Which Mountain Pastures Matter?
Fine-scale selection within pastoral systems by a mountain bird of conservation concern: The Rock Partridge (*Alectoris graeca*)

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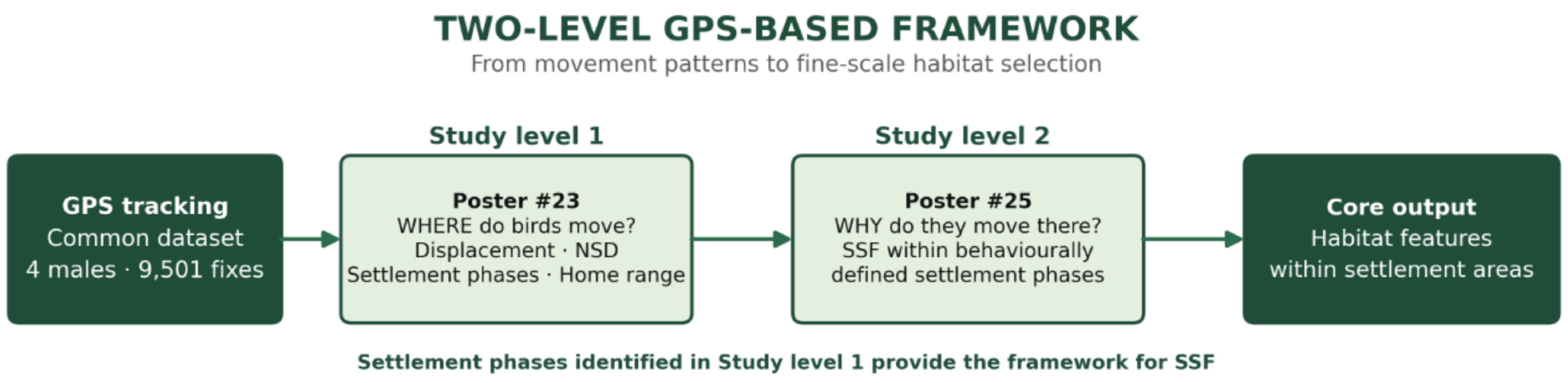
4 GPS-tagged males RPs	9501 GPS fixes	Frequency 1 fix/15-60 minutes	2 Behavioural groups	2 Settlement phases	20 Available steps per used step

BACKGROUND AND STUDY RATIONALE

Mountain grasslands and traditional pastoral systems are key habitats for the Rock Partridge (*Alectoris graeca* Meisner, 1804), a mountain Galliform of conservation concern in Europe [1]. These landscapes are **increasingly affected by grazing reduction**, shrub encroachment and forest expansion [2]. Using data from four GPS-tagged male birds, we developed a two-level GPS-based analytical framework:

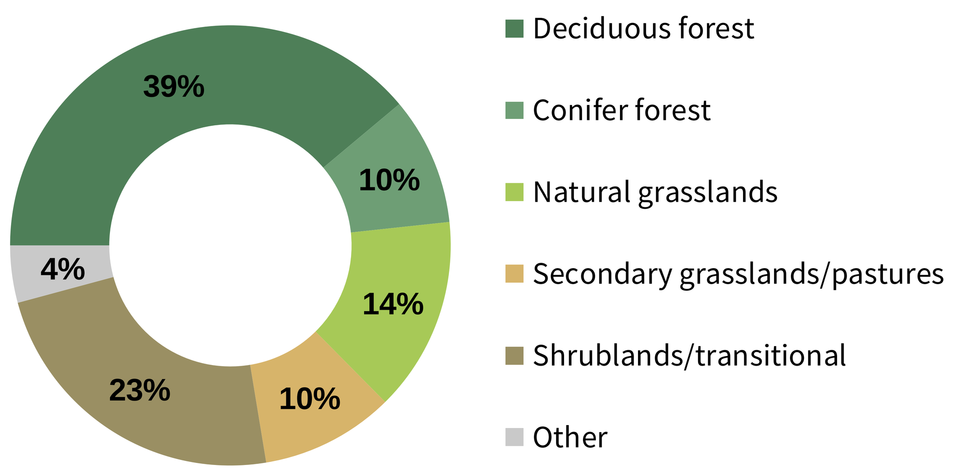
- **Study level 1 – Poster #23** quantified **movement behaviour and space use**, showing contrasting strategies: juveniles were largely resident, whereas adults showed settlement shifts and displacements up to 14.5 km. Resident phases occurred in mosaic landscapes where open grasslands co-occurred with shrub and woodland patches;
- **Study level 2 – Poster #25** applied a **Step Selection Functions (SSF)** within settlement phases, moving from space-use description to **fine-scale habitat-selection analysis**.

AIM



STUDY AREA & LANDSCAPE CONTEXT

Monti Sibillini National Park, Central Apennines, Umbria and Marche regions, Italy. Location: 42.904° N, 13.201° E. Protected area: ~700 km². Elevation range: ~900–2500 m a.s.l. The landscape is characterised by extensive sheep, horse and cattle grazing, mountain grasslands, shrub mosaics, deciduous forests, conifer forests and open–closed habitat interfaces.



Indicative land-cover composition derived from land-cover classification of the study area; values provide ecological context, not an official land-cover assessment of the entire protected area.

STUDY DESIGN AND ANALYTICAL FRAMEWORK

Habitat selection was investigated within settlement phases previously identified through Net Square Displacement (NSD) (poster 23). Observed movement steps were compared with movement-based available steps to evaluate which environmental conditions were associated with step selection [3] .

Tracking design

- 4 GPS-tagged males: 2 adult migrants + 2 juvenile residents;
- GPS fixes used to reconstruct movement trajectories;
- Analyses restricted to settlement phases

Settlement phases

- Identified through NSD
- Behavioural units for fine-scale inference
- Phase A ~ from May to mid June
- Phase B ~ from July to late Automn
- Only steps within the same settlement phase retained

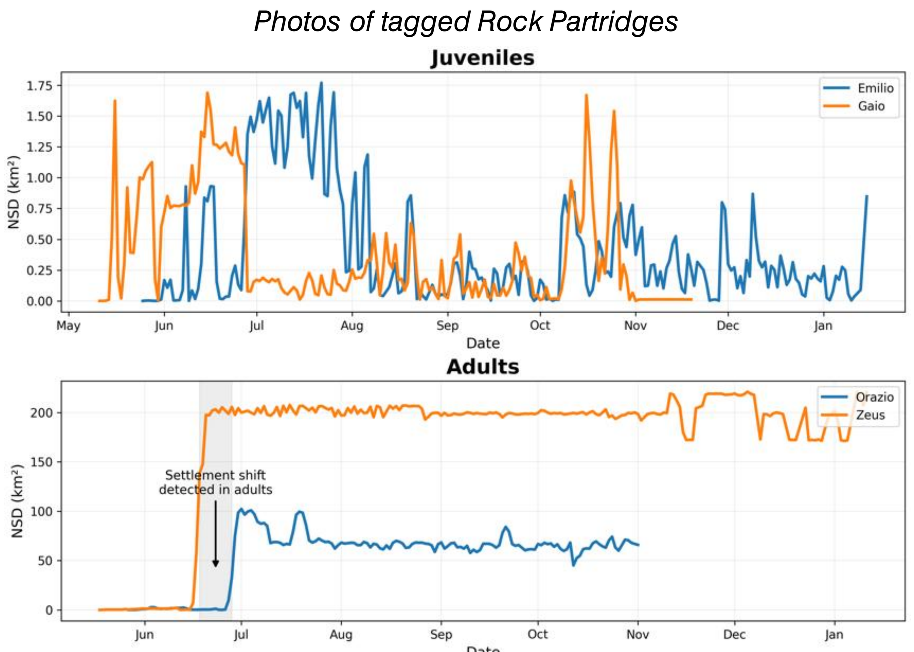
Step Selection Functions

- Used steps: GPS fix t → GPS fix t+1
- 20 available alternatives per used step
- Same starting point as observed step
- Step lengths and turning angles from empirical distributions [4]
- Conditional logistic regression

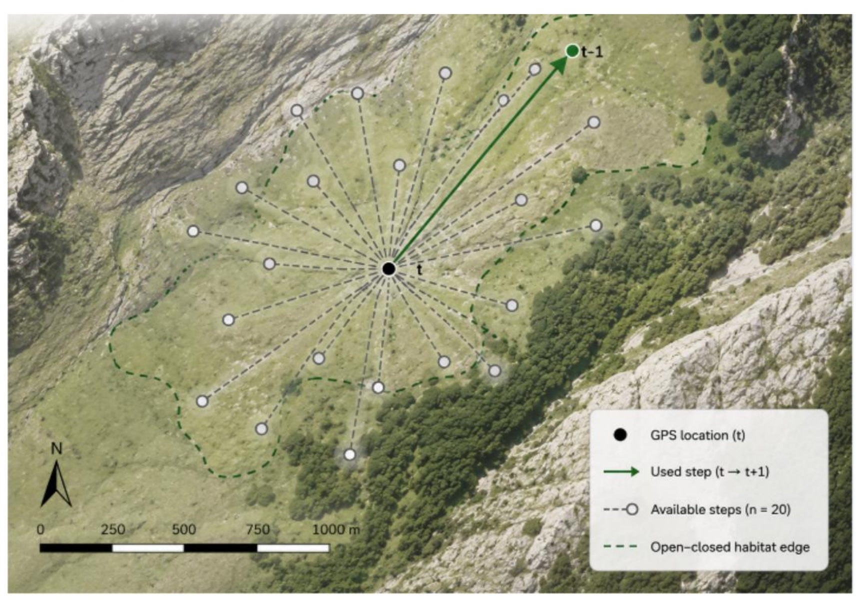
Environmental predictors

- Elevation (m a.s.l.)
- Slope (°)
- Northness (cos aspect)
- Land-cover class
- Distance to open–closed habitat edge (m)

Photos of tagged Rock Partridges



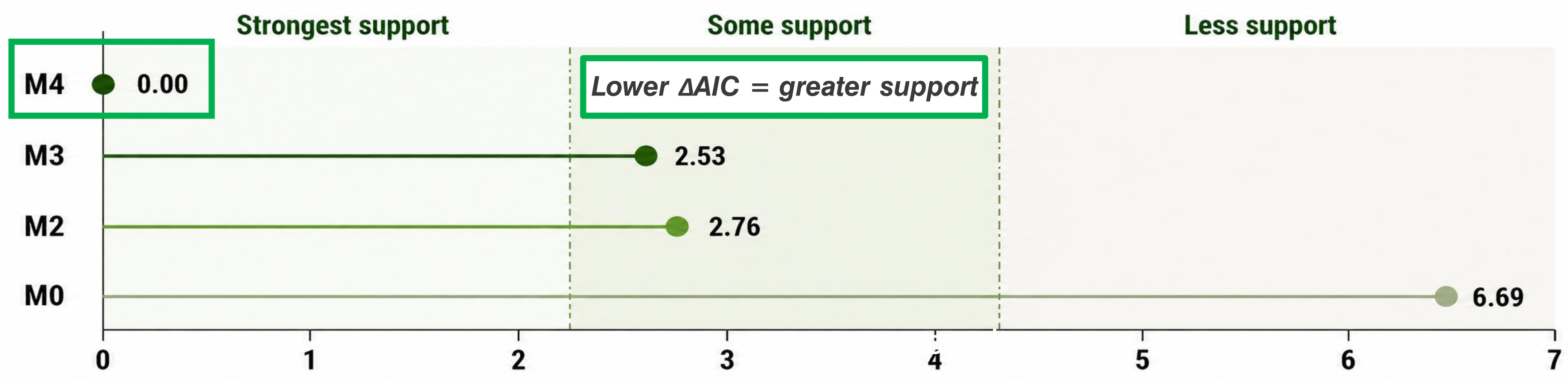
Net Square Displacement (NSD) for settlements identification



Step Selection Function (SSF) implementation

RESULTS — MODEL SELECTION

M0 represents the baseline SSF overall model, including land-cover class, topographic predictors and distance to open–closed habitat edges. **The best-supported model (M4) included both group and settlement phase.**



LIKELIHOOD RATIO TESTS (LRT)

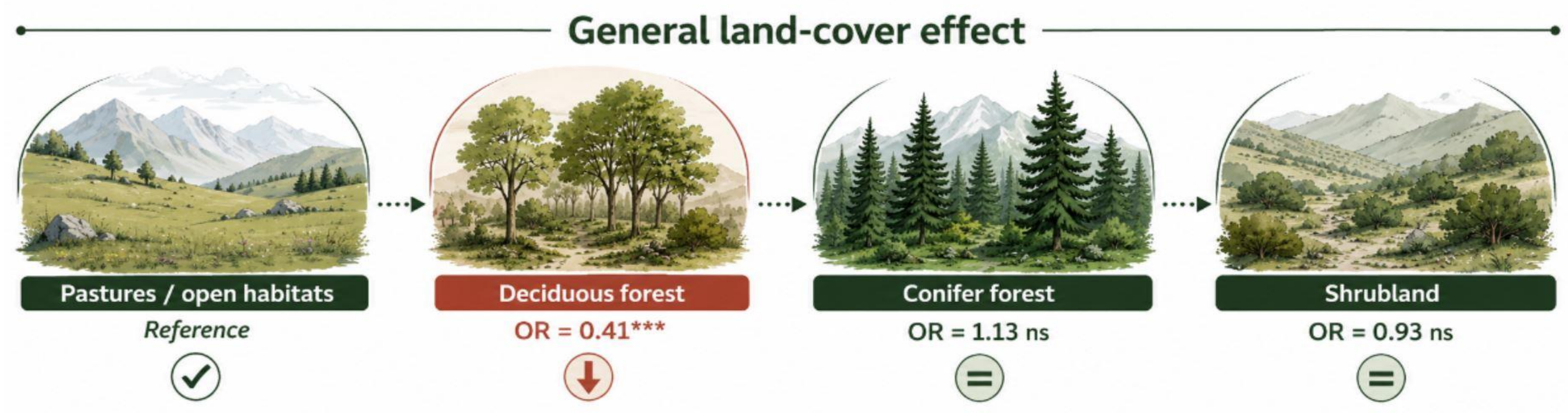
Model comparison	Added effect	χ^2	df	p-value
M0 vs M2	+ phase-specific effects	13.92	5	0.016
M0 vs M3	+ group-specific effects	14.15	5	0.015
M2 vs M4	+ group-specific effects	12.76	5	0.026
M3 vs M4	+ phase-specific effects	12.53	5	0.028
M0 vs M4	+ phase + group-specific effects	26.68	10	0.003

ODDS RATIO HEATMAP

Values above 1 indicate relative attraction; values below 1 indicate relative avoidance. Colour scale centred on OR = 1

Effect	Adult A	Adult B	Juvenile resident
Slope	2.08***	1.35***	1.38 ns
Elevation	0.74 ns	1.98***	2.04***
Distance to edge	0.80 ns	0.83***	0.97**

* p<0.05; ** p<0.01; *** p<0.001.



DISCUSSION AND MANAGEMENTI IMPLICATIONS

Odds ratios for continuous predictors refer to a +1 standard deviation increase:
~8° slope, ~140 m elevation, ~26 m distance to edge.
OR > 1 indicates selection for higher values; OR < 1 indicates selection for lower values.

1. DISCUSSION

- Adult migrants selected steeper terrain.
- During the later settlement phase, adults selected steps closer to open–closed habitat edges.
- Juvenile residents showed stronger elevation–related selection within their resident range, but weaker responses to slope and habitat configuration.
- Overall, fine–scale decisions were more strongly associated with topography and habitat configuration than with land–cover class alone.

2. HABITAT CONTEXT

- Pastures were the reference land–cover class and were used approximately in proportion to availability (OR = 0.99).
- Relative to this baseline, deciduous forests were avoided.
- Conifer forests and shrublands did not differ significantly from pastures.

3. LIMITS

- Phase– and group–specific contrasts are preliminary and should be interpreted cautiously.
- GPS fix frequency was not perfectly standardized among periods, a common limitation of solar–powered GPS tags.
- Within–period SSF inference remains informative.

4. MANAGEMENT IMPLICATIONS

- Not all mountain pastures are functionally equivalent.
- Conservation should prioritize heterogeneous pastoral mosaics.
- Maintain open grasslands interspersed with shrub or woodland patches, steep terrain, elevation gradients, and open–closed habitat edges.
- Further tracking data from a larger sample, including females and more standardized fix intervals, are needed to strengthen inference.

References

[1] BirdLife International. 2021. Alectoris graeca. The IUCN Red List of Threatened Species.
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[3] Thurfjell H., Ciuti S., Boyce M.S. 2014.. Movement Ecology, 2:4.DOI: 10.1186/2051-3933-2-4
[4] Avgar T. et al., 2016. Methods in Ecology and Evolution, 7:619–630.DOI: 10.1111/2041-210X.12528

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