Fragmentation of Western Capercaillie's Biotope in the Šumava Mountains and the Bavarian Forest

Ondřej Volf, Eva Volfová


Western Capercaillie (Tetrao urogallus)

1. STARTING POINT

The Western Capercaillie (Tetrao urogallus) is one of the flag species in the National Park Šumava as well as in the Bavarian Forest (both designated as Special Protected Areas). It is currently the only viable population of this species in the Middle Europe (outside the Alps). Its abundance is on critical level. Capercaillie has specific ecological demands, which are dependent on vast areas of well-preserved coniferous and mixed forests of Europe and Asia. Providing appropriate conditions for this species guarantees conservation of other species of mountainous forests at the same time. This is a typical example of umbrella species.

One of the main reasons, why the Western Capercaillie is endangered in its European area, is fragmentation of suitable habitats and loss of landscape connectivity, which is closely related to it. The negative effect of fragmentation is particularly noticeable in small, isolated populations surviving in smaller mountainous units, which are very vulnerable to random adverse effects. Fragmentation causes, apart from the loss of the area of habitats, also further isolation of the individual localities. As a final consequence, it has a negative effect on the genetic structure of the population, it limits gene flow, raises genetic drift and inbreeding, which consequently influences reproductive success rate and survival of juveniles. At the same time, its effects on genetic diversity can show as soon as in tens of years.

For the successful protection of this species, it is necessary to determine the size and spatial distribution of suitable habitat and the degree of its fragmentation. Therefore, a detail analysis "The Effect of Habitat Fragmentation on the Population of Western Capercaillie in Šumava and the Bavarian Forest" was compiled in 2014.

The aim of the presented study is to review to which extent the Western Capercaillie population in Šumava and the Bavarian Forest is threatened by habitat fragmentation. With the exception of the genetic study in 2014 this topic has not been given appropriate attention so far; particularly in areas outside of both national parks. The study looks into these questions: (1) Which of the chosen environmental conditions have the greatest influence on the present Western Capercaillie distribution in this area? (2) Where are the potential core areas of its occurrence? (3) How big is the present fragmentation of core areas, what are its causes and its influence on capercaillie distribution? (4) What measures can lead to reducing the impacts of the fragmentation on the Western Capercaillie population?


Biotope of Western Capercaillie

2. ACTIONS IMPLEMENTED

We examined size and spatial distribution of suitable habitat and the degree of its fragmentation using maximum entropy method, graph theory and simulation of potential capercaillie movement.

The model of fragmentation was based on following data:

Data on the occurrence of capercaillie:

- direct observation,
- findings of droppings,
- findings of tracks

Together 1053 of unique data.

Environmental data:

- altitude, average of rainfalls,
- distance from inhabited area,
- landcover,
- geographical latitude and longitude.

Analysis consisted of:

- model of prediction of the occurence
- analysis of connectivity of core areas
- analysis of migration routes and corridors

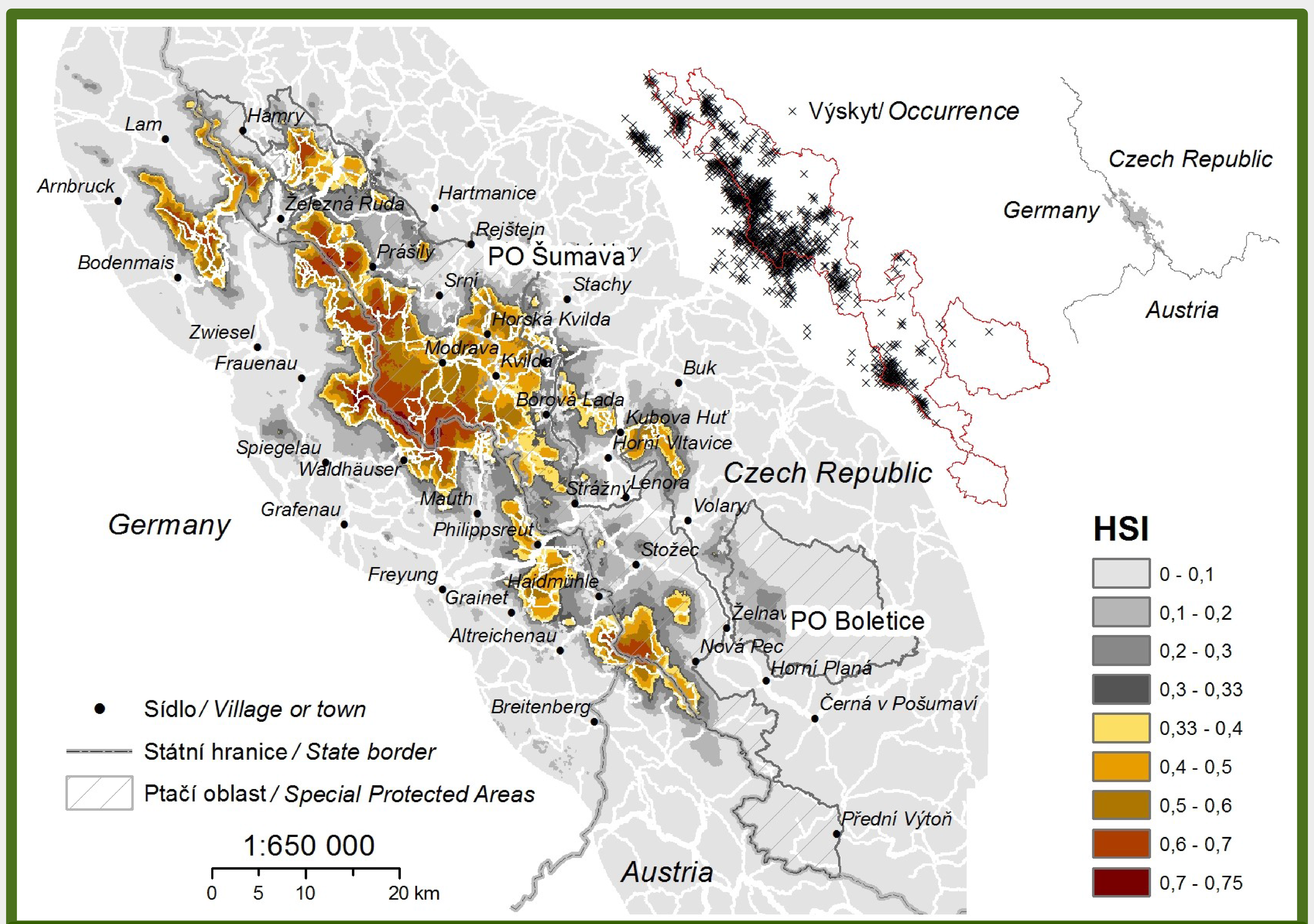

Fig. 1. Habitat suitability map of Western Capercaillie expressed by habitat suitability index (HSI). The HSI index was calculated using Maxent algorithm, explaining the variability of occurrences of capercaillie using selected environmental variables. Areas with HSI ≥ 0.33 were identified as potentially suitable (core areas). Conversely, areas with HSI under this threshold were identified as potentially unsuitable for capercaillie existence in long-term.


Forest management interventions in the biotope of Western Capercaillie

The potentially suitable capercaillie habitat was modelled using the maximum entropy method, implemented in the MaxEnt programme, version 3.3.3e (Phillips et al. 2006; http://www.cs.princeton.edu/~schapire/maxent/). This method has a great advantage in the ability to work solely with presence-only data which are available in most cases nowadays. The MaxEnt programme uses the principle of maximum entropy to estimate a set of statistical functions which approximate the species distribution out of data on their occurrence and environmental variables. The result of the modelling process is therefore a model defining a niche of the capercaillie in a geographical space. The specific parameters of the model (convergence threshold, the number of iterations etc.) were set with regard to the recommendations in professional literature.

In the following step, it was necessary to allow for the disturbing influence of traffic and tourism on the ability of individuals to migrate between suitable habitats. For this purpose, protection zones of a constant width were created, directly adjoining linear disturbance sources, and their area was omitted from the spatial model. The following were considered disturbance sources: 1st class roads (300 m on each side); 2nd and 3rd class roads and railways (150 m on each side); walking trails, educational trails, cross-country skiing trails and bicycle trails (100 m on each side).

The major result of the prediction model is a habitat suitability index (HSI) map. This index with the value range 0-1 (or 0-100%) represents the potential suitability of a habitat for capercaillie. For the needs of further analyses it was essential to identify the most valuable habitats (hereinafter "core areas"). To do that, it is necessary to set a boundary ("threshold") which divides the habitat suitability range into two categories: suitable and unsuitable habitat. On the recommendation of Liu et al. (2005) and Bean et al. (2012), the threshold defined by the identical ratio of correctly determined presences ("sensitivity") and absences ("specificity") of capercaillie through a model was used in this work ("Equal training sensitivity and specificity").

With regard to the scattered mosaic of suitable habitats and a complex network of their relations we used the probability of connectivity index, coming from the graph theory, to evaluate a functional connectivity (Saura & Pascual-Hortal 2007).

With respect to the local environmental conditions and the results of expert studies (e.g. Hjeljord et al. 2000, Marjakangas & Kiviniemi 2005 or Rösner et al. 2013), the distance of 2.6 km was considered an average capercaillie transfer distance (as a necessary calculation parameter). The connectivity index was first calculated for the core areas, spatially defined by the selected probability threshold (33.4 %).


Tracks of Western Capercaillie in snow

HSI (%)	PO/SPA Šumava	NP/NP Šumava	NP Bavorský les /NP *Bayerischer Wald*	CHKO/LP Šumava	PO/SPA Boletice	PO/SPA Arber **	Všechna CHÚ/ All protected areas	*Outside protected areas*		
< 0,33 (nevhodný biotop/ *unsuitable habitat*)	524	339,4	117,5	653	228,5	14	1325.4	**Česká republika /*Czech Republic***	**Německo /*Germany***	**Rakousko / *Austria***
> 0,33 (vhodný biotop/ *suitable habitat*)	**289,7**	**243,0**	**83,2**	**60,6**	**-**	**20**	**409.4**	**0,12**	**85,29**	**9,67**

Table 1. *The area (km²) of a potentially suitable habitat of capercaillie both outside and within the protected areas (national parks - NP, Special Protected Areas - SPA and Landscape Park - LP). Areas with HSI ≥ 0.33 were identified as a potentially suitable habitat (core areas). Conversely, areas with HSI under this threshold were identified as potentially unsuitable for capercaillie existence in the long therm*

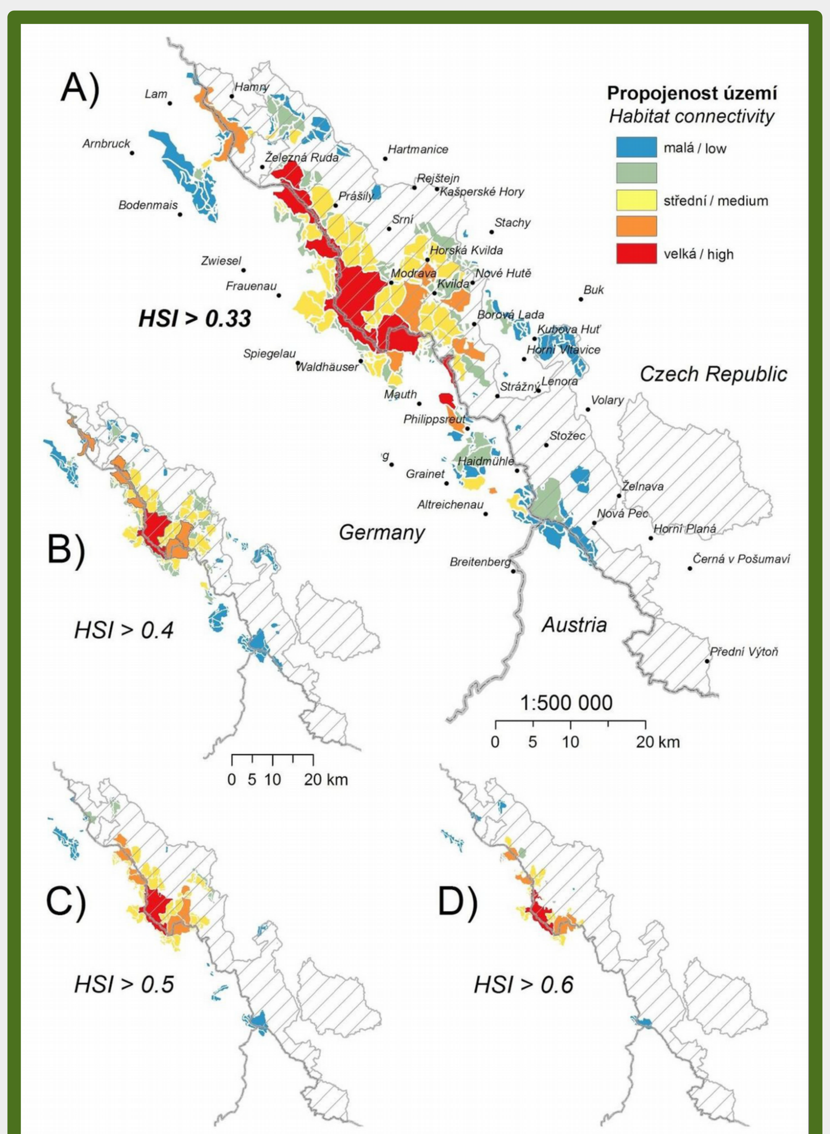

Fig. 2. Mutual connectivity of potential capercaillie habitat in Šumava. Individual variants (A-D) correspond to the connectivity analysis for different level of habitat quality. The quality of the habitat (measured by HSI value) represents the combination of suitable environmental conditions for the occurrence of capercaillie.

3. RESULTS

According to genetic studies conducted in previous years the size of the Western Capercaillie population in Šumava and the Bavarian Forest at present is estimated to be 500 individuals (Müller & Rösner 2011, Rösner et al. 2014, Rösner & Leibl 2014). It is at the critical level of its long-term survival, that is 470 individuals (Grimm and Storch 2000, Braunisch and Suchant 2013).

To create the capercaillie distribution model, 1053 out of 4453 occurrence records were used eventually. The majority of the variability of these data (75 %) was explained by altitude, average annual precipitation and land cover type on the basis of a jackknife test. Another part of the occurrence data variability was explained in the model on the basis of their distance from urbanised areas and factors correlating with latitude and longitude. Other predictors did not contribute to explaining the remaining data variability and were not included in the final model.

The results of study indicate that the best habitat conditions for capercaillie are in the central ("core") area of Šumava and some of the adjacent locations. The total area of potentially suitable capercaillie habitat is 503 km^2, out of which 95 km^2 are not under targeted protection. Limited connections were found mainly between capercaillie populations in the core part of the Šumava Mountains and Trojmezenská area, strongly dependent on the presence of suitable habitats on the Bavarian side of Šumava. Similarly, we found insufficient connection between suitable habitats near Železná Ruda and habitats located near Großer Arber, Jezerní hora and Můstek.

The fragmentation of suitable habitat is currently strongly influenced by frequented roads (including tourist trails) affecting the use of habitat, overall vitality and reproduction of capercaillie individuals. The population of capercaillie in Šumava and the Bavarian Forest survives mainly in well-connected core area and some crucial smaller population, within a reasonable distance. Any negative interventions (e.g. large-scale logging, building ski resorts or excessive tourism) in the core area can lead to a worsening of conditions across the capercaillie metapopulation. Marginal and isolated population units, which are often not located in protected areas, also require extraordinary attention. We believe that successful protection of capercaillie in Šumava is possible only at cross-border level.

4. OUTLOOK

The study set very good scientific baseline data for conservation of Western Capercaillie in the Šumava Mountains and the Bavarian Forest. The population here survives mainly in a well-connected core area and some crucial smaller populations, within a reasonable distance. Any negative interventions (e.g. large-scale logging, building ski resorts or excessive tourism) in the core area can lead to a worsening of conditions across the capercaillie metapopulation or its extinction. Marginal and isolated population units, which are often not located in protected areas, also require extraordinary attention. We believe that successful protection of Western Capercaillie in Šumava is possible only at cross-border level.

The outputs of the study were used in the process of appropriate assessment and setting rules of small scale interventions in forests and also limiting tourist activities within core area of capercaillie.

Pilot Region 1 of the Interreg Project Dare to Connect is located just in the area of the Šumava Mountains and the Bavarian Forest. Further steps based upon the analysis are planned to support the protection of Western Capercaillie.

Interreg
EUROPEAN UNION
Danube Transnational Programme
DaRe to Connect
Project co-funded by European Union funds (ERDF, IPA)

Green Belt – Borders separate. Nature unites!

Ametyst
www.ametyst21.cz