|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **T****able S1.** Summary of installation scenarios for biased random walk simulations to test the reliability of the REST model. | | | | | | | | | |
| ID | Biased random walk\*1 | Step interval\*2 | Solitary/pairs | Activity proportion\*3 | | Activity syn.\*4 | Outliers of staying time\*5 | Speed variations\*6 | Censored (%) |
| ins. 1-1 | Y | 15 min | Solitary | Known | 0.5 | Y | - | N | 0 |
| ins. 1-2 | Y | 15 min | Solitary | Known | 0.5 | Y | - | Y | 0 |
| ins. 1-3 | Y | 15 min | Pairs | Unknown | 0.5 | Y | - | N | 0 |
| ins. 2-1 | Y | 15 min | Solitary | Unknown | 0.45 | Y | Used | N | 0 |
| ins. 2-2 | Y | 15 min | Solitary | Unknown | 0.45 | Y | Removed | N | 0 |
| ins. 2-3 | Y | 15 min | Solitary | Unknown | 0.45 | N | Removed | N | 0 |
| ins. 3-1 | Y | 15 min | Solitary | Known | 0.5 | Y | - | N | 10 |
| ins. 3-2 | Y | 15 min | Solitary | Known | 0.5 | Y | - | N | 25 |
| ins. 4 | N | 2 sec. | Solitary | Known | 0.5 | Y | - | N | 0 |
| \*1Biased random walk indicates the direction of the animal movement at each step was biased toward the home range centre. | | | | | | | | | |
| \*2Step intervals at which animals changed the speed and direction of movements. | | | | | | | | | |
| \*3Proportion of time that the animal spends active within a day. Known/Unknown indicates whether the proportion was treated as a known variable or was estimated using the method of Rowcliffe *et al.* (2014). For additional details, see the main text. | | | | | | | | | |
| \*4Activity synchronization among individuals. Y assumes that all individuals are active at the peak of the daily activity cycle. | | | | | | | | | |
| \*5Treatments with outliers for staying time. For additional details, see the main text. | | | | | | | | | |
| \*6Variation in animal travel speed among individuals. Y (Ins. 1-2) assumes that mean travel distance of each individual followed a lognormal distribution with a mean (± SD) of 62.5 ± 50.0 m. SD indicates the standard deviation of each distribution model. | | | | | | | | | |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **T****able S2.** Details of installation scenarios for biased random walk simulations to test the reliability of the REST model. | | | | | | | | | |
| ID | Movement speed\*1 | Travel distance per step (m)\*2 | | | | | Direction of animal movement | | 95% MCP (ha)\*7 |
| *Μ* | σ2 | (Mean ± SD\*3) | | | *K*\*5 | Mean ± SD\*6 | (mean ± SD\*2) |
| ins. 1-1 | - | 3.89 | 0.7 | 62.5 | ± | 50 | 0.69 | - | 40.8 ± 8.5 |
| ins. 1-2 | - | 3.89 | 0.7 | 62.5\*4 | ± | 50 | 0.69 | - | 43.2 ± 12.1 |
| ins. 1-3 | - | 3.89 | 0.7 | 62.5 | ± | 50 | 0.69 | - | 40.8 ± 8.5 |
| ins. 2-1 | - | 4.00 | 0.64 | 69.9 | ± | 50 | 0.70 | - | 41.0 ± 10.8 |
| ins. 2-2 | - | 4.00 | 0.64 | 69.9 | ± | 50 | 0.70 | - | 41.0 ± 10.8 |
| ins. 2-3 | - | 4.00 | 0.64 | 69.9 | ± | 50 | 0.70 | - | 41.0 ± 10.8 |
| ins. 3-1 | - | 3.89 | 0.7 | 62.5 | ± | 50 | 0.69 | - | 40.8 ± 8.5 |
| ins. 3-2 | - | 3.89 | 0.7 | 62.5 | ± | 50 | 0.69 | - | 40.8 ± 8.5 |
| ins. 4 | Rapid | 0.00 | 0.09 | 1.046 | ± | 0.103 | - | 0.0 ± 0.3 | - |
|  | Slow | -1.61 | 0.09 | 0.209 | ± | 0.004 | - | 0.0 ± 8.0 | - |
| \*1Variation in animal movement speed. Rapid phase continued 144 min, whereas slow phase continued 236 min. Animals repeated the phased during a day. | | | | | | | | | |
| \*2Travel distance per step followed the lognormal distribution. | | | | | | | | | |
| \*3SD indicates the standard deviation of each distribution. | | | | | | | | | |
| \*4The mean travel distance of each individual followed a lognormal distribution with a mean (± SD) of 62.5 ± 50.0 m. | | | | | | | | | |
| \*5Concentration parameter of the Von Mises distribution to determine the direction of animal movements. | | | | | | | | | |
| \*6Turn angle of animal movement followed a normal distribution. SD indicates the standard deviation. | | | | | | | | | |
| \*7MCP indicates the minimum convex polygon home range (ha). | | | | | | | | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **T****able S3.** Number of sightings (N), estimated group density (D), and the 95% confidence interval (CI) of D by the distance sampling approach based on line-transect surveys for the two duiker groups in the Moukalaba-Doudou National Park, Gabon, Africa. | | | | | | | | | | | | | | | | |
| Forest types1 | Number of surveys | Blue duikers | | | | |  | | Red duikers | | | | | | | |
| N | D km-2 | 95% CI | | | |  | | N | | D km-2 | | 95% CI | | |
| SW | 25 | 29 | 15 | 10.7 | – | 20.9 |  | | 16 | | 5.7 | | 3.8 | | – | 8.6 |
| YS | 23 | 16 | 9 | 5.5 | – | 14.7 |  | | 8 | | 3.1 | | 1.6 | | – | 6 |
| GL | 19 | 17 | 11.6 | 6.4 | – | 21 |  | | 2 | | 0.9 | | 0.3 | | – | 3.2 |
| PR | 23 | 14 | 7.9 | 3.9 | – | 15.8 |  | | 27 | | 10.4 | | 6.9 | | – | 15.8 |
| OS | 21 | 24 | 14.8 | 9.3 | – | 23.3 |  | | 27 | | 11.4 | | 8 | | – | 16.2 |
| 1SW: Swamp; YS: Young secondary; GL: Gallery; PR: Primary; OS: Old secondary. | | | | | | | | | | | | | | | | |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **T****able S4.** Summary of the Monte Carlo biased random walk simulations. Results are the number of successful fits of the REST models (*N*) among the 500 iterations, the mean and median of estimated densities, and credible interval (CI) coverage of the densities. Parameter estimation of the REST model was performed using the Markov chain Monte Carlo (MCMC) method, and their variances and credible limits were calculated as the posterior summary. | | | | | | |
| ID | *N* |  | Density estimates km-2 | |  | CI |
|  | Mean | Median |  | Coverage (%) |
| ins. 1-1 | 499 |  | 10.09 | 9.89 |  | 95.2 |
| ins. 1-2 | 500 |  | 10.15 | 9.83 |  | 94.2 |
| ins. 1-3 | 500 |  | 10.28 | 10.19 |  | 95.8 |
| ins. 2-1 | 500 |  | 11.93 | 10.98 |  | 80.6 |
| ins. 2-2 | 500 |  | 10.09 | 9.84 |  | 89 |
| ins. 2-3 | 499 |  | 7.46 | 7.82 |  | 24.5 |
| ins. 3-1 | 499 |  | 9.97 | 9.85 |  | 94.6 |
| ins. 3-2 | 499 |  | 9.09 | 9.36 |  | 94.2 |
| ins. 4 | 500 |  | 9.93 | 9.79 |  | 94.0 |

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **T****able S5.** Values of WAIC (Watanabe-Akaike widely applicable information criterion, Watanabe 2013) after fitting four temporal distributions to the staying time in front of cameras and the number of videos of two duiker groups at five transects located in different forest types in the Moukalaba-Doudou National Park, Gabon, Africa. Minimum values are shown in bold. | | | | | | | | | | | |
| Species | Focal area | Vegetation\*1 | Sample size\*2 | Staying time | | | |  | Sample size\*2 | *N* of videos | |
| Exponential | Gamma | Lognormal | Weibull |  | Poisson | Negative binomial |
| Blue duikers | Larger | SW | 64 | 366.6 | 363.8 | **354.8** | 367 |  | 240 | 506.9 | **183.1** |
|  |  | YS | 46 | 275.6 | **265.2** | 265.3 | 267.5 |  | 176 | 268.4 | **157.9** |
|  |  | GL | 68 | 425.1 | 427.1 | **423.4** | 427.3 |  | 218 | 275.3 | **183.2** |
|  |  | PR | 64 | 370.2 | 372.2 | **363.7** | 372.1 |  | 168 | 395.5 | **169.0** |
|  |  | OS | 82 | **454.8** | 456.5 | 460.5 | 456.9 |  | 371 | 783.0 | **185.4** |
|  | Smaller | SW | 64 | 326.4 | 331.3 | **316.5** | 334.9 |  | 132 | 274.3 | **152.0** |
|  |  | YS | 46 | 207.4 | **203.3** | 204 | 205.1 |  | 98 | 171.7 | **130.6** |
|  |  | GL | 68 | 336.8 | 353.4 | **317.3** | 385.6 |  | 125 | 200.1 | **156.1** |
|  |  | PR | 64 | 323 | 326.4 | **307.8** | 329 |  | 109 | 262.9 | **146.5** |
|  |  | OS | 82 | **325.9** | 327 | 327.2 | 326.5 |  | 158 | 293.4 | **147.8** |
| Red duikers | Larger | SW | 13 | 80.9 | 80.4 | **77.5** | 81.3 |  | 58 | 157.7 | **112.0** |
|  |  | YS | 10 | **64.4** | 66.7 | 73.1 | 67.2 |  | 35 | 96.6 | **92.1** |
|  |  | GL | 9 | **50.7** | 52.3 | 51.5 | 52.3 |  | 27 | 88.8 | **86.3** |
|  |  | PR | 46 | 246 | 246.6 | **240.8** | 245 |  | 177 | 248.4 | **169.6** |
|  |  | OS | 53 | 306.6 | 306 | **304.1** | 307.4 |  | 202 | 292.5 | **155.3** |
|  | Smaller | SW | 13 | **63.2** | 64.7 | 68.3 | 65.4 |  | 25 | 79.1 | **78.1** |
|  |  | YS | 10 | **54** | 56.1 | 59.9 | 56.6 |  | 17 | 58.5 | **58.4** |
|  |  | GL | 9 | **39.4** | 41 | 40.2 | 40.9 |  | 13 | 59.6 | **58.7** |
|  |  | PR | 46 | 212.5 | 214.4 | **208.8** | 216.7 |  | 83 | 138.2 | **131.3** |
|  |  | OS | 53 | **244.4** | 245.9 | 253.8 | 245.9 |  | 119 | 181.1 | **131.1** |
| \*1SW: Swamp; YS: Young secondary; GL: Gallery; PR: Primary; OS: Old secondary. | | | | | | | | | | | |
| \*2Sample size used for the estimation of parameters. | | | | | | | | | | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **T****able S6.** Results of goodness-of-fit test on the duikers' staying time in lager focal areas using Lilliefors-corrected Kolmogorov-Smirnoff test in the Moukalaba-Doudou National Park, Gabon, Africa. *P*-values of the distribution of the highest WAIC values were shown in bold. | | | | | | | | | | | | | |
| Species | Focal area | Vegetation\*1 | Exponential | |  | Gamma | |  | Lognormal | |  | Weibull | |
| *D* | *P*-value |  | *D* | *P*-value |  | *D* | *P*-value |  | *D* | *P*-value |
| Blue duikers | Larger | SW | 0.060 | 0.014 |  | 0.082 | 0.326 |  | **0.098** | **0.778** |  | 0.082 | 0.170 |
|  |  | YS | 0.120 | 0.007 |  | **0.083** | **0.182** |  | 0.124 | 0.101 |  | 0.094 | 0.089 |
|  |  | GL | 0.130 | 0.600 |  | 0.079 | 0.124 |  | **0.097** | **0.040** |  | 0.072 | 0.122 |
|  |  | PR | 0.140 | 0.041 |  | 0.130 | 0.001 |  | **0.085** | **0.073** |  | 0.130 | 0.002 |
|  |  | OS | **0.102** | **0.073** |  | 0.099 | 0.155 |  | 0.118 | 0.002 |  | 0.091 | 0.133 |
|  | Smaller | SW | 0.060 | 0.926 |  | 0.082 | 0.397 |  | **0.098** | **0.126** |  | 0.082 | 0.326 |
|  |  | YS | 0.120 | 0.258 |  | **0.083** | **0.628** |  | 0.124 | 0.082 |  | 0.094 | 0.371 |
|  |  | GL | 0.130 | 0.042 |  | 0.079 | 0.368 |  | **0.097** | **0.129** |  | 0.072 | 0.521 |
|  |  | PR | 0.140 | 0.050 |  | 0.130 | 0.011 |  | **0.085** | **0.277** |  | 0.130 | 0.010 |
|  |  | OS | **0.102** | **0.132** |  | 0.099 | 0.063 |  | 0.118 | 0.009 |  | 0.091 | 0.095 |
| Red duikers | Larger | SW | 0.254 | 0.104 |  | 0.264 | 0.200 |  | **0.288** | **0.410** |  | 0.259 | 0.134 |
|  |  | YS | **0.181** | **0.513** |  | 0.185 | 0.331 |  | 0.246 | 0.072 |  | 0.180 | 0.320 |
|  |  | GL | **0.160** | **0.908** |  | 0.174 | 0.723 |  | 0.124 | 0.975 |  | 0.170 | 0.730 |
|  |  | PR | 0.097 | 0.968 |  | 0.098 | 0.992 |  | **0.140** | **0.115** |  | 0.098 | 0.999 |
|  |  | OS | 0.072 | 0.173 |  | 0.064 | 0.641 |  | **0.122** | **0.047** |  | 0.065 | 0.888 |
|  | Smaller | SW | **0.254** | **0.136** |  | 0.264 | 0.024 |  | 0.288 | 0.006 |  | 0.259 | 0.012 |
|  |  | YS | **0.181** | **0.659** |  | 0.185 | 0.485 |  | 0.246 | 0.093 |  | 0.180 | 0.500 |
|  |  | GL | **0.160** | **0.890** |  | 0.174 | 0.676 |  | 0.124 | 0.961 |  | 0.170 | 0.680 |
|  |  | PR | 0.097 | 0.560 |  | 0.098 | 0.364 |  | **0.140** | **0.022** |  | 0.098 | 0.332 |
|  |  | OS | **0.072** | **0.849** |  | 0.064 | 0.861 |  | 0.122 | 0.056 |  | 0.065 | 0.829 |
| \*1SW: Swamp; YS: Young secondary; GL: Gallery; PR: Primary; OS: Old secondary. | | | | | | | | | | | | | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **T****able S7.** Summary of density estimation by the REST model for the two duiker groups studied in the Moukalaba-Doudou National Park, Gabon, Africa. | | | | | | | | | | | | | | | | | | | | | | | | | |
| Species | Focal area | Forest types\*1 | Activity proportion | Distribution | Staying time | | | | | | | | |  | | *N* of videos | | | | | | | Density km-2 | | |
|  | Mean | ± | SD\*2 |  | Mean | ± | SD\*2 |  | | lambda | | ± | SD\*2 | alpha | ± | SD\*2 | Mean | | ± | SD\*2 |
| Blue duikers | Larger | SW | 0.32 | Lognormal | mu | 1.58 | ± | 0.11 | tau | 1.37 | ± | 0.24 |  | | 8.27 | | ± | 1.70 | 0.92 | ± | 0.28 | 15.89 | | ± | 3.77 |
|  |  | YS | 0.37 | Gamma | shape | 2.26 | ± | 0.44 | rate | 0.31 | ± | 0.07 |  | | 6.70 | | ± | 1.24 | 1.51 | ± | 0.53 | 11.48 | | ± | 2.43 |
|  |  | GL | 0.41 | Lognormal | mu | 1.72 | ± | 0.13 | tau | 0.83 | ± | 0.14 |  | | 7.14 | | ± | 0.96 | 2.53 | ± | 0.89 | 15.79 | | ± | 3.41 |
|  |  | PR | 0.42 | Lognormal | mu | 1.53 | ± | 0.13 | tau | 0.89 | ± | 0.16 |  | | 5.77 | | ± | 1.26 | 0.90 | ± | 0.29 | 9.86 | | ± | 2.73 |
|  |  | OS | 0.36 | Exponential | mu | 0.17 | ± | 0.02 | tau |  |  |  |  | | 14.82 | | ± | 2.61 | 1.44 | ± | 0.43 | 21.44 | | ± | 4.37 |
|  | Smaller | SW | - | Lognormal | mu | 0.88 | ± | 0.14 | tau | 0.80 | ± | 0.14 |  | | 4.39 | | ± | 0.94 | 0.92 | ± | 0.33 | 22.42 | | ± | 5.78 |
|  |  | YS | - | Gamma | shape | 1.69 | ± | 0.33 | rate | 0.47 | ± | 0.11 |  | | 3.69 | | ± | 0.69 | 1.82 | ± | 1.18 | 13.56 | | ± | 2.92 |
|  |  | GL | - | Lognormal | mu | 0.88 | ± | 0.12 | tau | 1.06 | ± | 0.18 |  | | 4.12 | | ± | 0.63 | 2.30 | ± | 1.05 | 14.53 | | ± | 3.08 |
|  |  | PR | - | Lognormal | mu | 1.03 | ± | 0.11 | tau | 1.23 | ± | 0.21 |  | | 3.66 | | ± | 0.81 | 0.93 | ± | 0.34 | 13.40 | | ± | 3.36 |
|  |  | OS | - | Exponential | lambda | 0.38 | ± | 0.04 |  |  |  |  |  | | 6.41 | | ± | 1.15 | 1.61 | ± | 0.56 | 15.90 | | ± | 3.30 |
| Red duikers | Larger | SW | 0.35 | Lognormal | mu | 1.79 | ± | 0.21 | tau | 2.07 | ± | 0.83 |  | | 2.13 | | ± | 0.55 | 0.91 | ± | 0.51 | 4.30 | | ± | 1.58 |
|  |  | YS | 0.40 | Exponential | lambda | 0.11 | ± | 0.04 |  |  |  |  |  | | 1.36 | | ± | 0.31 | 18.43 | ± | 27.05 | 2.83 | | ± | 1.18 |
|  |  | GL | 0.31 | Exponential | lambda | 0.19 | ± | 0.06 |  |  |  |  |  | | 0.91 | | ± | 0.20 | 31.51 | ± | 31.50 | 1.53 | | ± | 0.65 |
|  |  | PR | 0.44 | Lognormal | mu | 1.03 | ± | 0.20 | tau | 0.58 | ± | 0.12 |  | | 6.11 | | ± | 0.99 | 1.93 | ± | 0.70 | 8.64 | | ± | 2.76 |
|  |  | OS | 0.35 | Lognormal | mu | 1.52 | ± | 0.13 | tau | 1.09 | ± | 0.21 |  | | 8.27 | | ± | 1.41 | 1.85 | ± | 0.64 | 15.05 | | ± | 3.47 |
|  | Smaller | SW | - | Exponential | lambda | 0.26 | ± | 0.07 |  |  |  |  |  | | 0.88 | | ± | 0.18 | 40.79 | ± | 30.80 | 3.90 | | ± | 1.40 |
|  |  | YS | - | Exponential | lambda | 0.20 | ± | 0.06 |  |  |  |  |  | | 0.65 | | ± | 0.16 | 50.67 | ± | 28.96 | 2.54 | | ± | 1.10 |
|  |  | GL | - | Exponential | lambda | 0.35 | ± | 0.11 |  |  |  |  |  | | 0.43 | | ± | 0.13 | 42.45 | ± | 31.08 | 1.63 | | ± | 0.76 |
|  |  | PR | - | Lognormal | mu | 0.35 | ± | 0.25 | tau | 0.56 | ± | 0.12 |  | | 2.85 | | ± | 0.40 | 17.09 | ± | 23.33 | 8.01 | | ± | 2.66 |
|  |  | OS | - | Exponential | lambda | 0.28 | ± | 0.04 |  |  |  |  |  | | 4.82 | | ± | 0.80 | 2.35 | ± | 1.11 | 16.77 | | ± | 3.54 |
| \*1SW: Swamp; YS: Young secondary; GL: Gallery; PR: Primary; OS: Old secondary | | | | | | | | | | | | | | | | | | | | | | | | | |
| \*2SD indicates the standard deviation of each distribution model. | | | | | | | | | | | | | | | | | | | | | | | | | |