution in area 4, were characteristic of coniferous woods. The canonical correspondence analysis of point stop bird data and the forest inventory parameters came, compared to the line transect analysis, to quite different results. Noticeable is a large dispersion of the counting points in areas 1 and 3, which is the consequence of an insufficient number of samples in the point count method, especially in deciduous rich areas. The statistical analyzes showed how the mapped species react to different habitat characteristics and which forest structures are largely responsible for it. As the most valuable manifestations of mixed alpine forests of the Ennstal Alps in the Gesäuse National Park, three types could be defined: (1) natural, deciduous and deadwood rich types, (2) natural, clear types, and (3) shrub and herb-rich coniferous-dominated types. Considering existing studies (ZECHNER 2001; SACKL&SAMWALD 1997) and the results of this work, indicator species to these three "target forms" were derived and provide a basis for monitoring programs.

Conclusions

Method comparison

Comparing the two mapping methods, a number of differences was found. The most remarkable difference is the small amount of point count data, especially in the first area. This might be due to the fact that it is easier to detect species in relatively heterogeneous areas with the line transect count method. This is also confirmed by BIBBY et al. (1995). Accordingly, coniferous-dominated, homogenous forests could be comparatively well recorded with the point stop count method. However, surrounding effects (as the near spruce forests in the small, isolated area 2) can hardly be detected with the point stop count method. In addition, a significantly lower number of *Sitta europaea* and rare species have been mapped with the point stop count method. This had a negative influence especially in the species-richness of areas 1, 3 and 4, were for example significant species such as *Phylloscopus bonelli*, *Bonasa bonasia* or *Scolopax rusticola* have been overlooked. A detailed interpretation of the forest data only with the point count bird data, such as the derivation of indicator species, would not have been possible. The results lead to the conclusion that the line transect count method is more appropriate for the heterogeneous forest. Alternatively, a significantly higher number of counting points would be possible, but regarding the accessibility of the research sites it is getting quickly ineffective (too unfavourable data volume/cost ratio).

Indicator species

Due to the consideration of the indicator system for the Gesäuse region (ZECHNER 2001) and the relations between the different forest "target forms", the transferability of the indicator species system to other mixed alpine forests is possible (see also KOCH 1976; of KLOSIUS 2008). Relatively uncertain is the transferability to mixed alpine forests at lower elevations (<500 meters above sea level) respectively in the Alpine foothills.

Relevance of forest structures

If a forest management in the National Park is necessary at all, it should be done under the model of a near-natural forest management, to help establishing site specific and thus richly structured and natural forests. With regard to the support of bird communities of the Gesäuse, ZECHNER (2001) already suggested possible management measures. Because of the complexity of forest habitats, it is necessary to find certain parameters that achieve the widest possible impact. Therefore, special attention should be paid to the following forest parameters

for the mixed alpine forests in the Gesäuse national park: tree species composition, herb and shrub layer, wood ages, deadwood and habitat trees.

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