Appendix S1

Humans rather than Eurasian lynx (*Lynx lynx*) shape ungulate browsing patterns in a temperate forest

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Ecosphere

Lynx habitat suitability

We created a habitat suitability model for lynx using the Maxent algorithm (Phillips et al. 2006). As information on lynx occurrence, we used GPS telemetry data of 9 individual lynx (four females and five males), recorded between 2005 and 2012 inside the Bavarian Forest National Park as well as the adjacent Šumava National Park (Figure S1). To reflect the hunting behaviour of lynx (Heurich et al. 2014) and thus better indicate risk for roe deer, only night-time positions of lynx were used for creating habitat suitability models. Night-time positions were defined as all locations recorded after nautical dusk and before nautical dawn (Fille et al. 2017). In total, we used 3,679 lynx locations (200-634 locations per individual collected over monitoring periods of 418-1801 days). As background points characterizing areas available to lynx, we randomly sampled five times the number of presence locations within the 100% minimum convex polygon encompassing all lynx locations. We thus characterize habitat use by lynx at the level of within-home range habitat selection (Northrup et al. 2013), corresponding to third-order habitat selection *sensu* Johnson (1980). We used lynx locations from throughout the entire year, as our browsing intensity measurements also represented last year's browsing.

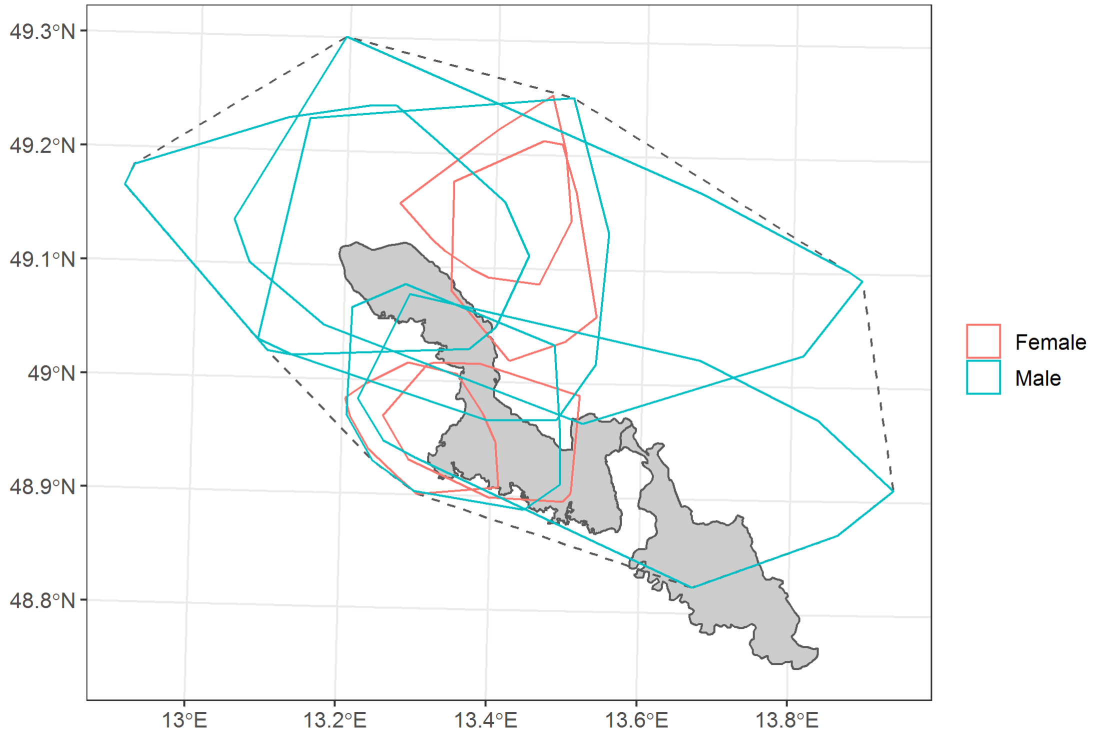

Figure S1: Spatial distribution of lynx telemetry data used for modelling habitat suitability. Coloured polygons correspond to 100% minimum convex polygons (MCP) per lynx individual, with colours indicating the sex of individuals. Dashed polygon shows 100% MCP around all lynx locations. The extent of the Bavarian Forest National Park and the state forest enterprise Neureichenau are shown in grey for reference.

We used a total of 15 predictor variables in our habitat suitability models, which capture a range of different habitat aspects (Table S1). Previous studies on lynx habitat use in the Bohemian Forest Ecosystem found that lynx mainly select forested areas in relatively rugged terrain and avoid areas close to roads and settlements (Magg et al. 2015; Filla et al. 2017). We included the terrain ruggedness index, as well as the distance to settlements, small roads and large roads (large roads being primary and secondary roads and small roads tertiary roads) based on OpenStreetMap data (Haklay and Weber 2008) to characterize topography and human disturbance. To capture the amount and fragmentation of potentially suitable habitat for lynx surrounding a given location in our study area (Schadt et al. 2002), we calculated raster maps of the amount of forests and other seminatural areas as well as the proportion of forest edges (indicating habitat fragmentation) at the scale of female lynx home ranges (~125km^2; Filla et al. 2017) based on CORINE land cover data. Finally, to characterize fine-scale variation in land cover and vegetation structure, we used satellite-based metrics based on multi-temporal Landsat imagery. We followed the approach of Oeser et al. (2019) and calculated the 10^{th}, 50^{th} and 90^{th} percentile of the Tasseled Cap indices greenness, brightness and wetness for each pixel in our study area (resulting in nine metrics in total). Summarizing the intra-annual phenological variation of the Tasseled Cap indices, these metrics are indicative of land cover and vegetation structure (Pasquarella et al. 2016) and are highly useful for modelling large mammal habitat (Oeser et al. 2019). To allow temporally matching telemetry observations with the satellite-based metrics, we derived metrics for each year of the telemetry records (2005-2012), using three year moving windows of Landsat imagery (e.g., using all available, cloud-free Landsat observations from 2007-2009 to compute metrics for the year 2008; Oeser et al. 2020). We resampled all predictor variables to a 30m spatial resolution, corresponding to the target resolution of our habitat suitability maps.

Table S1: Overview of predictor variables used for modelling lynx habitat suitability.

Habitat aspect	No. of variables	Variables	Data source
Land cover and vegetation structure	9	10^{th}, 50^{th} and 90^{th} percentile of Tasseled Cap greenness, brightness and wetness	Landsat satellite imagery
Habitat amount	1	Amount of forests and other seminatural areas within a circular buffer of 125km² (size of a female home range)	CORINE land cover
Habitat fragmentation	1	Proportion of pixels corresponding to forest edges within a circular buffer of 125km² (size of a female home range)	CORINE land cover
Human disturbance	3	Distance to small roads, distance to large roads, distance to settlements	OpenStreetMap
Topography	1	Terrain ruggedness index	SRTM elevation model (30m resolution)

We validated our habitat suitability models by performing cross-validation, leaving out data from one lynx individual at a time (Roberts et al. 2017). To measure predictive performance, we used the Continuous Boyce Index (CBI; Hirzel et al. 2006), which measures how well predicted habitat suitability values correspond with the frequency of lynx habitat use (Phillips and Elith 2010).

Comparing models based on CBI, we also tested different parameter settings for the Maxent algorithm ('model tuning') in order to avoid model overfitting (Radosavljevic and Anderson 2014). We tested three different combinations of Maxent feature classes, as well five different settings for the regularization multiplier β (Table S2; see Merow et al. 2013 for a detailed description of Maxent and its parameters). Based on our cross-validation, Maxent models using only hinge features and β = 6 showed the highest CBI values (0.93; Figure S2). Therefore, we used these parameter settings for creating habitat suitability maps.

Table S2: Overview of tested maxent parameter settings.

Feature class combination	Tested values for regularization multiplier β
Linear, product and quadratic	1, 2, 4, 6, 8
Linear, product, quadratic and hinge	1, 2, 4, 6, 8
Only hinge	1, 2, 4, 6, 8

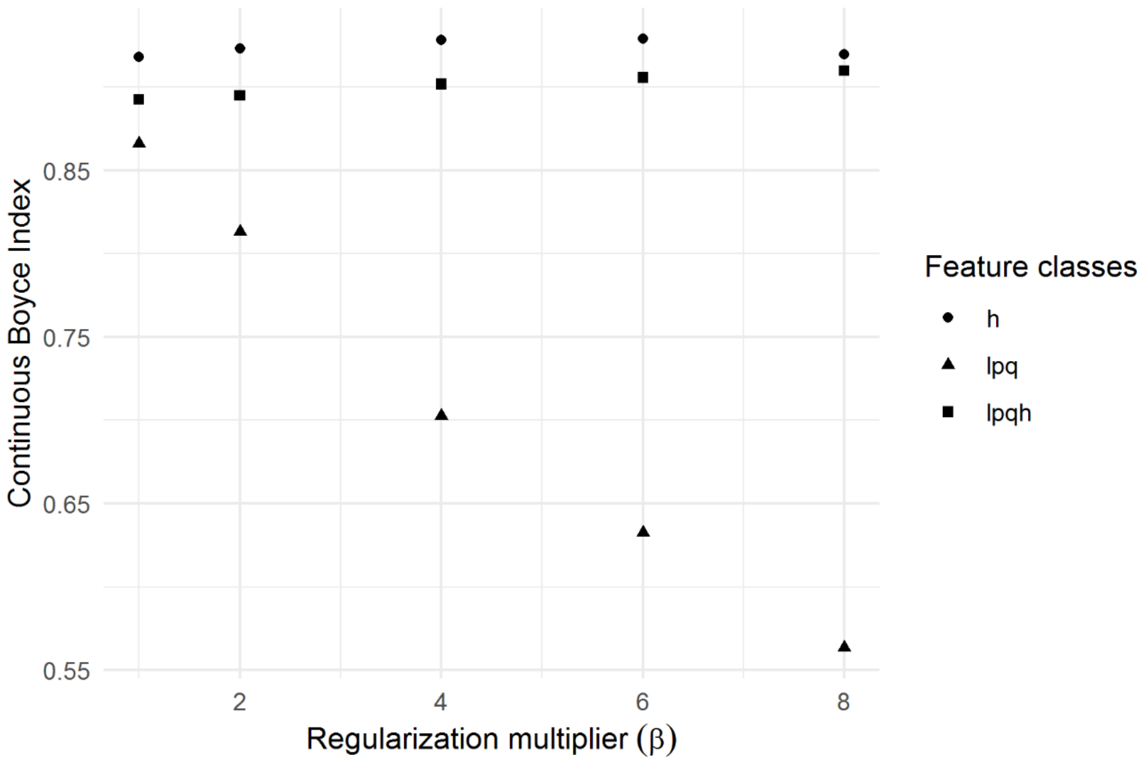

Figure S2: Results of the tuning process of Maxent models, comparing different feature class combinations and levels of model regularization. Circles, squares and triangles indicate which combination of Maxent feature classes were used in the model (l = linear, p = product, q = quadratic, h = hinge).

Finally, we created habitat suitability maps for our study area using the parameter settings selected based on cross-validation. To represent habitat conditions for the time period in which we conducted our browsing survey, we derived the Landsat-based metrics for the year 2017 for predicting lynx habitat suitability in our study area.

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