Supplementary Information

Extrinsic and intrinsic factors affecting the daily rhythms of a semiaquatic carnivore in a mediterranean environment

Lorenzo Quaglietta, António Mira, Luigi Boitani

Table S1: Description of the 12 variables used in multicosinor analyses, performed using Generalized Linear Mixed Models (GLMM), to assess the influence of each variable on the daily activity rhythms of Eurasian otters (*Lutra lutra*) in a Mediterranean area in Southern Portugal (N=4097 otter radio-locations). Climatic-meteorological data, namely air temperature (°C) and rainfall (mm), were provided by the Geophysics Centre at Évora University (http://www.cge.uevora.pt/) and had a temporal resolution of 10 minutes.

Independent Variables	**Typology**	**Brief Description**
Sex	Factor	Individual Otter Gender.
Age	Factor	Otter Age: Subadult, Adult.
Season	Factor	Dry or Wet Season.
Dam	Dummy	Otters located in Dam (1) or other habitat types, including Stream and Pond (0).
Temperature	Numerical	Air Temperature (°C).
Wind	Dummy	Presence of Strong Wind.
Moon	Factor	Moon Phase (New, Waxing, Full, Waning).
Hour	Numerical	Time (fitted as multicosinor functions — see main text).
Random Variables		
Individual	Factor	Individual Otter radio-tracked.
Year	Factor	Year of Sampling (2007, 2008, 2009, 2010).
Response Variable		
Activity	Binary	Otter radio-locations: Active (1) and Resting (0).

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Table S2: Summary results of MC model selection of Eurasian otter (*Lutra lutra*) daily activity rhythms, comparing alternative models reflecting the effects of season (S) and covariates (covar) — the residuals' percentiles of the GAM of air temperature modelled as a function of time of day and season (resPerc), a dummy variable indicating otters located in the dam habitat (dam), the moon phase (moon), and a dummy variable representing the occurrence of strong winds (wind) — on the probability of an otter being active. MC = multicosinor function; RE = random effects; CD = fundamental circadian 24 h period; HCD = 12 h hemicircadian period; UD = 6 h ultradian period.

Model	**No. of parameters**	**ΔAIC**	**Akaike weight**	**Evidence ratio**	**Rank**
null (Intercept + RE)	4	1133	0.00	1.20×10^{246}	19
Intercept + MC + RE	5	56	0.00	1.13×10^{12}	16
null + covar	10	1017	0.00	6.29×10^{220}	17
- Season - Season × MC	16	43	0.00	1.99×10^{9}	14
- CD	17	1012	0.00	5.07×10^{219}	18
- HCD	17	9	0.01	9.91×10^{1}	5
- Season × CD.HCD	17	45	0.00	5.24×10^{9}	15
- Moon - Dam	17	26	0.00	4.29×10^{5}	11
- UD	19	10	0.00	1.33×10^{2}	6
- Season × CD	19	36	0.00	5.02×10^{7}	12
- Season × HCD	19	11	0.00	2.60×10^{2}	7
- Res.GAM.T.S	20	18	0.00	9.55×10^{3}	9
- Dam	20	20	0.00	2.21×10^{4}	10
- Moon	18	8	0.01	4.41×10^{1}	4
- Wind	20	3	0.16	3.74	3
all - Season × UD	21	0	0.60	1.00	1
- Season × HCD + Season × UD	21	12	0.00	5.15×10^{2}	8
- Season × CD + Season × UD	21	38	0.00	1.76×10^{8}	13
all + Season × UD	23	2	0.21	2.91	2

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Table S3: Model-averaged parameter estimates, standard errors, z and *p* values for the 3 best MC models representing Eurasian otter (*Lutra lutra*) daily activity rhythms.

Variable	**Estimate**	**SE**	**z**	***p***
Intercept	−0.216	0.127	1.706	0.088
Season (Wet)	0.058	0.082	0.709	0.478
$\cos(2\pi\,\text{Hour}/24)$	1.981	0.093	21.248	<0.001
$\sin(2\pi\,\text{Hour}/24)$	0.368	0.075	4.924	<0.001
$\cos(2\pi\,\text{Hour}/12)$	−0.168	0.084	2.009	0.045
$\sin(2\pi\,\text{Hour}/12)$	0.225	0.081	2.765	0.006
$\cos(2\pi\,\text{Hour}/6)$	−0.175	0.060	2.908	0.004
$\sin(2\pi\,\text{Hour}/6)$	−0.108	0.068	1.584	0.113
Res.GAM.T.S	−0.240	0.053	4.493	<0.001
Dam	0.385	0.082	4.683	<0.001
Moon (Waxing)	−0.109	0.100	1.092	0.275
Moon (Full)	0.118	0.105	1.127	0.260
Moon (Waning)	0.263	0.108	2.443	0.015
Wind	−0.900	0.427	2.108	0.035
Season (Wet) $\times \cos(2\pi\,\text{Hour}/24)$	−0.717	0.118	6.075	<0.001
Season (Wet) $\times \sin(2\pi\,\text{Hour}/24)$	−0.135	0.100	1.342	0.180
Season (Wet) $\times \cos(2\pi\,\text{Hour}/12)$	0.150	0.108	1.387	0.166
Season (Wet) $\times \sin(2\pi\,\text{Hour}/12)$	−0.387	0.107	3.609	<0.001
Season (Wet) $\times \cos(2\pi\,\text{Hour}/6)$	0.139	0.106	1.314	0.189
Season (Wet) $\times \sin(2\pi\,\text{Hour}/6)$	0.044	0.105	0.419	0.675

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Table S4: Parameter estimates, standard errors, z and *p* values for a binomial GLMM testing the influence of gestation on the probability of activity in adult Eurasian otter (*Lutra lutra*) females.

Variable	**Estimate**	**SE**	**z**	***p***
Intercept	-0.130	0.086	-1.506	0.132
Gestation	-0.281	0.113	-2.473	0.013

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Table S5: Parameter estimates, standard errors, z and *p* values for a binomial GLM testing the influence of reproductive status on the probability of diurnal activity in adult Eurasian otter (*Lutra lutra*) females.

Variable	**Estimate**	**SE**	**z**	***p***
Intercept	-0.470	0.570	-0.824	0.410
Gestation	0.047	0.607	0.078	0.938
Lactation peak	-0.511	0.691	-0.739	0.460
Late lactation	-1.640	0.682	-2.405	0.016