Actual and potential distribution of ibex in the Swiss National Park

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Introduction

The first re-introduction of ibex in Switzerland in the canton of St. Gallen in 2011 had only limited success due to suboptimal winter habitat (Imesch-Bebié et al., 2010). Even after re-introductions started in the Swiss National Park in 1920, the small colony increased only slowly in size, until the animals relocated to Val Trupchun on their own accord in the 1950‘s. Here they found more suitable habitat, and the population began to thrive.

By comparison to other ungulate species, ibex are habitat specialists. Besides climatic factors, important parameters in determining suitable conditions include high altitude, steep rocky slopes with a sufficient concentration of pastures, and south-facing slopes with low snow cover in winter (e.g. Nievergelt, 1966; Hirzel et al., 2002). Its specialisation to a relatively narrow range of environmental conditions makes ibex well suited to applying presence-only habitat models to compare its actual and potential distribution.

Methods

Park rangers have regularly collected positional data of ibex on visual surveys in two dedicated study areas within the Swiss National Park. The surveys have been conducted four times a year during one day in the first half of January, May, August and November since 1997.

Environmental data and ibex sightings were summarised in 4m x 4m grid cells over the entire park. Environmental parameters included altitude (m), slope (deg), aspect (deg; divided into a sin (north – south) and cos (east – west) component), ruggedness (after Sappington et al., 2007), distance to forest and rock (m), respectively, and dominant habitat class within each grid cell (bare soil, forest or meadow).

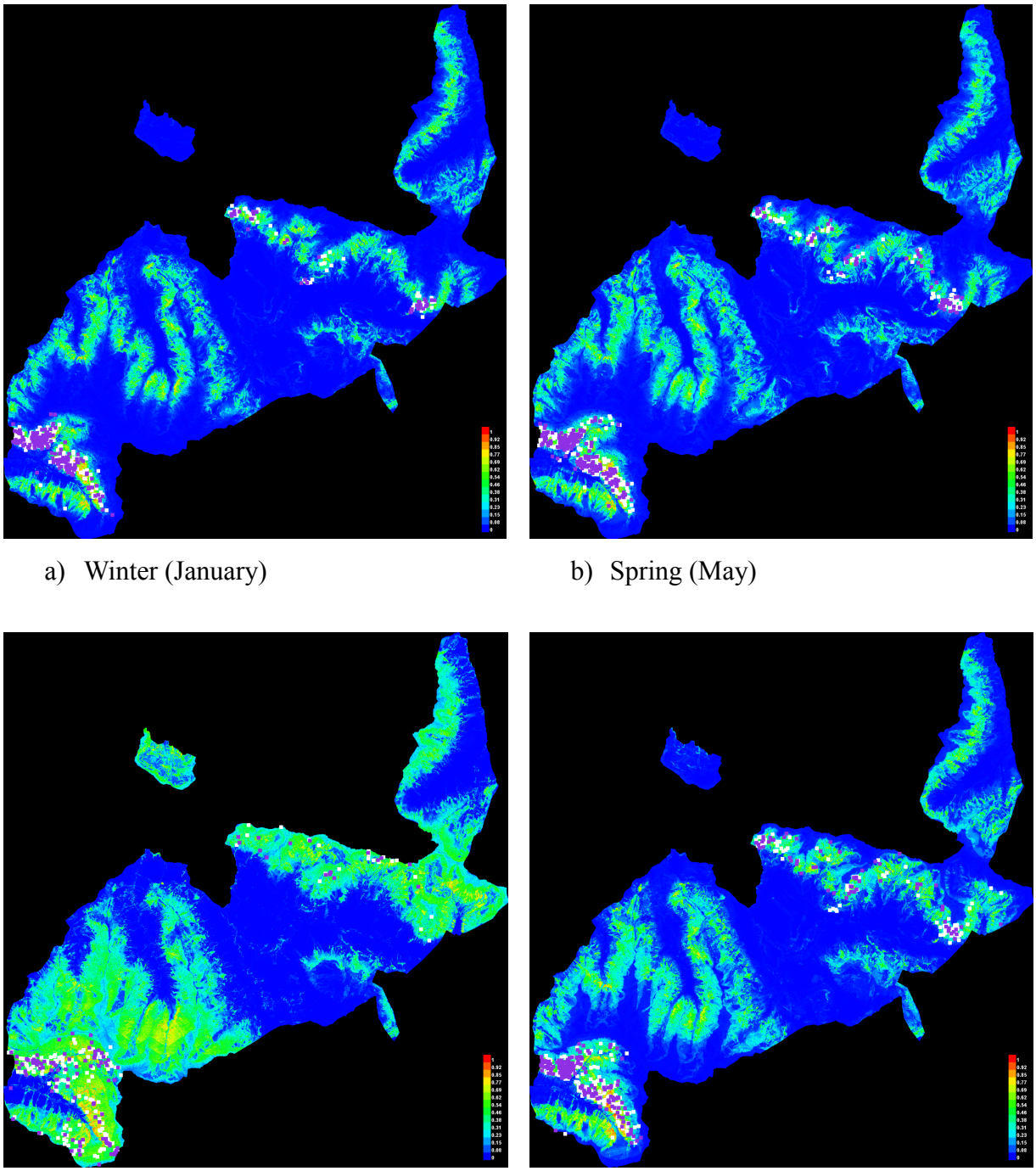
The potential distribution of ibex in the Swiss National Park according to these environmental parameters for each season was modeled using MaxEnt v3.3.3 (Phillips et al. 2006). Each model was trained with 60% of randomly selected sightings records and validated using the remaining 40%. 10‘000 background pixels were randomly selected as pseudo-absence data.

Results

MaxEnt predictions of suitable habitat for ibex within the Swiss National Park indicated that favourable environmental conditions for the species were restricted to relatively few areas during winter (Figure 1a). However, during summer, a considerable proportion of the total area provided suitable habitat (Figure 1c). The predictive performance of the four models was consistent with this variation in range width of the species between seasons: the AUC (area under the curve) ranged from 0.819 in summer, 0.87 in autumn, 0.892 in spring to a maximum of 0.904 in winter. However, for all seasons, very suitable areas (i.e. prediction values exceeding 0.7, represented by yellow and orange in the maps) were mostly restricted to Val Trupchun (in the south-western part of the park), where most ibex observations had been made.

The most important variables in predicting ibex presence were slope (in winter and spring), altitude (in spring, together with slope) and distance to forest (in summer and autumn; Table 1). However, altitude and distance to forest were correlated, so that the two variables can be viewed as largely interchangeable. By contrast, neither the north-south nor east-west component of aspect played a role in model predictions and were therefore excluded from all seasonal models.

The probability of ibex presence generally increased with increasing slopes up to intermediate values and then either decreased again slightly or remained constant. As expected, the animals stayed closer to the forest (i.e. at lower altitudes) during winter, spring and autumn than during summer, when they moved to higher altitudes at greater distances from the forest.



a) Winter (January)

b) Spring (May)

c) Summer (August)

d) Autumn (November)

Figure 1. MaxEnt habitat suitability maps for ibex in the Swiss National Park for each season. The scale ranges from blue (0; unsuitable) to red (1; very suitable). White cells indicate sighting locations used for training the model, purple cells represent test locations.

Table 1. Permutation importance (%) of all variables retained in the final seasonal models.

Variable	winter	spring	summer	autumn
Altitude	23.6	33.7	10.7	27
Slope	34.4	33.5	13.9	18.4
Ruggedness	4.7	2	0.9	1.7
Distance to forest	25.9	21	51.8	41.4
Distance to rock	6.8	5.3	11.9	5.8
Habitat class	4.7	4.5	10.7	5.6

Discussion

Most likely due to the relatively restricted range of ibex, the presence-only models performed well in predicting suitable habitat for the species within the Swiss National Park: as expected, the AUC's were comparatively high for each seasonal model, with the highest value for winter, when the range of the animals is most restricted within the park. More importantly though, based on sightings data collected only in the two dedicated study areas, the locations predicted by the model as suitable habitat for ibex outside these areas were largely consistent with locations where the park rangers have reported animals to be present. An exception was the northeastern part of the park, where the model predicted probabilities of up to 50% of encountering ibex, even though the animals are not known to occur there.

The model predicted the most suitable habitat for ibex for Val Trupchun in the south-western part. This was most likely caused by the great concentration of sightings from this area, so that the conclusion that the valley represents favourable habitat for the species is circular. However, this was the area where re-introduced ibex relocated to on their own accord after being released in a different part of the park. The model prediction of limited winter habitat being available for ibex within the Swiss National Park is also consistent with observations: indeed, a lot of ibex from the park spend the winter on south-facing slopes just south of the park boundaries over the border in Italy to return to Val Trupchun in the spring.

Giacometti (1997) states that all available suitable ibex habitat in Switzerland is occupied by the species. The seasonal MaxEnt models suggest that this statement is probably also true at a finer scale for the Swiss National Park, at least for the highly suitable areas.

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