Predicting movement pathways with a-priori least cost models: The reintroduced Asiatic wild ass in Israel

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Introduction

Our knowledge of large scale animal movements in complex landscapes is very limited. Successfully reintroduced species offer a unique opportunity to study the effect of different landscape features on population range expansion. Understanding mechanisms affecting animal movement patterns is essential for predicting and conserving movement corridors between population core areas.

The Asiatic wild ass (Equus hemionus), an endangered species (IUCN), was reintroduced into the Israeli Negev desert between 1982-93. Currently the wild population is estimated at about 200 individuals, distributed throughout the Negev. Today there are three main population core areas and other smaller core areas

Research goal

Predict the movement pathways of the reintroduced Asiatic wild ass between population core areas in the Negev desert by understanding the effect of landscape factors on their movement patterns

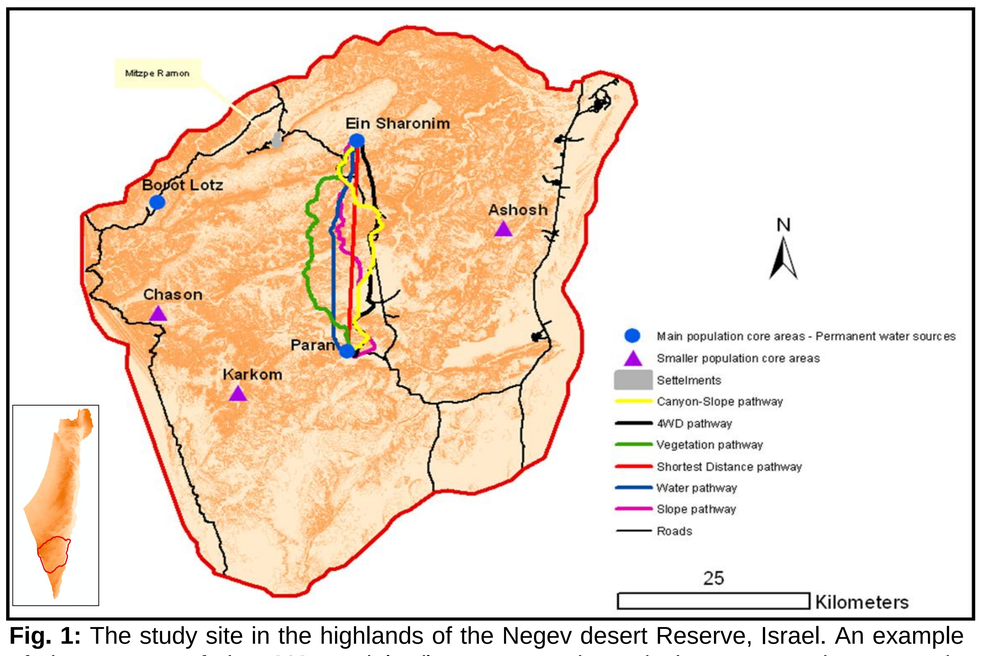


Fig. 1: The study site in the highlands of the Negev desert Reserve, Israel. An example of the outputs of the GIS models (least-cost pathways) that connect between Ein Sharonim population core areas to Paran population core area

Methods

1. We developed a set of 40 a-priori alternative models to explain the effect of landscape factors on the movement patterns of the wild ass.

2. We constructed six a-priori GIS models that took into account main landscape factors: **topography (slope, canyons), vegetation, water sources and 4WD trails**. The outputs were least cost pathways that connect between one population core area to another (Fig. 1).

3. We surveyed the field dung density using transects along each lest-cost pathway, as an index of pathway use.

4. We characterized each of the surveyed transects by: a) the total feces count along it; and b) the relevant landscape factors.

5. We combined the transects, their feces counts and their landscape characteristics, and grouped them into three data sets: a) “Entire terrain”: transects from the whole study site (n=128); b) “Open landscape”: transects that are not from the mountain ridges (n=74); c) “Landscape barriers”: only transects from mountain ridges (n=54).

6. We constructed General Linear Models (GLMs) from the three data sets. We selected the best a-priori models that fitted the empirical data the best using a model selection approach.

Results

Model selection of the a-priori models – For the “open landscape“ (Table 1) and “entire terrain” data sets the GLMs that gave the best fit to the data included vegetation coverage and distance from water sources . However, in order to study long distance movement pathways, we analyzed only transects in mountain ridges (landscape barriers). This analysis showed that for the “Landscape barriers” the best GLMs included canyons and 4WD trails (Table 2).

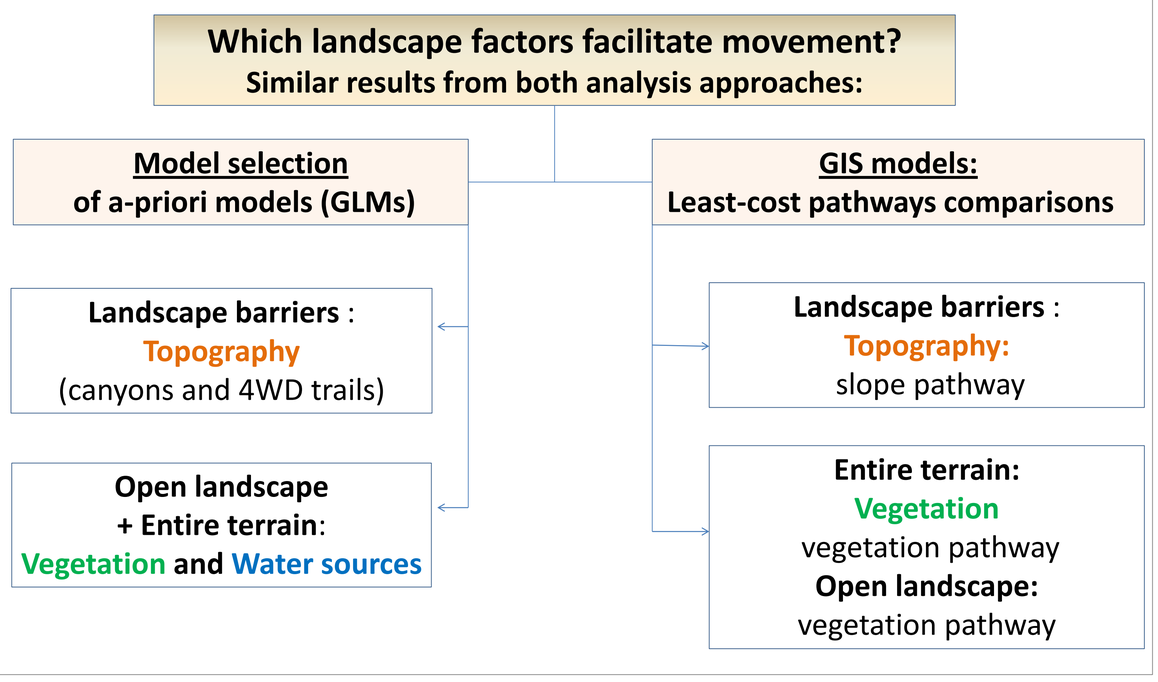
Comparing least-cost pathways - For the “entire terrain” dataset the best least-cost pathway was the vegetation coverage model (Kruskal-Wallis test H (5) = 13.29, P=0.02). Likewise, in the “open landscape“, the most used least cost pathway (though not significantly, P=0.08) was the vegetation pathway. However, in the “landscape barriers” the most used least cost pathway was the slope pathway (P=0.059).

Table 1: A-priori models sorted by AICc and model weight for “open landscape“ (n=74). Interactions are indicated with a colon (:). K: number of model parameters.

Rank	Model structure	K	AICc	Δ AICc	Weight	R2
1	vegetation+water+slope	5	631.2	1	0.360	0.46
2	vegetation+water	4	632.4	1.2	0.198	0.41
3	vegetation+water+slope+water:vegetation	6	633.2	2	0.133	0.46

Table 2: A-priori models sorted by AICc and model weight for “Landscape barriers” (n=54). Interactions are indicated with a colon (:). K: number of model parameters.

Rank	Model structure	K	AICc	Δ AICc	Weight	R2
1	canyon+4WD+water+water:4WD+4WD:canyon	7	410.1	0	0.418	0.43
2	canyon+4WD+vegetation+vegetation:4WD+4WD:canyon	7	411.6	1.5	0.197	0.39
3	4WD+canyon+slope+slope:4WD	6	414.8	4.7	0.040	0.28



Conclusions

1. A few landscape factors have a considerable effect on the wild ass movement, but the type and magnitude of the effect is a function of the terrain. In open landscapes – vegetation and water sources are preferred whereas in mountain ridges (landscape barriers) – canyons with no 4WD trails are preferred.
2. The models that had the best fit to the empirical data could be used to predict movement pathways of the wild ass that connect between population core areas.
3. Our method based on least-cost models, feces surveys and strategy of model selection enabled the assessment of complex landscape factors that facilitate wild ass movements. This new original methodology could be used for non-invasive ecological studies of animal movement.

Conservation implications

The identification of landscape factors that affect movement, as well as important pathways, could facilitate the selection of appropriate movement corridors. These findings should be considered in the conservation and management of the endangered Asiatic Wild Ass.

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