Identifying key habitats in different scales provides a reliable basis for the conservation of forest dwelling Bechstein's bat

Markus DIETZ[1], Barbara DAWO[1], Axel KRANNICH[1] & Jacques B. PIR[2]

[1]Institute of Animal Ecology and Nature Education, Altes Forsthaus, Hauptstr. 30, D-35321 Gonterskirchen, Germany; [2]57, rue des Carrefours, L-8015 Strassen, Luxembourg

Institut für Tierökologie und Naturbildung

1. Introduction

Understanding key habitat requirements and distribution of a species is critical for its conservation as well as for prioritising and designing conservation measures. The almost most characteristic bat species that live in western Palaearctic forests is the tree-dwelling Bechstein's bat (*Myotis bechsteinii*). Due to their specific habitat requirements and their organisation in demographically independent small populations, Bechstein´s bats might be especially susceptible to habitat alteration or degradation. Its distribution range shows strong correlation with the occurrence of the common beech (*Fagus sylvatica)* (Fig. 1). Bechstein`s bats are considered near threatened by the IUCN and "*in need of strict protection*" by the European Habitats Directive (92/43/CEE).

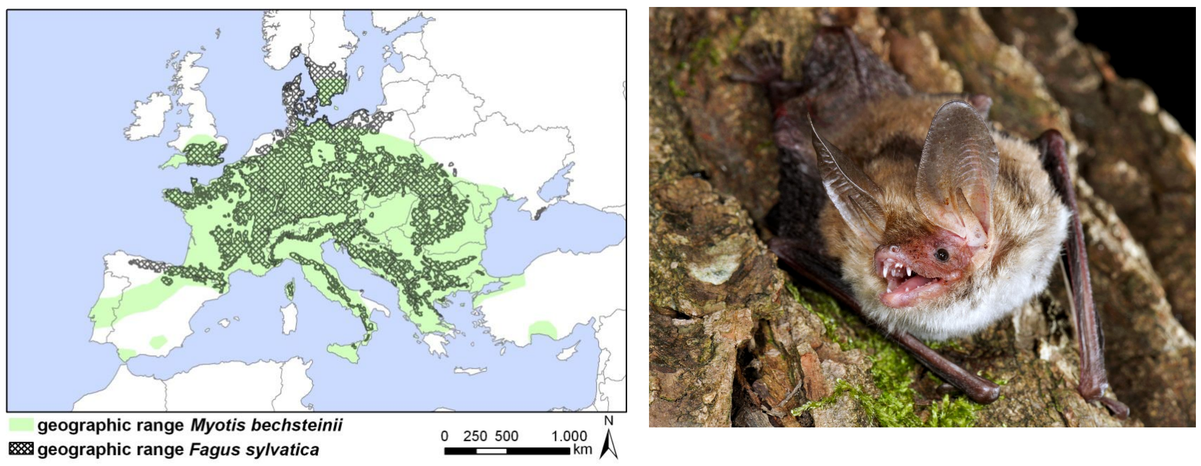

Fig. 1: *The distribution of Myotis bechsteinii shows a strong correlation to the areal of broad leafed deciduous woodlands with the common beech Fagus sylvatica as dominant tree species.*

2. Methods

We radio-tracked in all 92 reproductive females from 13 nursery colonies in different landscapes in Germany and in the Grand Duchy of Luxembourg to identify key habitat requirements and habitat types preferred by Bechstein`s bats in a small scale area (Fig. 2). Using **E**cological **N**iche **F**actor **A**nalysis (ENFA) leads to a good a priori knowledge of optimal habitat components and ecological niche parameters (Hirzel et al., 2002).

Based on the results from the small scale analyses we created habitat suitability maps with the help of a MaxEnt (**Max**imum **Ent**ropy Modeling) model to predict distribution and key habitats for Bechstein`s bat in a large scale area (Luxembourg). MaxEnt utilises a statistical mechanics approach called maximum entropy to make predictions from incomplete information. It is crucial that MaxEnt only requires presence data, performed well and remained fairly stable at a set of different sample sizes in both prediction accuracy and the total area predicted.

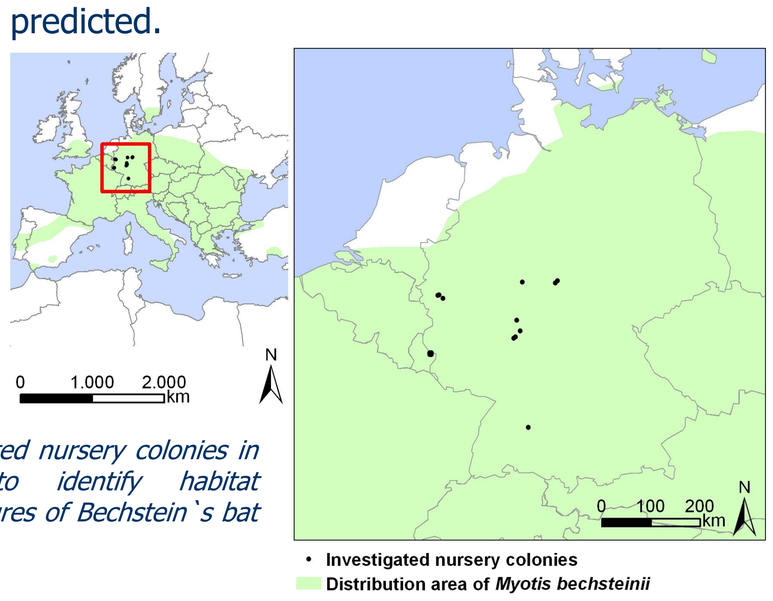

Fig. 2: *Locations of 13 investigated nursery colonies in Germany and Luxembourg to identify habitat requirements and key habitat features of Bechstein`s bat Myotis bechsteinii.*

3. Results

Habitat requirements

We localized 270 nursery-trees from the 13 colonies and could conclude that Bechstein`s bats predominantly occupied woodpecker-made cavities (>80%). Beside this also crevices and branch-break-offs were used. Two third of the nursery colonies were found in old oak trees, furthermore beeches, hornbeams and spruce were rarely used.

We mostly found Bechstein`s bats in temperate old oak-hornbeam woodlands and beech forests. Also favorable habitats were traditional orchards and semi-open parkland with old solitary broadleaved trees.

Reproductive females hunted in a short-range around their roosting trees, most of the feeding grounds were within distances of less than 1 km, closely associated to the day-roosts. Overall ENFA analyses revealed high marginality and specialisation values, indicating a high selectivity and a narrow ecological niche for habitat use in Bechstein`s bats.

Prediction of distribution by modelling

After examining 32 variables that were considered to be relevant and affect distribution of *Myotis bechsteinii* only 8 variables were chosen for the final model. The other variables were stepwise removed from the model due to low contribution. The results showed that the variable with highest gain when used in isolation is the amount (percent-) of oak trees, which therefore appears to have the most useful information by itself for modelling the bats distribution. The environmental variable that mostly decreases gain of the model when omitted is mixed broad-leafed forest (Tab. 1, Fig. 3). Furthermore an important variable that shows a strong positive correlation to Bechstein´s distribution is age of the forest.

Tab. 1: *V*ariables that mostly contribute to the MaxEnt model to predict distribution of *Myotis bechsteinii* (***bf*** *broad leafed forest).*

Variable	Percent contribution	Permutation importance
bf_mixed	37	35.2
percent_oak	24.7	3.1
age	13.7	2.6
lang_index	11.7	27.6
canopy layers	5.6	1.8
bf_beech	3.9	21.3
elevation	2.7	6.4
grassland	0.8	2

Fig. 3: *Curves represents a MaxEnt model created using only the corresponding variable. These plots reflect the dependence of predicted suitability both on the selected variable and on dependencies induced by correlations between the selected variable and other variables.*

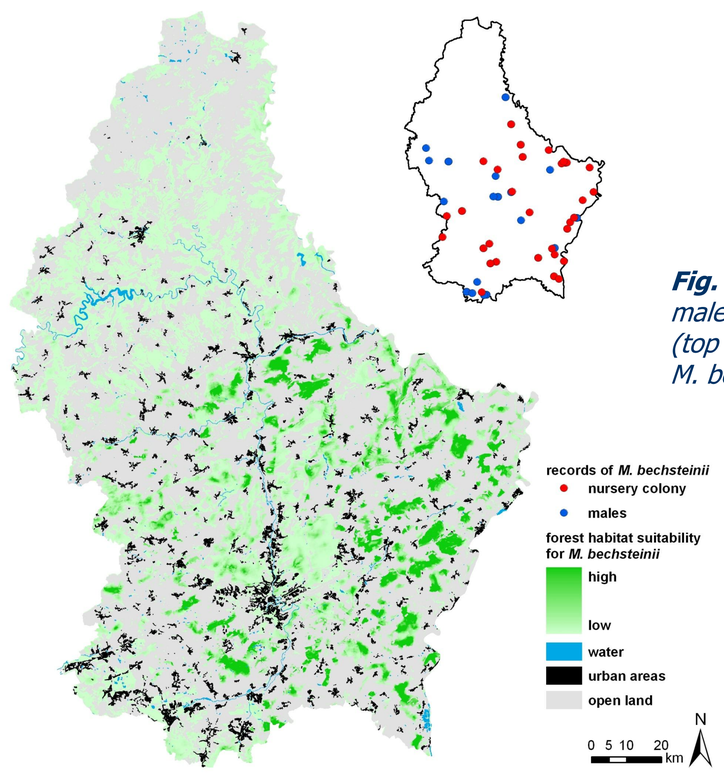

Fig. 4: *Records of nursery colonies and males of M. bechsteinii in Luxembourg (top right) and habitat suitability map for M. bechsteinii based on MaxEnt model.*

4. Conclusion

Current distribution of Bechstein`s bat is insular and strongly influenced by deforestation (Bauer 1987, Blant et al. 2010, Napal et al. 2013) and forest management practice (Dietz et al. 2013). The results emphasize the large dependency on old growth oak and beech forests (Greenaway & Hill 2004, Güttinger & Burkhard 2013).

Results of ENFA analysis highlights the grand selectivity and the narrow ecological niche for habitat use in Bechstein`s bats. As the occurrence of this species is strongly correlated to mature deciduous forest ecosystems and in view of legal obligations by European Habitat Directive it is essential to take care for this forest types. Beside local field studies modelling can help to predict distribution of Bechstein`s bats.

References:

Bauer, K. (1987): Die Holozäne Fledermausfauna des Katerloches bei Weiz, Steiermark (Mammalia, Chiroptera). – Mitteilungen Abteilung für Zoologie, Landesmuseum Joanneum 40: 25-40., **Blant, M.; Moretti, M. & Tinner, W. (**2010**):** Effect of climatic and palaeoenvironmental changes on the occurrence of Holocene bats in the Swiss Alps. The holocene 20(5): 7011 – 721., **Dietz, M., Pir, JB**. (2011): Distribution, Ecology and Habitat Selection by Bechstein`s Bat (*Myotis bechsteinii*) in Luxembourg. Ökologie der Säugetiere 6 , 88 S., **Dietz, M., Bögelsack, K., Dawo, B. & Krannich, A**. (2013): Habitatbindng und räumliche Organisation der Bechsteinfledermaus. In: Dietz, M. (2013): Populationsökologie und Habitatansprüche der Bechsteinfledermaus *Myotis bechsteinii.* Beiträge zur Fachtagung in der Trinkkuranlage Bad Nauheim: 85-104. , **Greenaway, F. , Hill, D. A**. (2004). Woodland management advice for bechstein's bat and barbastelle bat.). Report no. 658, English Nature., **Güttinger, R. & Burkhard, W.D.** (2013: Bechsteinfledermäuse würden Eichen pflanzen. In: Dietz, M. (2013: Habitatansprüche der Bechsteinfledermaus *Myotis bechsteinii.* Beiträge zur Fachtagung in der Trinkkuranlage Bad Nauheim: 105 -130., **Hirzel, A. H., et al.** (2002). Ecological-niche factor analysis: Hot to compute habitat-suitability maps without absence data? Ecology, 83: 2027-2036., **Napal, M.; I. Garin, U.; Goiti, E.; Salsamendi & Aihartza**, J. (2013): Past deforestation of Mediterranean Europe explains the present distribution of the strict forst dweller Myotis bechsteinii. Forest Ecology and Management 293: 161 -170.

Corresponding Author: Dr. Markus DIETZ (markus.dietz@tieroekologie.com)