Searching for the Fundamental Niche of wild reindeer in Norway

Manuela Panzacchi , Bram Van Moorter, Olav Strand

Norwegian Institute for Nature Research, Tungasletta-2, N-7485 Trondheim, Norway

manuela.panzacchi@nina.no

EXECUTIVE SUMMARY

Roads and infrastructures divide Norwegian wild reindeer *Rangifer trandus* into 23 populations, most of which can no longer perform traditional migrations and are confined to areas that do not provide both good summer and good winter pastures. We developed a method to identify the ***optimal*** **summer and winter pastures** in Norway (*i.e.* the seasonal fundamental niche) by integrating the response curves of populations exposed to different ranges of availability for environmental variables. The estimate of the *niche optimum* and *breadth* improves by adding more individuals and, in particular, more populations

INTRODUCTION

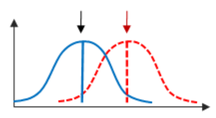
Roads and infrastructures delimit population ranges and limit the range of environmental choices available to each reindeer in Norway. Classical habitat suitability models assume that individuals can choose among the full range of available values for a given variable. Hence, such models can identify the **realized niche of each population**, but not the **species' fundamental niche**.

We present a method to infer the optimal seasonal pastures nation-wide using individual-based resource selection modeling across populations

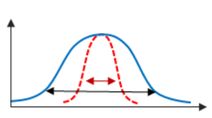
NICHE MODELLING

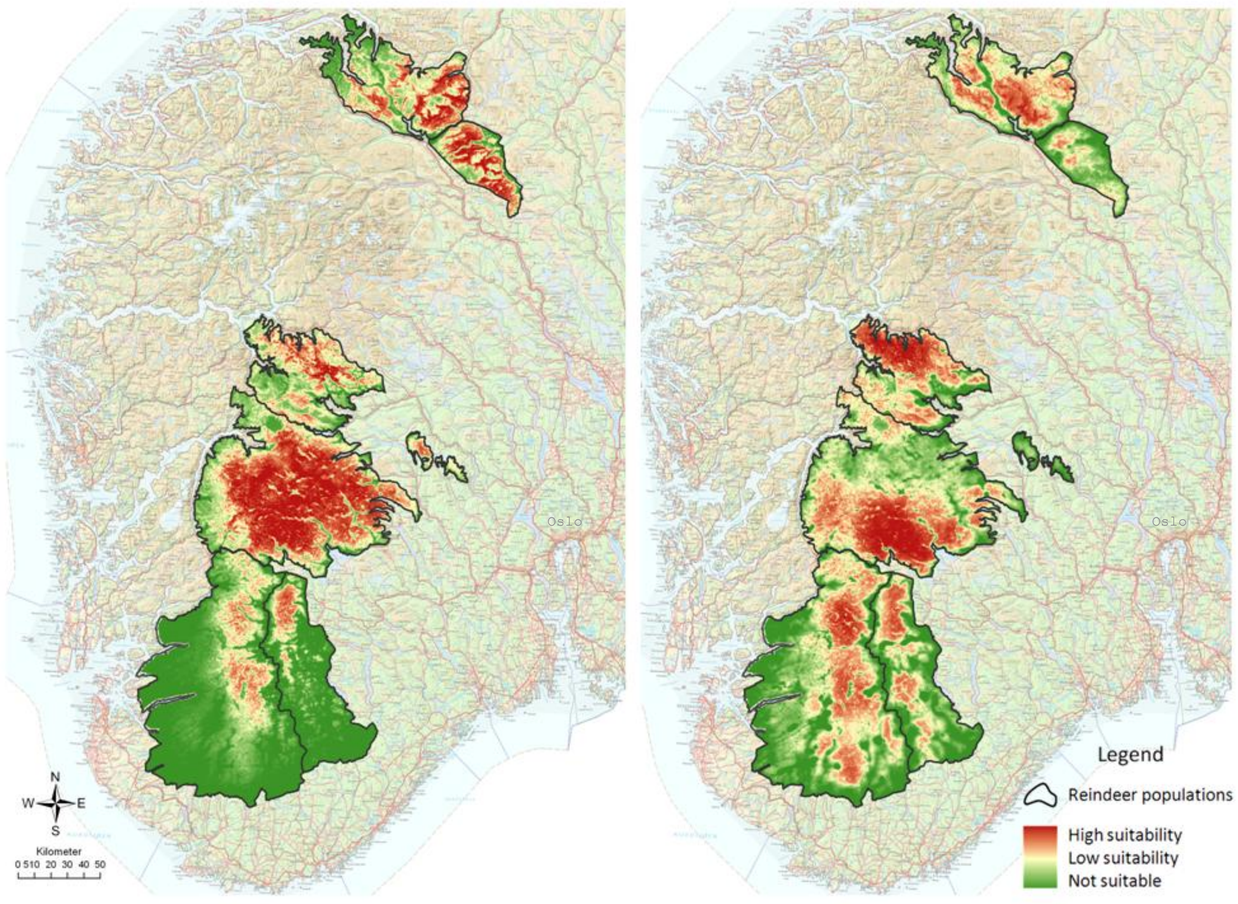
Data: 147 GPS-collared reindeer, 7 populations, 2001-2011. Model: Conditional Logistic Regression with log-link function across populations in a use-available design, conditioning used to available points within each population. Variables of interest were modeled using 2nd degree polynomials (which, on a log scale, equal a Gaussian curve, *i.e.* niche representation). Using regression coefficients we calculated *niche optimum* (i.e. the curve mean μ) & *breadth* (variance σ^2):

$$\text{Use}/\text{Available} \sim \alpha + \beta_0 [\text{Human disturbance}_i \text{ (different scales)}] + \beta_1 [\text{Environmental variable}_j] + \beta_2 [\text{Environmental variable}_j]^2 + \ldots + \varepsilon$$



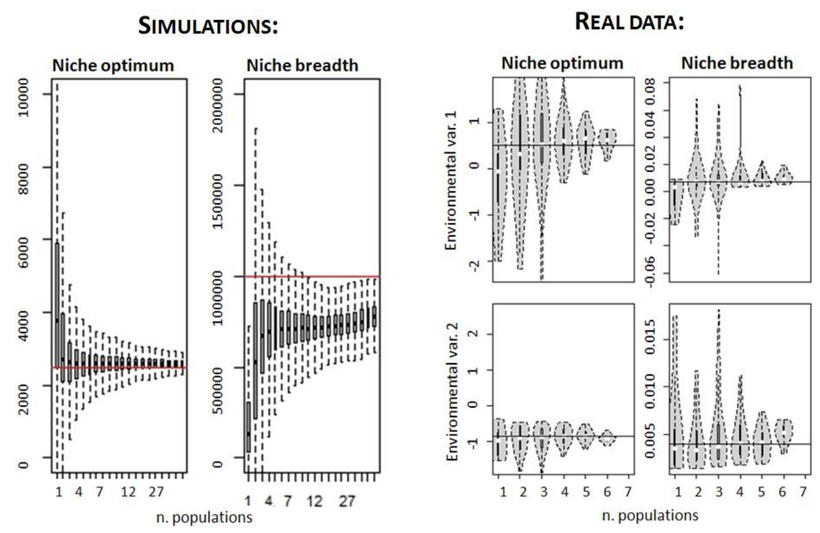
$$\text{Niche Optimum} = \beta_1 \sigma^2 \qquad \text{Niche Breadth} = -1/(2\,\beta_2)$$





HOW MANY POPULATIONS ARE NEEDED?

Both simulations and real data show that the precision of the estimated niche optimum and breadth increases with the n of populations. Roughly, min ca. 5-10 pop. (min. ca. 10 individuals each) are needed:



RESULTS, DISCUSSION & APPLICATIONS

The models have high predictive power (*K-fold cross-validation*: $p < 0.000$, $\delta > 0.9$). The models show that several populations are confined to *sub-optimal* summer or winter areas and that, consequently, should seasonally migrate to better areas (right fig). In fact, archaeological data (large-scale pitfalls) and VHF data from the '80 testify the past existence of large-scale migrations among presently isolated reindeer areas. The models help identifying optimal seasonal pastures and **understanding the drivers of movements**, which are the first step for planning sound mitigation measures to anthropogenic disturbance

INFERRING DIRECTIONS FOR MIGRATION

Based on the location of optimal pastures, we can infer past migrations among 5 reindeer areas, now isolated. These migrations occurred, and stopped in the '80 after the construction of a road and a railway