Herpetological Journal SUPPLEMENTARY MATERIALS

Published by the British Herpetological Society

A stable home: Autocorrelated Kernel Density Estimated home ranges of the critically endangered Elongated tortoise

Ysabella Montano, Benjamin Michael Marshall, Matt Ward, Ines Silva, Taksin Artchawakom, Surachit Waengsothorn, Colin Thomas Strine

Supplementary Material

Supplementary material includes:

Table S1 - R packages used and citations.

Table S2 - Top movement model fits and effective sample sizes.

Table S3 - All movement model fits.

Figure S1 - Sampling of data points over the three years of tracking. Colours separate individual years, and are nudged (y) to aid differentiating years.

Figure S2 - Bar plot showing the time lag in hours between tracks, with median (dotted) and mean ±standard error (dashed) annotated.

Table S1 - R packages used and citations.

Use of package	Package, version, and citation
Data manipulation	dplyr v.1.0.2 (Wickham et al., 2020), lubridate v.1.7.9.2 (Grolemund & Wickham, 2011), stringr v.1.4.0 (Wickham, 2019), reshape2 v.1.4.4 (Wickham, 2007)
Home range estimation	rgdal v.1.5.18 (Bivand, Keitt, & Rowlingson, 2020), ctmm v.0.6.0 (Fleming & Calabrese, 2021), sp v.1.4.4 (Bivand, Pebesma, & Gomez-Rubio, 2013)
Bayesian modelling	bayesplot v.1.7.2 (Gabry et al., 2019), brms v.2.14.4 (Bürkner, 2018), performance v.0.6.1 (Lüdecke et al., 2020), tidybayes v.2.3.1 (Kay, 2020)
Visualisation	cowplot v.1.1.0 (Wilke 2020a), ggplot2 v.3.3.2 (Wickham 2016), scico v.1.2.0 (Pedersen & Crameri, 2020), scales v.4.0.3 (Wickham & Seidel 2020), ggpubr v.0.4.0 (Kassambara, 2020), ggspatial v.1.1.4 (Dunnington, 2020), ggridges v.0.5.2 (Wilke, 2020b)

Bivand, R.S., Pebesma, E. & Gomez-Rubio, V. (2013). Applied Spatial Data Analysis with R, Second Edition. Springer, NY. https://asdar-book.org/.

Bivand, R., Keitt, T. & Rowlingson, B. (2020). Rgdal: Bindings for the 'Geospatial' Data Abstraction Library. https://CRAN.R-project.org/package=rgdal.

Bürkner, P.C. (2018). Advanced Bayesian Multilevel Modeling with the R Package brms. *The R Journal* 10 (1): 395–411. https://doi.org/10.32614/RJ-2018-017.

Dunnington, D. (2020). Ggspatial: Spatial Data Framework for Ggplot2. https://CRAN.R-project.org/package=ggspatial.

Fleming, C.H. & Calabrese, J.M. (2021). Ctmm: Continuous-Time Movement Modeling. https://CRAN.R-project.org/package=ctmm.

Gabry, J., Simpson, D., Vehtari, A., Betancourt, M. & Gelman, A. (2019). Visualization in Bayesian Workflow. T*he Journal of the Royal Statistical Society A* 182: 389–402. https://doi.org/10.1111/rssa.12378.

Grolemund, G. & Wickham, H. (2011). Dates and Times Made Easy with lubridate. *Journal of Statistical Software* 40(3): 1–25. https://www.jstatsoft.org/v40/i03/.

Kassambara, A. (2020). Ggpubr: 'Ggplot2' Based Publication Ready Plots. https://CRAN.R-project.org/package=ggpubr.

Kay, M. (2020). tidybayes: Tidy Data and Geoms for Bayesian Models. https://doi.org/10.5281/zenodo.1308151.

Kranstauber, B., Cameron, A., Weinzierl, R., Fountain, T., Tilak, S., Wikelski, M. & Kays, R. (2011). The Movebank data model for animal tracking. Environ Model Softw. 26(6):834–835. DOI: 10.1016/j.envsoft.2010.12.005

Lüdecke, D., Makowski, D., Waggoner, P. & Patil, I. (2020). Performance: Assessment of

Regression Models Performance. CRAN. https://doi.org/10.5281/zenodo.3952174.

Pedersen, T.L. & Crameri, F. (2020). Scico: Colour Palettes Based on the Scientific Colour-Maps. https://CRAN.R-project.org/package=scico.

Wickham, H. (2007). Reshaping Data with the reshape Package. *Journal of Statistical Software* 21(12): 1–20. http://www.jstatsoft.org/v21/i12/.

Wickham, H. (2016). Ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag New York. https://ggplot2.tidyverse.org.

Wickham, H. (2019). Stringr: Simple, Consistent Wrappers for Common String Operations. https://CRAN.R-project.org/package=stringr.

Wickham, H., François, R., Henry, L. & Müller, K. (2020). Dplyr: A Grammar of Data Manipulation. https://CRAN.R-project.org/package=dplyr.

Wickham, H. & Seidel, D. (2020). Scales: Scale Functions for Visualization. https://CRAN.R-project.org/package=scales.

Wilke, C.O. (2020a). Cowplot: Streamlined Plot Theme and Plot Annotations for 'Ggplot2'. https://CRAN.R-project.org/package=cowplot.

Wickham, H. (2020b). Ggridges: Ridgeline Plots in 'Ggplot2'. https://CRAN.R-project.org/package=ggridges.

Table S2 - Top movement model fits and effective sample sizes. dRMSPE: root mean squared prediction error

ID	dRMSPE (m)	Effective sample size	Movement model	t (crossing time est.; days)
F01	33.624	27.880	OU anisotropic	9.830
F02	1507.207	32.406	OU isotropic	8.432
F03	33.994	19.081	OU anisotropic	14.444
F04	4.425	55.510	OU anisotropic	4.870
F05	21.393	39.396	OU anisotropic	14.071
F06	68.060	6.052	OU anisotropic	1.510
F08	175.805	3.389	OUF isotropic	2.369
F09	15.077	21.578	OU isotropic	12.870

F10	44.596	7.793	OU anisotropic	24.924
F12	54.938	4.894	OU anisotropic	1.073
F14	8.323	23.865	OU isotropic	10.702
F15	5.726	24.137	OU anisotropic	9.453
M01	17.963	47.951	OU anisotropic	5.559
M03	308.551	58.953	OU anisotropic	4.611
M04	25.342	33.578	OU anisotropic	8.641
M05	156.404	75.065	OU anisotropic	2.713
M06	39.709	19.654	OU anisotropic	11.011

Table S3 - All movement model fits. Model abbreviations: Ornstein-Uhlenbeck (OU), Ornstein–Uhlenbeck Foraging (OUF), and Independent Identically Distributed (IID). dRMSPE: *root mean squared prediction error*.

ID	Movement model	dAICc	dRMSPE (m)	Effective sample size
F01	OU anisotropic	0.000	33.624	27.880
F01	OUF anisotropic	2.093	26.715	33.326
F01	OU isotropic	22.806	30.828	32.089
F01	OUF isotropic	24.840	25.144	37.719
F01	OUF anisotropic	31.483	3.932	60.449
F01	IID anisotropic	120.676	0.000	4.022
F02	OU isotropic	0.000	15.072	32.406
F02	OU anisotropic	1.025	22.976	27.567
F02	OUF isotropic	2.050	11.010	37.852
F02	OUF anisotropic	3.141	17.711	32.993
F02	OUF isotropic	83.437	0.148	82.564
F02	OUF anisotropic	85.386	0.000	73.656
F02	IID anisotropic	150.039	5.957	111.331
F02	IID isotropic	178.560	5.957	110.000
F03	OU anisotropic	0.000	33.994	19.081
F03	OUF anisotropic	2.060	24.043	24.664
F03	OU isotropic	3.830	60.740	17.271
F03	OUF isotropic	5.813	48.561	23.113
F03	OUF anisotropic	100.788	0.000	66.586
F03	IID anisotropic	205.322	31.258	0.091

F04	OU anisotropic	0.000	4.425	55.510
F04	OUF anisotropic	2.112	4.408	58.015
F04	OU isotropic	7.123	2.479	57.605
F04	OUF anisotropic	9.160	1.677	78.111
F04	OUF isotropic	9.250	2.412	0.000
F04	IID anisotropic	125.744	0.000	120.359
F05	OU anisotropic	0.000	21.393	39.396
F05	OUF anisotropic	2.025	16.855	45.489
F05	OU isotropic	65.668	59.276	30.744
F05	OUF isotropic	67.642	52.226	36.980
F05	OUF anisotropic	128.598	0.000	123.822
F05	IID anisotropic	449.476	36.355	271.801
F06	OU anisotropic	0.000	68.060	6.052
F06	OUF anisotropic	1.304	65.475	6.589
F06	OU isotropic	8.939	118.995	5.054
F06	OUF isotropic	9.974	113.467	5.584
F06	OUF anisotropic	43.919	0.000	28.361
F06	IID anisotropic	276.214	9.472	1.539
F08	OUF isotropic	0.000	175.805	3.389
F08	OUF anisotropic	0.883	165.078	3.616
F08	OU isotropic	3.262	213.652	2.704
F08	OU anisotropic	4.252	199.564	2.865
F08	OUF isotropic	46.725	0.000	29.446
F08	OUF anisotropic	47.680	1.522	29.471
F09	OU isotropic	0.000	15.077	21.578
F09	OU anisotropic	1.488	16.640	19.648
F09	OUF isotropic	2.026	10.003	27.448
F09	OUF anisotropic	3.592	10.909	25.363
F09	OUF isotropic	27.047	1.772	51.849
F09	OUF anisotropic	29.286	0.000	46.758
F09	IID anisotropic	174.144	6.239	97.592

F09	IID isotropic	201.718	6.239	101.000
F10	OU anisotropic	0.000	44.596	7.793
F10	OUF anisotropic	1.354	40.370	8.862
F10	OUF anisotropic	28.388	0.000	36.588
F10	OU isotropic	39.546	95.097	4.939
F10	OUF isotropic	39.689	82.272	6.189
F10	IID anisotropic	225.794	35.029	0.010
F12	OU anisotropic	0.000	54.938	4.894
F12	OUF anisotropic	1.667	45.091	5.989
F12	OUF anisotropic	17.334	0.000	34.121
F12	OU isotropic	34.504	116.055	2.762
F12	OUF isotropic	35.932	91.230	3.605
F12	IID anisotropic	195.824	9.209	91.148
F14	OU isotropic	0.000	8.323	23.865
F14	OUF isotropic	2.060	5.715	29.443
F14	OU anisotropic	4.224	7.550	21.428
F14	OUF anisotropic	6.372	4.577	26.804
F14	OUF isotropic	29.190	3.452	48.883
F14	OUF anisotropic	31.254	0.000	43.509
F14	IID isotropic	151.787	4.408	88.000
F15	OU anisotropic	0.000	5.726	24.137
F15	OUF anisotropic	2.158	3.596	24.701
F15	OU isotropic	4.729	11.146	22.071
F15	OUF isotropic	6.649	10.840	23.092
F15	OUF anisotropic	20.244	0.000	46.213
F15	IID anisotropic	113.479	7.936	7.692
M01	OU anisotropic	0.000	17.963	47.951
M01	OUF anisotropic	2.120	15.824	53.174
M01	OU isotropic	14.747	6.040	63.448
M01	OUF isotropic	16.815	4.878	68.085
M01	OUF anisotropic	47.466	3.072	94.968

M01	IID anisotropic	105.411	0.000	126.984
M03	OU anisotropic	0.000	3.086	58.953
M03	OUF anisotropic	2.134	0.756	63.816
M03	OUF anisotropic	28.546	0.000	88.560
M03	OU isotropic	38.360	2.791	59.375
M03	OUF isotropic	40.426	0.496	64.203
M03	IID anisotropic	157.610	7.146	106.979
M04	OU anisotropic	0.000	25.342	33.578
M04	OUF anisotropic	2.107	20.203	39.152
M04	OU isotropic	6.519	22.677	34.344
M04	OUF isotropic	8.555	17.762	39.911
M04	OUF anisotropic	67.749	11.001	78.422
M04	IID anisotropic	188.051	0.000	121.813
M05	OU anisotropic	0.000	1.564	75.065
M05	OUF anisotropic	2.144	0.168	79.262
M05	OU isotropic	2.598	11.729	73.186
M05	OUF isotropic	4.675	9.988	77.304
M05	OUF anisotropic	25.039	0.000	108.941
M05	IID anisotropic	63.634	15.464	134.900
M06	OU anisotropic	0.000	39.709	19.654
M06	OUF anisotropic	2.124	25.472	24.968
M06	OU isotropic	29.332	102.924	16.161
M06	OUF isotropic	31.346	82.023	21.755
M06	OUF anisotropic	52.939	0.000	57.127
M06	IID anisotropic	137.127	32.798	4.336

Figure S1 - Sampling of data points over the three years of tracking. Colours separate individual years, and are nudged (y) to aid differentiating years.

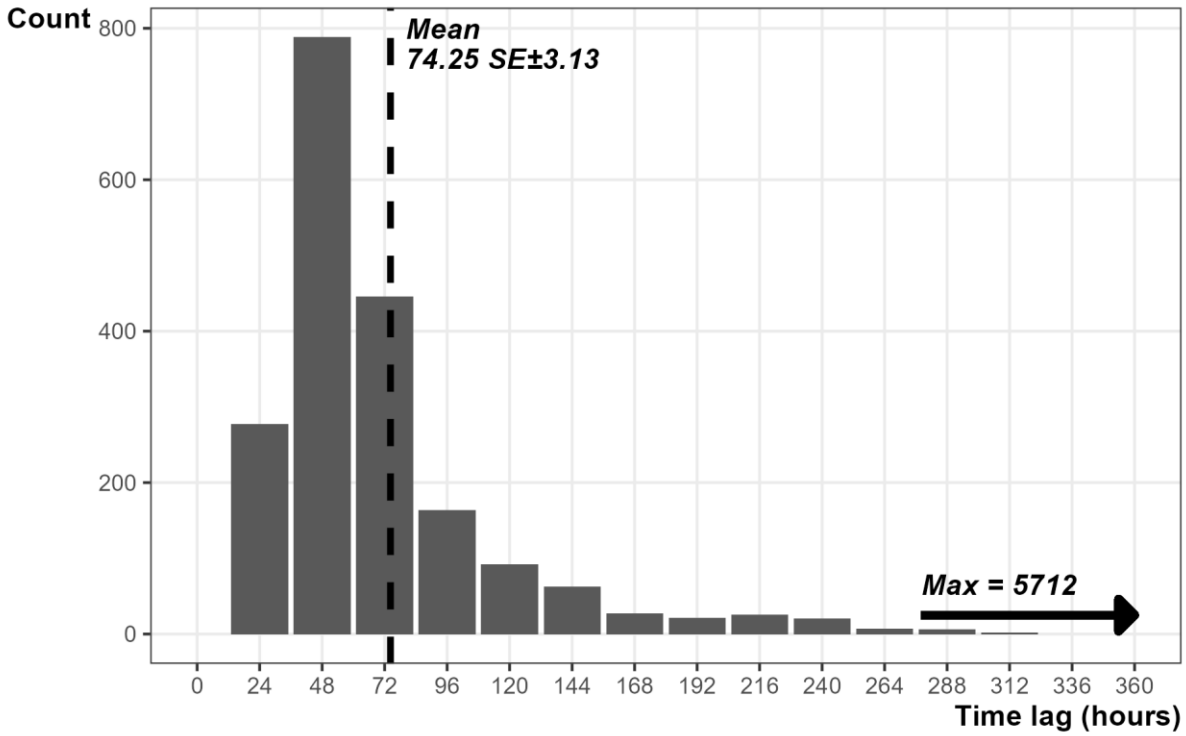

Figure S2 - Bar plot showing the time lag in hours between tracks, with mean (dashed line) annotated.