Oikos

OIK-07158

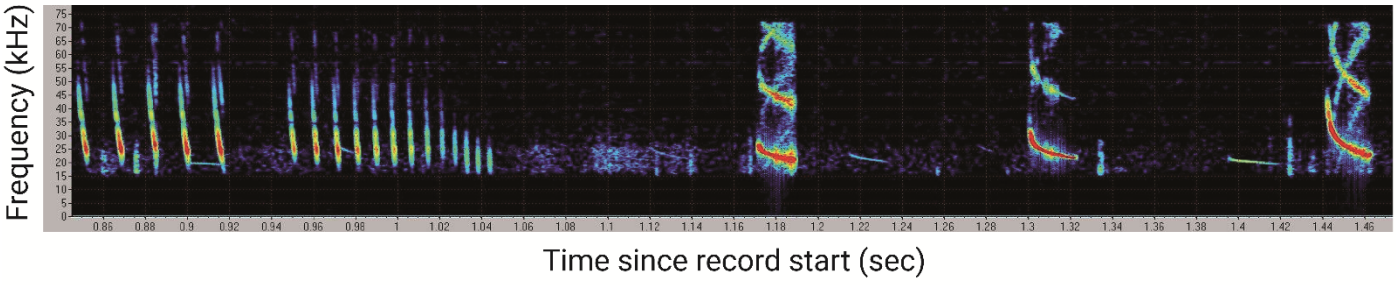
Roeleke, M., Blohm, T., Hoffmeister, U., Marggraf, L., Schlägel, U. E., Teige, T. and Voigt, C. C. 2020. Landscape structure influences the use of social information in an insectivorous bat. – Oikos doi: 10.1111/oik.07158

Appendix 1

Description of analysis of ultrasonic recordings

We annotated GPS fixes with the pooled data from the three last ultrasonic recordings (each lasting 1.5 s with a pause of 8.5 s). Therefore, we counted the total number of feeding buzzes summed over the last three records, and the maximum number of simultaneously recording conspecifics in any one of the three ultrasonic recordings, using spectrograms (FFT length 1024 or 512) in the software Avisoft-SASLab Pro (ver. 5.2.09, Avisoft Bioacoustics, Glienicke, Germany). Feeding buzzes are typical pulse trains that are characterized by the fast repetition of similar calls with steep shape, i.e. large frequency range and short duration. Further, feeding buzzes are characterized by a drop in frequency range and fainter calls in the terminal phase (Fig. A1). However, we also counted feeding buzzes which terminal phases were cut off by the end of the recording interval.

We determined if calls stem from the focal bat or from conspecifics by comparing the sound pressure. Further, calls from conspecifics often overlapped with calls from the focal bat (e.g. calls at 0.9 s and 0.97 s in Fig. A1) or did not fit to the rhythm of the calls of the focal bat (e.g. calls at 1.22 s and 1.4 s in Fig. A1). We determined the minimum number of present conspecifics by applying the same rules inbetween conspecific calls, i.e. examining differences in sound pressure, call overlap, and rhythm. We determined whether calls stemmed from conspecifics by the common approach of measuring the end frequency of the calls.



the focal bat (time: 0.85 to 1.05), followed by three search calls (time: 1.17, 1.3, 1.44). Sound pressure is indicated by color intensity (purple to red). Six fainter calls in the background (time: 0.9, 0.97, 1.12, 1.22, 1.28, 1.4) stem from a nearby conspecific.

Appendix 2

Table A1. Flight activity of the individual common noctules during their major foraging trips used in all analyses. Median values for all bats within the respective study sites are given.

CROPLAND DOMINATED LANDSCAPE					FOREST DOMINATED LANDSCAPE				
BAT ID	flight distance (km)	max distance from roost (km)	flight time (min)	number of feeding buzzes	BAT ID	flight distance (km)	max distance from roost (km)	flight time (min)	number of feeding buzzes
A133679	11.4	3.1	71	44	A137363	22.3	6.4	84	43
A133680	24.4	6.2	105	48	A137369	51.2	7.4	190	44
A133687	29.4	4.0	162	87	A137396	22.4	5.3	103	27
A133688	20.0	3.6	86	9	A143507	75.6	32.3	189	38
A133689	8.3	3.1	30	6	A143508	28.7	6.4	117	62
A133690	11.1	5.1	32	9	A143521	84.3	33.8	221	30
f02_18	48.6	9.2	192	138	A143525	35.8	10.3	141	26
f04_18	24.7	3.5	103	33	A143538	11.7	1.7	48	27
f05_18	46.4	6.0	164	68	A143675	25.3	5.2	126	47
f06_18	57.7	6.9	173	106	A143676	38.3	4.3	165	74
f08_18	10.4	3.9	38	61	A143681	19.1	4.3	124	23
f23_18	35.3	4.4	125	52	A143683	18.4	2.2	110	29
f26_18	28.8	5.3	112	93					
f28_18	25.3	5.2	91	82					
f31_18	49.0	9.8	143	65					
median ± mad	25.3 ± 20.9	5.1 ± 1.8	105 ± 56	61 ± 39	median ± mad	27.0 ± 12.9	5.8 ± 2.3	125 ± 46	34 ± 13

Appendix 3

Model statistics and AICc values of different submodels of the model explaining the probability that focal bats met conspecifics

Generalized linear mixed model fit by maximum likelihood
Family: binomial (logit)

Formula:
Conspecifics present (yes or no) ~ study site (forest or cropland) * gps point in ARM patch (yes or no) + (1 | bat id) + (1 | year) + (1 | day)

AIC	BIC	logLik	deviance	df.resid
5668.5	5714.7	-2827.3	5654.5	5376

Scaled residuals:

Min	1Q	Median	3Q	Max
-1.4780	-0.6031	-0.3942	0.7433	5.6609

Random effects:

Groups Name	Variance	Std.Dev.
Bat id	6.887e-01	8.299e-01
day	9.877e-09	9.938e-05
year	8.594e-09	9.270e-05

Number of obs: 5383, groups: bat_id, 27; day, 6; year, 3

Fixed effects:

	Estimate	se	z value	Pr(>|z|)
Intercept	-1.9259	0.2307	-8.349	<2e-16 ***
Study site: forest	0.8596	0.3379	2.544	0.0110 *
ARM patch: yes	1.2610	0.1120	11.254	<2e-16 ***
forest / ARM patch yes	-0.3617	0.1482	-2.440	0.0147 *

marginal pseudo-R^2 = 0.09, conditional pseudo-R^2 = 0.27

AICc values of the full model and submodels

Intercept	ARM patch	study site	ARM patch : study site	df	AICc
-1.926	yes	yes	yes	7	5668.6
-1.833	yes	yes	no	6	5672.5
-1.519	yes	no	no	5	5674.7
-1.414	no	yes	no	5	5882.2
-1.113	no	no	no	4	5884.1

Appendix 4

Model statistics and AICc values of different submodels of the model explaining the probability that gps points were located within ARM patches

Generalized linear mixed model fit by maximum likelihood
Family: binomial (logit)

Formula:
gps point in ARM patch (yes or no) ~ (number of conspecifics recorded + number of feeding buzzes recorded + landuse class) * study site (forest or cropland) + (1 | year) + (1 | bat id) + (1 | day)

AIC	BIC	logLik	deviance	df.resid
5943.8	6056.6	-2954.9	5909.8	5610

Scaled residuals:

Min	1Q	Median	3Q	Max
-11.1461	-0.6406	-0.3859	0.7098	6.0979

Random effects:

Groups	Name	Variance	Std.Dev.
Bat id		7.990e-01	0.8938690
day		3.941e-08	0.0001985
year		8.401e-07	0.0009166

Number of obs: 5627, groups: bat id, 27; day, 6; year, 3

Fixed effects:

	Estimate	se	z value	Pr(>|z|)
Intercept	-0.10786	0.30008	-0.359	0.719262
Study site forest	-1.05598	0.53104	-1.989	0.046756 *
number conspecifics	0.87411	0.08021	10.897	< 2e-16 ***
number feeding buzzes	0.22143	0.04470	4.954	7.27e-07 ***
landuse forest	-1.83358	0.28811	-6.364	1.96e-10 ***
landuse open	-1.18061	0.20050	-5.888	3.90e-09 ***
landuse urban	-1.31639	0.34271	-3.841	0.000123 ***
landuse water	-1.01565	0.27673	-3.670	0.000242 ***
study site forest : conspecifics	-0.27836	0.10393	-2.678	0.007401 **
study site forest : feeding buzzes	-0.13215	0.06861	-1.926	0.054076 .
study site forest : landuse forest	1.27323	0.54910	2.319	0.020409 *
study site forest : landuse open	1.32138	0.51012	2.590	0.009588 **
study site forest : landuse urban	0.21831	0.64522	0.338	0.735098
study site forest : landuse water	1.36388	0.55040	2.478	0.013213 *

marginal pseudo-R^2 = 0.12, conditional pseudo-R^2 = 0.29

AICc values of the full model and submodels. Submodels with AICc values more than 100 points higher than the best model are not shown.

feeding	landuse	conspecifics	site	feeding:site	landuse:site	conspecifics:site	df	AICc
0.2212	yes	0.8747	yes	yes	yes	yes	17	5943.9
0.1651	yes	0.8823	yes	no	yes	yes	16	5945.6
0.2278	yes	0.7131	yes	yes	yes	no	16	5949.2
0.2219	yes	0.8546	yes	yes	no	yes	13	5950.0
0.1693	yes	0.7158	yes	no	yes	no	15	5951.4
0.1664	yes	0.8624	yes	no	no	yes	12	5951.6
0.2287	yes	0.7134	yes	yes	no	no	12	5954.7
0.1704	yes	0.7166	no	no	no	no	10	5954.9
0.1705	yes	0.7165	yes	no	no	no	11	5956.9
no	yes	0.9109	yes	no	yes	yes	15	5967.5
no	yes	0.8899	yes	no	no	yes	11	5974.0
no	yes	0.7316	yes	no	yes	no	14	5974.6
no	yes	0.7318	no	no	no	no	9	5978.6
no	yes	0.7317	yes	no	no	no	10	5980.6

Appendix 5

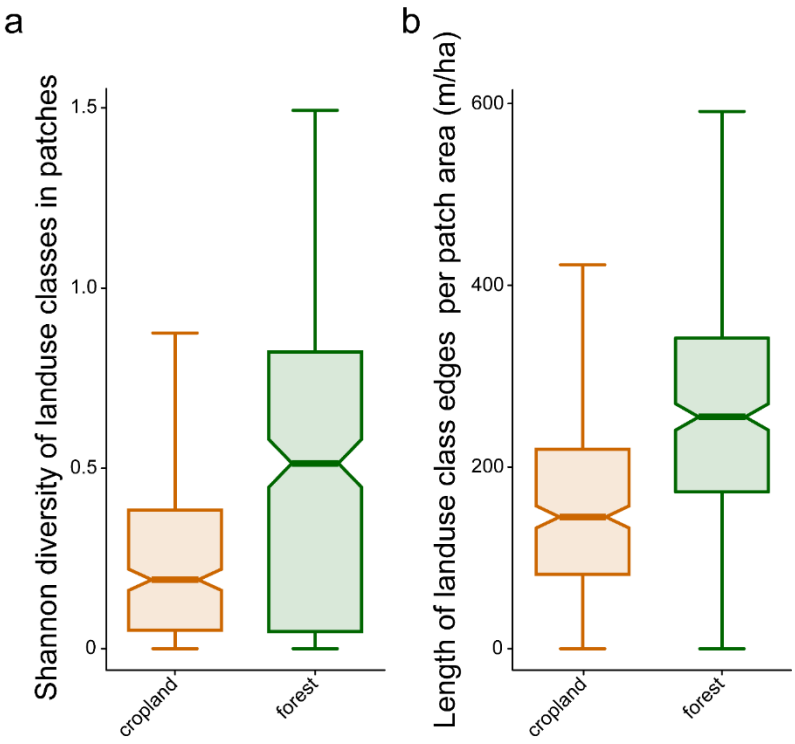


Figure A2. Shannon diversity index (a) and relative edge length between landuse classes (b) observed in randomly distributed patches derived from area restricted movement (ARM) patches of bats in cropland dominated and forest dominated landscape mosaics. Thick lines show the median values, boxes show the second and third quartiles of data, whiskers reach out to a maximum of 1.5 times the inter quartile ranges. Notches extend to 1.58 times inter quartile ranges divided by the square roots of observations and roughly represent the 95% confidence intervals of the medians. For graphical reasons, outliers are not shown.