Supplementary Materials

Behavioural thermoregulation via microhabitat selection of winter sleeping areas in an endangered primate: Implications for habitat conservation

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Table S1: Weather measurements (± SD, where applicable) over the study period. Values obtained for Azrou, Morocco (1250 m a.s.l.) from www.meteoblue.com for 1st January to 16th April, 2015.

| Month  | Average overnight temperature (°C) | Minimum overnight temperature (°C) | Average overnight precipitation (mm) | Average overnight snowfall (mm) | Average overnight wind speed (m/s) | Maximum overnight wind speed (m/s) |
|--------|-----------------------------------|-----------------------------------|-------------------------------------|---------------------------------|-----------------------------------|-----------------------------------|
| January| 6.33 ± 3.47                       | -2.6                              | 3.80 ± 7.05                         | 1.16 ± 2.83                     | 4.57 ± 2.74                       | 14.2                              |
| February| 4.24 ± 2.28                      | -3.7                              | 1.02 ± 2.11                         | 0.34 ± 0.92                     | 4.03 ± 2.89                       | 18.2                              |
| March  | 9.30 ± 3.73                       | -0.2                              | 2.17 ± 5.02                         | 0.51 ± 1.69                     | 3.45 ± 1.68                       | 10.9                              |
| April  | 13.67 ± 2.83                      | 7.0                               | 0.94 ± 3.22                         | 0.00 ± 0.00                     | 2.62 ± 1.11                       | 6.2                               |

Table S2: Results from logistic models assessing whether there was a credible difference between Blue Group (BG) and Green Group (GG) in either the observed or expected proportion of use of areas with different topographies as sleeping sites, estimated following a Bayesian approach.

### Observed Use

| Topography | BG Mean [95% HDI] | GG Mean [95% HDI] | Difference Mean [95% HDI] | Credible Non-Zero Difference |
|------------|------------------|------------------|--------------------------|-----------------------------|
| Flat       | 0.523 [0.376, 0.671] | 0.425 [0.274, 0.574] | 0.098 [-0.117, 0.307] | No                          |
| Valley     | 0.429 [0.282, 0.577] | 0.425 [0.274, 0.577] | 0.003 [-0.214, 0.208] | No                          |
| Hillside   | 0.072 [0.009, 0.149] | 0.175 [0.066, 0.292] | -0.103 [-0.248, 0.034] | No                          |

### Expected Use

| Topography | BG Mean [95% HDI] | GG Mean [95% HDI] | Difference Mean [95% HDI] | Credible Non-Zero Difference |
|------------|------------------|------------------|--------------------------|-----------------------------|
| Flat       | 0.632 [0.420, 0.834] | 0.541 [0.345, 0.732] | 0.090 [-0.205, 0.371] | No                          |
| Valley     | 0.105 [0.003, 0.238] | 0.042 [0.000, 0.122] | 0.063 [-0.080, 0.240] | No                          |
| Hillside   | 0.315 [0.123, 0.518] | 0.458 [0.264, 0.651] | -0.143 [-0.415, 0.145] | No                          |
Table S3: Standardized parameter estimates from logistic regression models assessing whether there was a credible difference between the two study groups in any variables relating to sleeping site plots, forest tree plots, or sleeping trees, estimated following a Bayesian approach.

| Variable                  | Mean   | SD     | 2.5% HDI | 97.5% HDI | ESS     | Credible Non-Zero Difference |
|---------------------------|--------|--------|----------|-----------|---------|-----------------------------|
| **Sleeping Site Plots**   |        |        |          |           |         |                             |
| Intercept                 | -1.116 | 0.697  | -2.651   | 0.165     | 27310   | No                          |
| Cedar Density             | -0.872 | 0.842  | -2.552   | 0.761     | 27555   | No                          |
| Total Tree Density        | 1.218  | 0.726  | -0.136   | 2.681     | 26289   | No                          |
| Average DBH               | -0.572 | 0.650  | -1.888   | 0.698     | 27587   | No                          |
| Average Upper Branching   | -0.307 | 1.239  | -2.742   | 2.170     | 27199   | No                          |
| Average Lower Branching   | 2.416  | 1.334  | -0.095   | 5.079     | 27387   | No                          |
| **Forest Tree Plots**     |        |        |          |           |         |                             |
| Intercept                 | -0.070 | 0.557  | -1.151   | 1.053     | 26977   | No                          |
| Cedar Density             | -0.802 | 0.768  | -2.355   | 0.668     | 28127   | No                          |
| Total Tree Density        | 1.353  | 0.803  | -0.166   | 2.946     | 26835   | No                          |
| Average DBH               | -0.686 | 0.764  | -2.196   | 0.832     | 27136   | No                          |
| Average Upper Branching   | -0.375 | 1.529  | -3.334   | 2.665     | 26453   | No                          |
| Average Lower Branching   | 2.865  | 1.589  | -0.226   | 5.981     | 26114   | No                          |
| **Sleeping Trees**        |        |        |          |           |         |                             |
| Intercept                 | -0.559 | 2.168  | -4.832   | 3.701     | 25058   | No                          |
| DBH                       | -0.131 | 0.885  | -1.898   | 1.581     | 29800   | No                          |
| Upper Branching           | 0.175  | 0.908  | -1.583   | 1.970     | 30000   | No                          |
| Lower Branching           | -0.156 | 0.880  | -1.882   | 1.568     | 30000   | No                          |
| Random Effect Variance    | 9.220  | 0.689  | 7.819    | 10.000    | 29256   | *                           |

Figure S1: MCMC chain traceplots from logistic GLM assessing the difference in forest characteristics between sleeping sites and forest plots. A sampled parameter value of zero is indicated by the red line. ESS for all parameters > 29,000.
Figure S2: MCMC chain traceplots from logistic GLMM assessing differences between sleeping trees and non-sleeping trees within a sleeping site. A sampled value of zero is indicated by the red line. ESS for all parameters > 30,000.

Figure S3: Posterior predictive check of (a) Logistic GLM comparing sleeping site tree plots to forest tree plots and (b) Logistic GLMM comparing sleeping trees and non-sleeping tree within a sleeping site, including the raw data points (black) and simulated data points from the fitted model (grey). The simulated values are shown slightly above the raw data and random jittering has been added along the x-axis to aid visualization.
Figure S4: Posterior distributions from logistic GLM assessing the difference in forest characteristics between sleeping sites and forest plots, including the 95% highest density interval. A parameter value of zero is indicated by the vertical red line.

Figure S5: Posterior distributions from GLMM assessing differences between sleeping trees and non-sleeping trees within a sleeping site.
Table S4: Standardized regression parameter estimates from logistic model comparing a subset of sleeping tree plots and forest tree plots with only flat topography (n=32), estimated following a Bayesian approach, including the mean, standard deviation (SD) and 95% highest density interval (HDI) of the posterior distribution.

| Variable                  | Mean  | SD    | 2.5% HDI | 97.5% HDI | ESS  | Credible Non-Zero Effect |
|---------------------------|-------|-------|----------|-----------|------|--------------------------|
| Intercept                 | -0.814| 1.002 | -2.840   | 1.091     | 26066|                          |
| Cedar Density             | 3.055 | 1.109 | 1.040    | 5.258     | 23187*|                          |
| Total Tree Density        | -2.056| 1.508 | -5.135   | 0.457     | 24891|                          |
| Average DBH               | 1.845 | 0.940 | 0.058    | 3.684     | 25091*|                          |
| Average Upper Branching   | -0.669| 1.062 | -2.814   | 1.377     | 27331|                          |
| Average Lower Branching   | -1.347| 1.059 | -3.496   | 0.643     | 26016|                          |

* Credible non-zero effect (0 not contained in the 95% HDI)

Figure S6: Logistic curves showing the predicted probability (posterior distribution mean ± 95% HDI) of an area of forest being used as a sleeping site by Barbary macaques as a function of a) Atlas cedar density (ha\(^{-1}\)) and b) average Atlas cedar diameter at breast height (DBH, cm), given average values of the other covariates, when considering only a subset of the data with flat topography.