RECREATION AND BLACK GROUSE IN THE GIANT MOUNTAINS - WITH LOVE FOR NATURE TO THE EXTINCTION OF THE ICONIC SPECIES

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Abstract
The paper presents a study on the evaluation of a potentially suitable habitat for Black Grouse in the Giant Mountains. The modelling of suitable habitat using the traditional MAXENT method was extended by a detailed assessment of the impact of intensive recreation on the level of fragmentation of suitable habitat. The results showed that the degree of isolation of individual populations due to intensive recreational impact within the area leads to gradual extinction of particular subpopulations. Therefore, a much stricter form of visitor regulation in the region is urgently needed to save these populations from extincion.

Key words: Black Grouse, Giant Mountains, habitat suitability modelling, recreational impact

Introduction

The Black Grouse (*Tetrao tetrix*) is a highly endangered species whose numbers are constantly declining in the Czech Republic. Apart from the Ore and Šumava Mountains, the grouse is found in relatively higher numbers only in the Krkonoše and Jizera Mountains. Even here, however, there has been a steady decline in numbers in recent years, despite the fact, that these are relatively strictly protected areas.

In order to effectively protect the grouse and set up appropriate management, it is important to understand its habitat preferences, spatial requirements, critical limits and threatening factors. A widely used approach to such an assessment is habitat modelling, which enables a comprehensive assessment of the relationship between the occurrence of a species of interest and a suite of relevant environmental factors. The outputs of habitat models then include maps of potential distribution or an assessment of the suitability of habitats for the occurrence of the model species. These can then be confronted with background anthropogenic activities, spatial development data or management maps of forest and agricultural management. At the same time, they serve as a basis for defining sites that are key for the conservation and development of populations of the species of interest or for defining core areas as supporting elements of a possible ecological network.

The interconnected area of the Krkonoše National Park and the Jizera Mountains Protected Landscape Area represents an enormously exposed area where there is a significant concentration of disturbing human activities, especially in relation to recreational use of the environment. These activities very often penetrate into areas with a predominance of natural or near-natural biotopes. The current development of the use of the landscape and, in particular, the intensity of recreational use of the area brings with it a high degree of fragmentation by anthropogenic structures, which create significant barriers in terms of the permeability of the landscape. Together with the loss of suitable habitats (e.g. overgrowth of forest damaged formerly by air pollution), disturbance and fragmentation of grouse populations are critical factors for their long-term survival. Determination of the degree of habitat suitability, delineation of core areas of its current or potential range and determination of their spatial parameters thus constitute a useful basis for assessing the impacts of anthropogenic activities and also for planning measures within the framework of conservation management of the species.

The aim of this study was to characterize the gradient of environmental quality according to the suitability of habitats for sage grouse, to define core areas of suitable habitats in the Giant Mountains and the Jizera Mountains, and to express the degree of their fragmentation by disturbing factors of anthropogenic activities.

Materials and methods

MAXENT software (Phillips et al. 2006) was used in this study to predict potentially suitable habitat and assess habitat preferences of the species of interest. Maxent is one of the so-called machine learning methods, where the algorithm is based on the principle of maximizing entropy in geographic space or minimizing the relative entropy between two probability densities in environmental space,

one estimated from the presence data and the other determined from the entire area of interest (Elith et al. 2011). It works with georeferenced records of species occurrence, called presence data, and a set of predictors describing the environmental setting in the area of interest (Merow et al. 2013). The aim of the tool is to model the distribution of a species in a way that respects the distribution of predictor values across the area of interest as well as the species' preference for a particular range of predictor values (Elith et al. 2011).
The first step of the analysis is the processing of data on the occurrence of the species of interest, the second step is the preparation of documents describing relevant environmental factors and the final stage is the creation of the habitat model itself. Based on the map output, core habitat areas and stepping stones are then defined using expert knowledge of the spatial requirements of the Black Grouse, which can be further evaluated according to the quality of the habitats, interconnectivity or isolation, etc. Finally, the level of recreational impact on the area was evaluated to determine how it affects core areas of suitable habitat and the connectivity of grouse populations.
The input data on the occurrence of the grouse were compiled primarily from databases by the Krkonoše National Park Administration itself; furthermore, some data were compiled by the Administration of the Jizera Mountains Protected Landscape Area (CHKO Jizerské hory), which were supplemented with data from the Nature Conservation Finding Database (NDOP AOPK). The data were collected and evaluated from 1998 to the present, a total of 2461 records were processed in this way (Giant Mountains: n = 2151, Jizera Mountains: n = 310). All input data were standardized and "rarefied" before entering into the model to reduce spatial autocorrelation and prevent multiplication.
At the same time, input data describing relevant environmental factors were processed and evaluated. The input environmental variables included factors describing the basic abiotic gradients of the environment (altitude, slope, solar radiation), habitat factors (derived from the Consolidated Ecosystem Layer database – KVES, ©AOPK ČR & CzechGlobe), habitat mapping of the Karkonoski Park Narodowy and Sentinel 2 satellite image classification) and anthropogenic disturbance factors expressing the distance from built-up areas or roads. The source of the relief data was the pan-European digital elevation model EU-DEM 2; in the case of anthropogenic disturbance factors, the primary source was the Open Street Map (OSM) database, which was supplemented by national databases (e.g. ZABAGED). The most complicated was the preparation of a database on habitats or ecosystem types for the whole transboundary area with different availability of data. Here, the Consolidated Ecosystem Layer (KVES) was chosen as the basic database, which is available for the entire territory of the Czech Republic and thus covers the area of interest of the KRNAP and the Jizera Mountains Protected Landscape Area without any problems. For the Polish Karkonosze National Park, a habitat mapping layer was provided, which could be linked to the KVES layer thanks to the common coding of habitats. For the remaining territory on the Polish side, it was then necessary to classify and vectorise a cutout from the scene taken at the end of 2017. The merged layer resulting from the necessary generalization of subcategories distinguishes 20 habitat types (see Table 1).
The last step was a comprehensive assessment of the recreational load of the area. Based on a combination of census data, field monitoring and expert evaluation, a three-level scale of tourist intensity of tracks and roads was established. Each of these pathways was thus assigned a buffer expressing the level of disturbance according to the intensity of the recreation load.

Results & Discussion

The result of the habitat model shows on a scale of 0 - 100% the suitability of the environment for the species of interest. In addition, the MAXENT model generates a series of tabular and graphical results that aid in model interpretation. The habitat model shows the species' association with the upper parts of the mountains at the upper forest boundary, open forest stands with clearings, peat bogs and other natural treeless areas. It is also limited by the climatic conditions of the highest parts of the mountains. However, the area of potential occurrence, which is naturally structured by natural barriers (deep valleys, summits, etc.), is significantly threatened by fragmentation by anthropogenic structures - especially elements of the so-called hard recreational infrastructure, such as ski areas, routes for summer and winter traffic of service vehicles, very intensively used hiking and skiing trails, or cycling tracks. The results of the grouse habitat model show a significant influence of altitudinal gradient, habitat, solar radiation and distance to roads as well as distance to buildings. The histograms of the model show the importance of preferred habitats, especially in the following categories: alpine meadows, wetlands and bogs, peatlands, shrubs and heathland.

Tab. 1: Habitat classification

HABITAT			
1	water	11	dry lawns
2	wetlands and marshes	12	deciduous forests
3	peat bogs	13	mixed forests
4	sagebrush	14	coniferous forests
5	alpine meadows	15	quarries
6	heathland	16	arable land
7	rocks, scree	17	other agricultural areas
8	shrubs	18	urban green areas
9	mesophilic meadows	19	Urban areas and industry
10	meadows	20	transport networks

Based on the outputs of the habitat model, core areas of suitable habitat were defined throughout the model area, in the first phase without including the disturbance or barrier effect of infrastructure, development and other anthropogenic structures. However, the model constructed in this way present only a very limited assessment of the real impact of anthropogenic structures, especially the tracks and road network. Given the intensity of its use in both mountain ranges, it represents a crucial element that limits the functioning of the sub-populations of grouse within suitable habitat. Therefore, a "realistic" version of a graded assessment of the disturbance effects of the tracks & road network was developed - according to the intensity of use or traffic on tracks and roads, disturbance envelope zones were defined (buffer 50 m around low-use tracks & roads, 200 m for medium and high-use tracks & roads). The output is then a set of datasets and maps that allow an objective assessment of the level fragmentation / isolation of core areas of suitable black grouse habitat within the area of interest.

If we quantify the impact of the disturbance of anthropogenic elements on the extent and character of the distribution of core areas according to the above parameters (graded disturbance effect of 50-200m of tracks & roads according to the intensity of traffic on low-medium-high use roads), we find a substantial degradation of suitable habitats. Out of a total area of over 23.800 ha of suitable habitat, the undisturbed area of habitat is reduced to only 3.496 ha when the disturbance effect is included. Similarly, the spatial structure of the arrangement of isolated core area patches decreases significantly - while their number increases, the average patch size also decreases. This also increases the necessary migration distances between suitable habitats and reduces the overall connectivity of habitats and sub-populations of grouse.

Conclusion

Habitat models enable objective processing of large volumes of data on the occurrence of species of interest and relevant environmental variables. In addition to maps of potential species distributions, the models also result in graphical and tabular outputs that assess the influence of selected environmental factors and, in particular, the actual habitat preferences of the species under study. The map outputs are the basis for the delineation of core areas of actual and potential distribution of the species of interest and also serve as a key input for the assessment of connectivity of suitable habitats.

The results of the study represent both the different habitat preferences of grouse in the two mountain ranges assessed, but also the similar vulnerability of the populations to anthropogenic activities in the area. It is the regulation of the impact of disturbance, particularly in relation to recreational use of the area, that appears to be the most significant challenge for grouse conservation in the future. If such regulation fails in the next few years, the black grouse population in the region will most likely disappear.

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Shrnutí
Příspěvek představuje studii hodnocení potenciálně vhodného habitatu pro tetřívka obecného v Krkonoších. Modelování vhodného habitatu pomocí tradiční metody MAXENT bylo rozšířeno o detailní hodnocení vlivu intenzivní rekreace na míru fragmentace vhodného habitatu. Výsledky ukázaly, že míra izolovanosti jednotlivých populací vlivem intenzivní rekreační zátěže území vede k postupnému zániku dílčích populací. Pro záchranu těchto populací je proto nezbytně nutné mnohem striktnější forma regulace návštěvnosti v tomto území.

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