Monitoring capercaillie habitat using ALS

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Abstract

Two areas of which one was populated by capercaillie were compared with respect to canopy cover. The canopy cover was computed for hexagons with an area of 452 m² as the proportion of canopy pixels in a digital surface model. The populated area reveals 3-8 times more open canopy structures. Since the capercaillie relies on the availability of open forest, this observation is accordant with the needs of the capercaillie. These first results indicate that ALS can be used to map potential and monitor existing habitat areas. It may support the planning and evaluation of measures implemented to stop the further degradation of the habitat quality, which is likely to be the cause for the decreasing population in the last decades.

Keywords: habitat monitoring, endangered species, capercaillie, lidar

1. Introduction

Endangered species have an indicator function in evaluating the endeavour of integrating the needs of forest management, nature conservation, tourism and game hunting in a multifunctional forestry. The capercaillie (*Tetrao urogallus*) is such an indicator species for parts of the Black Forest, Germany. Capercaillie forests are characterized by a low canopy cover and a high degree of structural diversity. In addition, habitat suitability is mainly defined by the availability of blueberry (*Vaccinium myrtillus*) as its main summer-food and conifer, preferably pine (*Pinus sylvestris*) needles as the main source of food in winter.

To ensure the continuance of the remaining sub-populations in the Black Forest, the forest management in the capercaillie habitat is being adapted to provide the forest structures that the capercaillie relies on. Suchant and Braunisch (2004) found that a suitable habitat consists of at least 10% unstocked area or open canopy and that at least 20% of the area should have an intermediate canopy cover between 50-70%. In addition, less than 30% of the area should be covered with dense forest (e.g., regeneration or thickets).

In the recent years, many studies proofed that airborne laser scanning (ALS) can be used to estimate various forest parameters (e.g., Nilssen 1996, Næsset, 1997, Magnussen and Boudewyn 1998). In Scandinavia, it has become an operational tool in forest inventories (Naesset 2004). Due to its ability of describing the vertical distribution of the vegetation canopy in three dimensions, it is obvious that ALS could also be used for mapping habitat structures. The number of studies with this background are, however, still limited. Hinsley et al. (2002) found that the ALS-derived canopy height can be used as a surrogate for tree density index. They used this statistical relation for assessing the habitat quality of Great Tits (*Parus major*) and Blue Tits (*Parus caeruleus*). Dees et al. (2006) presented methods for describing general habitat structures in forests as they are defined in the Flora-Fauna-Habitat directive (FFH) based on ALS and other remote sensing data. In a shrubland environment, Leyva et al. (2002) used ALS-derived surface models to identify different shapes of shrub-formations that can be related to potential habitat of black-capped vireo (*Vireo atricapillus*). Using large footprint ALS and other remote sensing techniques Hyde et al. (2005) estimated canopy heights and biomass. The estimations were then used to evaluate the quality of the forest structure for wildlife habitat.

In this paper, a concept for monitoring the habitat structure of capercaillie based on ALS is presented. Two adjacent forest areas are compared with respect to the proportion of crown cover classes. Both areas are suitable habitat regarding climatic and topographic attributes and human land use (Braunisch & Suchant 2007). However, just one area is inhabited by capercaillie. Aim is to describe differences of forest structures that may be the cause for why capercallie is found in just one of the areas. First results for canopy cover are presented.

2. Material and Methods

2.1 Study areas

Both study areas are located in the northern part of the distribution range of capercallie in the Black Forest, Germany. The distribution range of capercallie in Germany was determined by geographically explicit observations made by experts such as foresters and local hunters over several years (Braunisch and Suchant 2006). The distribution range was last updated in the year 2003. The area where capercallie was observed, named CO in the remainder of the text, is approximately 64 km² in size. The area where capercallie was absent, named NC in the remainder of the text, is about 36 km² in size. The two areas are separated from each other by the valley of the *Große Enz* river. The smallest distance between the areas is about 2 km.

Since the study areas contain both, public and private forests with many different land owners, no consistent inventory information is available. However, data from the second national forest inventory (2002) can be used to characterize the forest in the county in which the study areas are located (Kändler et al. 2006). The county level forest is dominated by Norway spruce (*Picea abies* L. Karst.) with a 39% proportion by area, silver fir (*Abies alba* Mill.) with 30%, pine (*Pinus sylvestris*) with 19% and beech (*Fagus sylvatica* L.) with 12%. The mean volume is 360.6 m^3 ha^{-1}. It should be noted however, that these parameters may be different in the two study areas.

2.1.2 Laser data

The laser scan data were collected with an Optech ALTM 1225 laser scanner in winter 2003/2004. A flight altitude of approx. 900 m above ground yielded an average distance of 1 m between returns on the ground. The first as well as the last pulse data were automatically classified by the data provider into vegetation- and ground points (reflection from terrain surface).

The commercial software TreesVis (Weinacker et al. 2004) was used to derive two elevation models: A digital terrain model (DTM) with one meter pixel spacing was computed from the ground returns. A digital surface model (DSM) with the same pixel spacing as the DTM was derived from all first pulse data. With a threshold of 1 m, the normalized digital surface model (nDSM, DSM minus DTM) was classified into canopy and ground pixels.

The study areas were tesselated into hexagons with an area of 452 m² each. The relative canopy cover was computed as the proportion of canopy pixels to all pixels. The hexagonal tiles were classified as light, intermediate and closed canopy cover. The intervals for the classification are given in Table 1.

Table 1: Intervals for canopy cover classes.

Canopy cover class	Canopy cover class #	Interval of relative canopy cover (%)
open	1	0 – 50%
intermediate	2	50 – 70%
dense	3	70 – 100%

3. Results

The two study areas can be well differentiated based on their canopy structure: In the CO area, more than 23% and 10% of the hexagon tiles possess open or intermediate canopy cover classes. This is 8 and 3 times more than in the NC area. It is also apparent, that the proportion of intermediate canopy density (50%-70% canopy cover) is below the minimum level of 20% even for the CO area. This however, seems to be levelled out to some extent by the 23% proportion of light canopy cover, which is 13% more than the minimum level for this class.

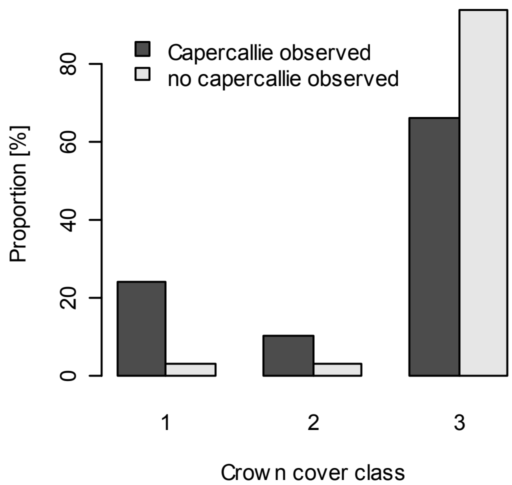

Figure 1: Distribution of the canopy cover classes in the CO and the NC areas.

4. Discussion

Information on stand density, derived from stand height was used by Hinsley et al. (2002) for quantifying the habitat quality of songbirds. We used the canopy cover, which is in fact the inverse of the gap fraction, to characterize the habitat quality of an area populated with capercallie and a non-populated area. The proportion of open canopy structures was between 3 and 8 times higher in the populated area. This is in accordance with the ecological needs of the capercallie: i) Light on the forest ground due to canopy gaps results in a high abundance of blueberries which comprise the main source of food in summer time, ii) low canopy cover is frequently associated with a higher diversity of horizontal stand structure and iii) open areas may facilitate to take refuge from predators.

These first results indicate, that ALS data can be used for monitoring structural aspects of habitat quality for capercaillie over large spatial scales. However, further research is needed to in order to quantify other forest structure parameters relevant to the species. A monitoring concept is needed to guarantee that the habitat quality does not further degrade. Since ALS data are still quite expensive, it might make sense to also analyse other remote sensing data sets for this purpose. Nuske et al. (2007) describe a method to model the gap fraction with orthophotographs. However, the inconsistent quality of the available images and shading effects would make the analysis of orthophotographs cumbersome in our case.

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