

Supplementary Materials for

Persistent producer-scrounger relationships in bats

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Published 7 February 2018, *Sci. Adv.* **4**, e1603293 (2018)

DOI: 10.1126/sciadv.1603293

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Other Supplementary Material for this manuscript includes the following:
(available at advances.sciencemag.org/cgi/content/full/4/2/e1603293/DC1)

- movie S1 (.mov format). An example of an aggressive scrounging attempt on a bat returning to its colony with food.

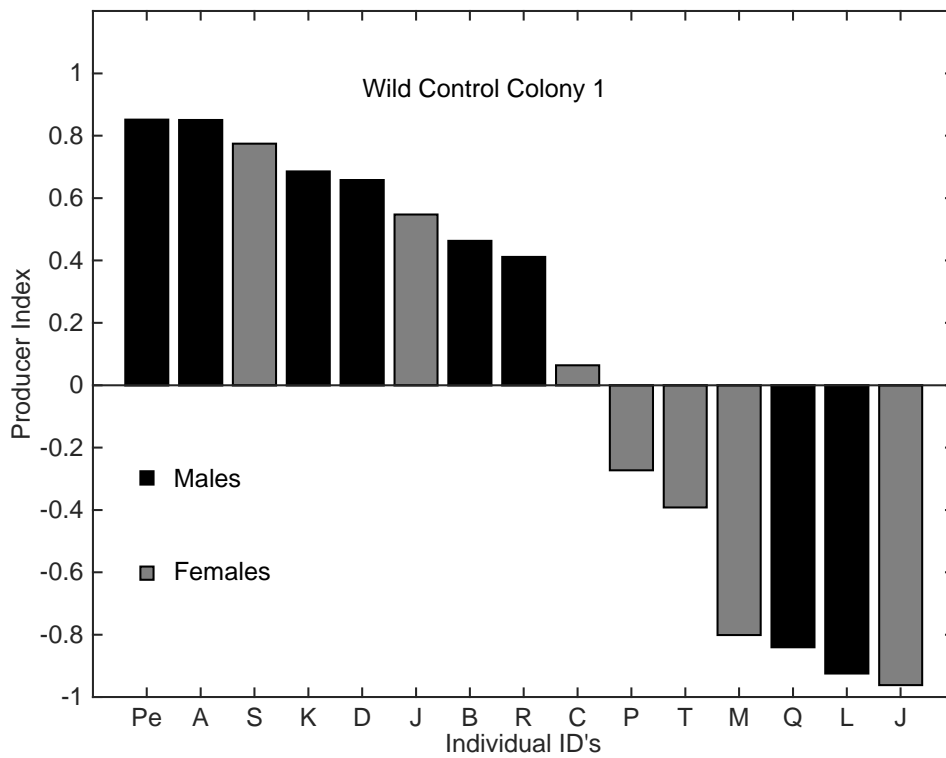


fig. S1. Wild Control Colony 1. Individual Producer indexes (PI) for all bats in the Wild Control Colony 1, with males in black (n=8) and females in grey (n=7). Symbols on the x-axis depict bats' ID. All PI's in this panel were calculated over the entire study period (Apr 2012-Jan 2013).

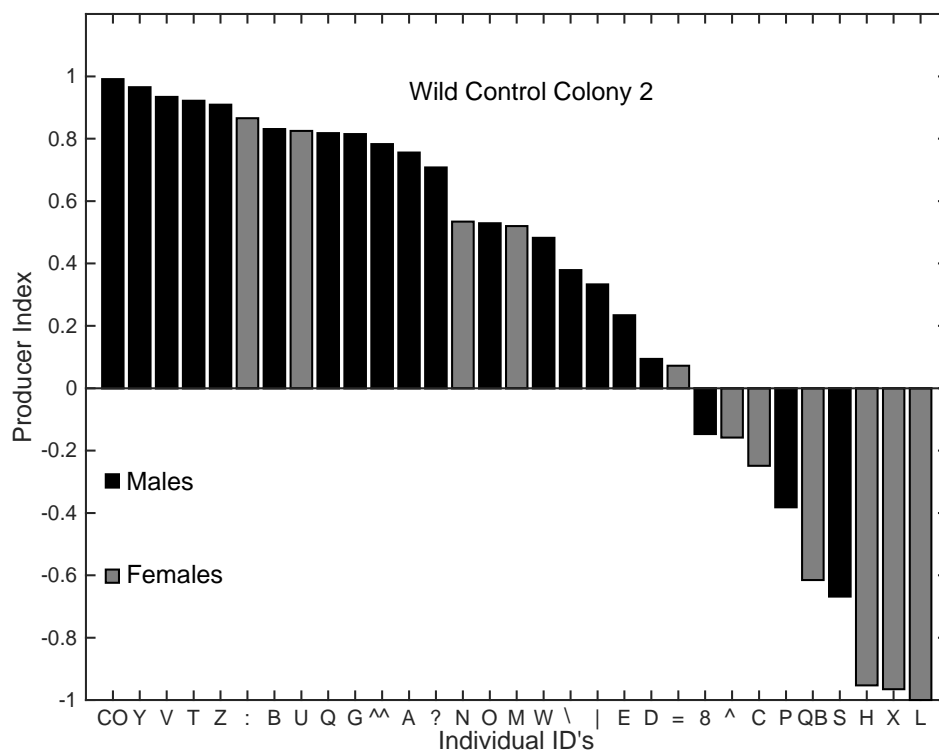


fig. S2. Wild Control Colony 2. Individual Producer indexes (PI) for all bats in the Wild Control Colony 2, with males in black (n=21) and females in grey (n=11). Symbols on the x-axis depict bats' ID. All PI's in this panel were calculated over the study period (March 2015-November 2015).

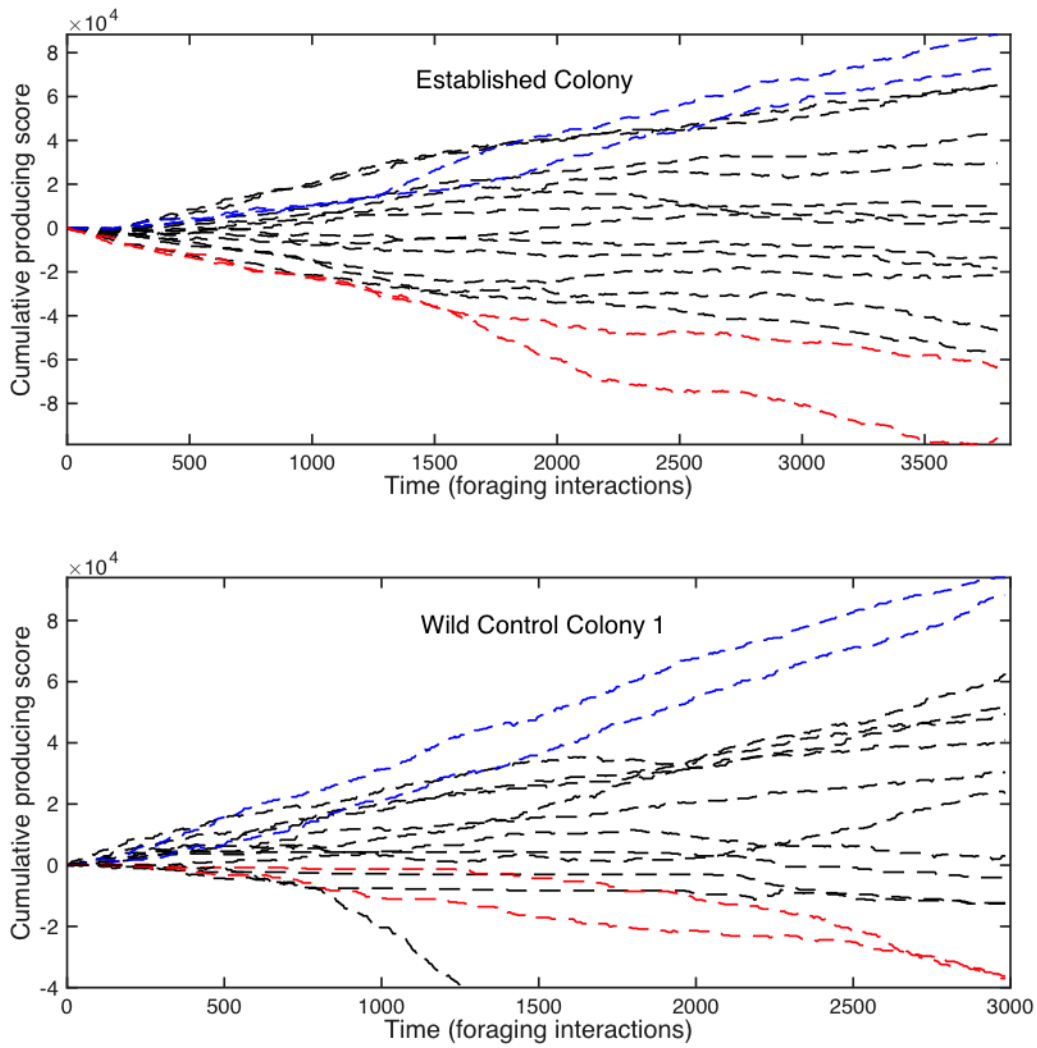


fig. S3. The cumulative producing rates over time for the Established Colony and Wild Control Colony 1. Note how individuals in both colonies show clear tendencies towards one of the strategies from start with very little change. Scores are based on the number of producing and scrounging events recorded per individual, when all individuals begin with an equal score ('Elo-rating' analysis, 64). The score of each individual was cumulatively increased and decreased by a constant with each producing and scrounging event respectively. X-axis represents sequential foraging events (i.e. producing and scrounging); y-axis represents the cumulative producing score. Examples for producers appear in blue and scroungers in red. Wild Control Colony 2 is not represented, as observations began 2 months after the group was assembled.

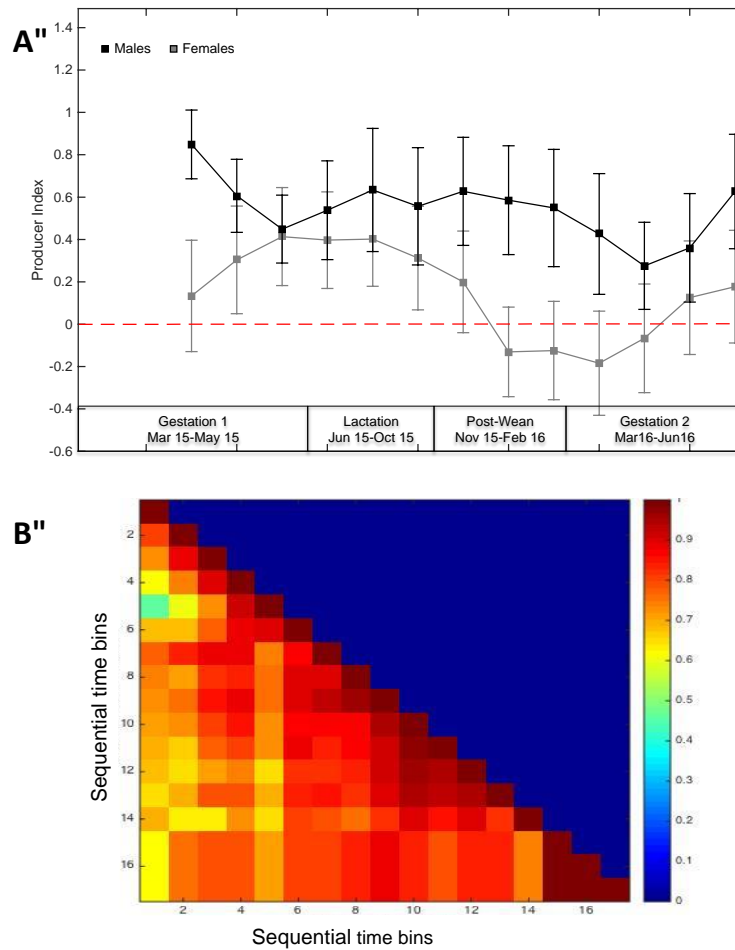


fig. S4. Temporal consistency of strategy use—Wild Control Colony 2. (A) Average PI + SE for males (black, n=6) and females (grey, n=9). The female reproductive periods are denoted along the X-axis. Average PI + SE with males in black and females in grey. The female reproductive periods are denoted along the X-axis. - Notice that as in the Established Colony, the average female PI (n=10) is positive throughout the gestation and lactation periods. PIs during post-weaning were significantly lower than both those in gestation (-0.1 ± 0.65 vs. -0.21 ± 0.76 , $p < 0.001$ and 0.33 ± 0.74 , $p < 0.01$ respectively; permutation based t-tests with a Bonferroni adjustment). However, no significant differences were found between gestation and lactation-PIs (0.21 ± 0.76 vs. 0.33 ± 0.74 , $P > 0.18$). Male PIs (n=22) did not change significantly during different reproductive periods (Gestation-Lactation, $p = 0.58$; Lactation-Post-weaning, $p = 0.6$; Post-weaning-Gestation, $p = 0.62$, black curves). (B) Each cell denotes the Spearman correlation coefficient between two time-bins (1-2 month each, see methods). The color indicates the strength of the correlation. There were high correlations between monthly PI ranks (n=17). All correlations were significant ($p < 0.05$), following a p-value adjustment for multiple comparisons

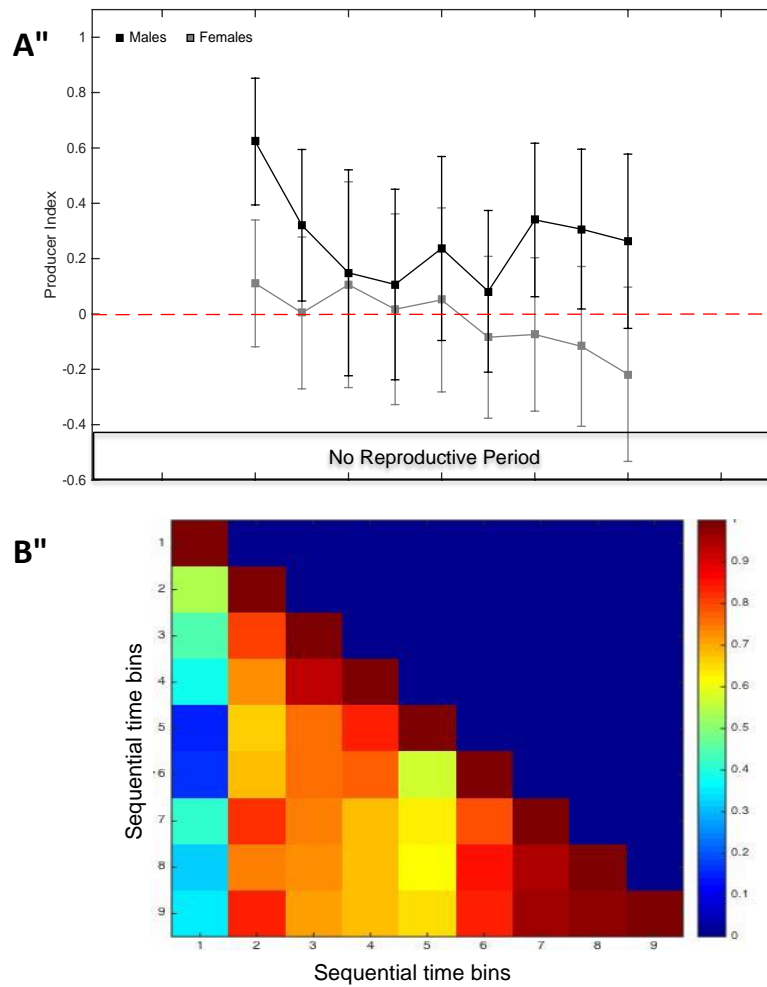


fig. S5. Temporal consistency of strategy use—Wild Control Colony 1. (A) Average PI + SE with males in black and females in grey. The female reproductive periods are denoted along the X-axis. Although no reproduction occurred in this colony a slight rise in female PI exists in similar to the Established Colony. However PIs of both males (n=8) and females (n=7) did not significantly differ between reproductive periods (Males: Gestation-Lactation 0.47 ± 0.55 vs. -0.56 ± 1.7 , $p=0.56$; Lactation-Post weaning -0.56 ± 1.7 vs. 0.24 ± 0.73 , $p=0.27$; Post weaning-Gestation -0.24 ± 0.73 vs. 0.47 ± 0.55 , $p=0.34$; permutation based t-tests with a Bonferroni adjustment, black curves. Females: Gestation-Lactation 0.06 ± 0.54 vs. 0.19 ± 0.42 , $p=0.56$; Lactation-Post weaning 0.19 ± 0.42 vs. -0.08 ± 0.68 , $p=0.11$; Post weaning-Gestation -0.08 ± 0.68 vs. 0.06 ± 0.54 , $p=0.72$; permutation based t-tests with a Bonferroni adjustment. (B) Each cell denotes the Spearman correlation coefficient between two time-bins (1-2 month each, see methods). The color indicates the strength of the correlation. There were high correlations between monthly PI ranks (n=9). All correlations were significant ($p < 0.05$, following a p-value adjustment for multiple comparisons) except for correlations with the month the colony was first established in April 2012 which had P-values between 0.5-0.08).

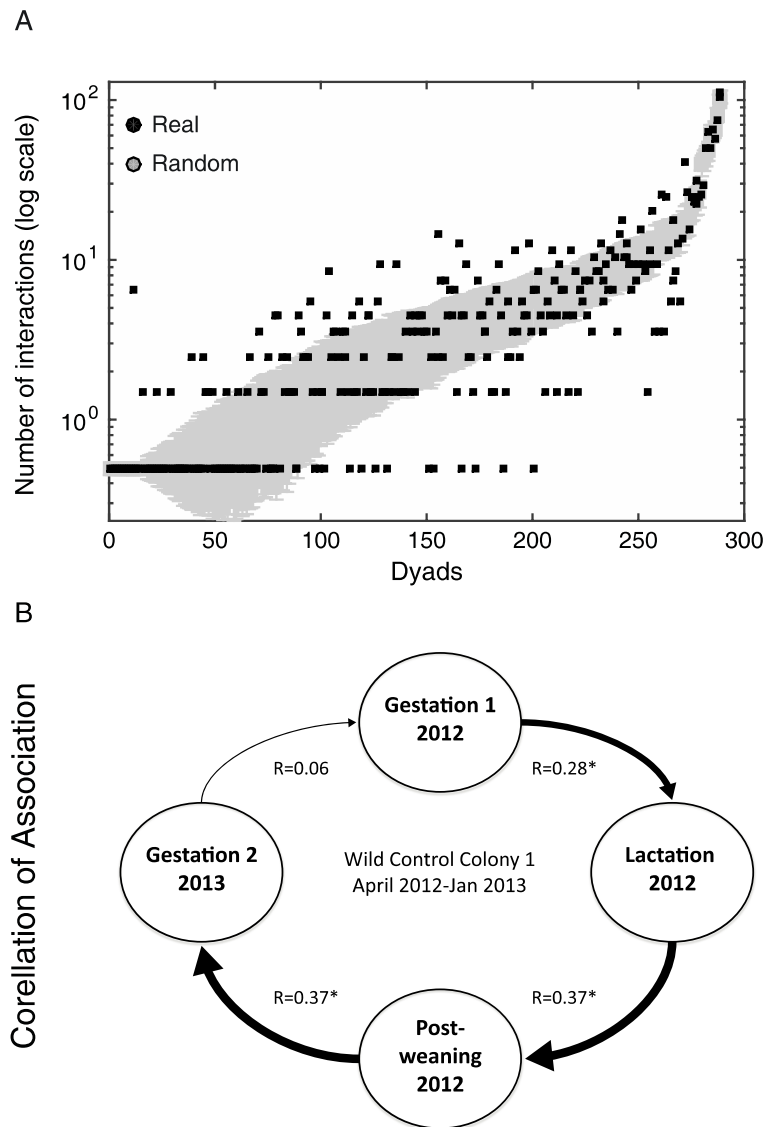


fig. S6. Bats exhibit individually specific social preferences—Wild Control Colony 1. (A) The number of observed and expected dyadic interactions (y-axis) for each of the 272 possible directional dyads (x-axis). Expected interactions (mean+SD) are depicted by grey bars and are sorted by their values with the corresponding real observed number of interaction depicted by a black dot. Note that each pair of individuals is represented by two dyads depending on who is the scrounger and who is the collector. (B) The social foraging network was stable, with correlations gradually increasing over time. There were significant correlations between the temporal interaction matrices representing the different periods except for between the last and first time bins, highlighting the gradual change in social preferences in a newly established colony. Each circle represents a reproductive period with thickness of the connective arrows representing the strength of the correlation coefficient between the social foraging networks of 2 reproductive periods. * $P < 0.001$ (Mantel test with a Bonferroni correction). The graph suggests that specific relations were generated over time, while the drop at the last bin reflects the fact that the final network was different from the beginning one.

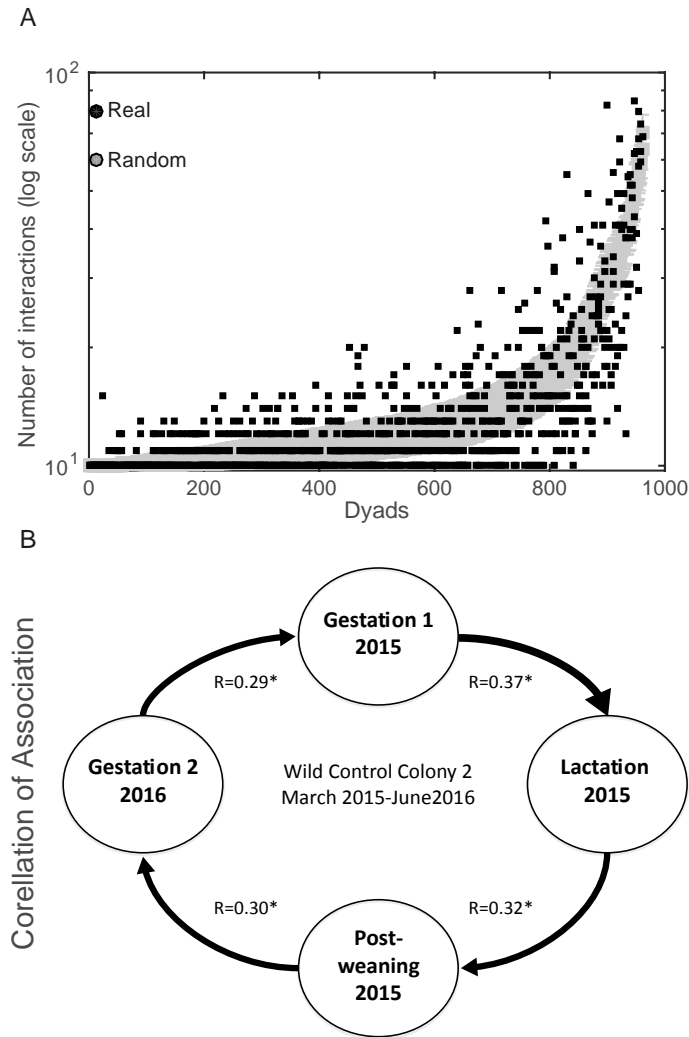


fig. S7. Bats exhibit individually specific social preferences—Wild Control Colony 2. (A) The number of observed and expected dyadic interactions (y-axis) for each of the 930 possible directional dyads (x-axis). Expected interactions (mean+SD) are depicted by grey bars and are sorted by their values with the corresponding real observed number of interaction depicted by a black dot. Note that each pair of individuals is represented by two dyads depending on who is the scrounger and who is the collector. (B) The social foraging network was stable over time. There were significant correlations between the temporal interaction matrices representing the different reproductive periods, the disassembly of social relations observed around the lactation period is not prominent in this colony; probably due to the low female to male ratio in comparison to the Established Colony (0.6:1 vs. 2.2:1), potentially masking the effect of female reproduction period on social relations. Each circle represents a reproductive period with thickness of the connective arrows representing the strength of the correlation coefficient between the social foraging networks of 2 reproductive periods. * $P < 0.001$ (Mantel test with a Bonferroni correction).

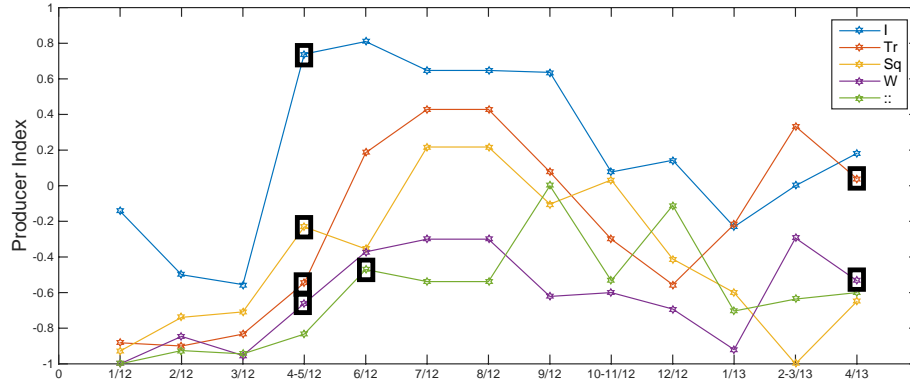


fig. S8. Females' rise in producing corresponded to parturition. Individual female PIs across months. Each female's parturition is denoted by a black square. Note that for each individual the rise in PI was close in time to parturition.



fig. S9. Bats avoid foraging on the lower branches of trees. A loquat (*Eriobotrya japonica*) tree depleted on the upper half by foraging bats. Bats have been foraging on this tree for ca. two weeks until depleting all fruit about ca. 1.5m. Fruits on low branches are denoted by red arrows. Photo Credit: Zeev M. Zamir (no institution).

table S1. Strategy indices (PIs) across individuals within the Established Colony ($n = 16$). PI = 1 means pure producer while a PI = -1 means a pure scrounger. P=absolute number of producing events, S=absolute number of scrounging events. M=male, F=female, J=juvenile Values in table were extracted from data collected between Jan-Feb/13 Symbols in the first column depict bats' ID. Producers in blue, Scroungers in red.

ID	Sex	P	S	PI
Eq	M	137	19	0.756
H	M	203	30	0.742
Hm	M	257	41	0.724
S	F	220	49	0.635
Z	M	234	53	0.63
.	M	71	38	0.3027
A	M	174	101	0.265
I	F	79	64	0.1
B	M	98	89	0.048
Cir	F	64	124	-0.319
Ne	F	49	95	-0.319
Tr	F	60	169	-0.475
Sq	F	64	218	-0.546
W	F	34	222	-0.734
::	F	33	263	-0.777
X	F	34	369	-0.831

table S2. Strategy indices (PIs) across individuals within Wild Control Colony 1 ($n = 17$). PI = 1 means pure producer while a PI = -1 means a pure scrounger. P=absolute number of producing events, S=absolute number of scrounging events. M=male, F=female. Values in table were extracted from data collected between Jan-Apr/13 Symbols in the first column depict bats' ID. Producers in blue, Scroungers in red.

ID	Sex	P	S	PI
Pe	M	411	33	0.851
A	M	384	31	0.851
S	F	244	31	0.775
K	M	241	45	0.685
G	M	187	35	0.685
De	M	315	65	0.658
Je	F	171	50	0.548
Hm	M	256	94	0.463
R	M	163	68	0.411
Ci	F	100	88	0.064
Su	M	151	153	-0.007
Ps	F	24	42	-0.273
Tl	F	38	87	-0.392
Sm	F	18	163	-0.801
Ss	M	61	703	-0.84
Lv	M	6	153	-0.925
Jf	F	1	51	-0.962

table S3. PIs across individuals within Wild Control Colony 2 ($n = 31$). PI = 1 means pure producer while a PI = -1 means a pure scrounger. P=absolute number of producing events, S=absolute number of scrounging events. M=male, F=female. Values in table were extracted from data collected between Mar/15-Jan/16 Symbols in the first column depict bats' ID. Producers in blue, Scroungers in red.

ID	Sex	P	S	PI
CO	M	124	1	0.991
Y	F	187	4	0.965
V	M	38	3	0.934
T	M	229	10	0.922
Z	M	210	12	0.909
:	F	225	16	0.866
B	M	222	22	0.831
U	F	267	22	0.825
Q	F	175	18	0.818
G	M	241	19	0.815
^^^	M	116	11	0.783
A	M	209	29	0.756
?	M	221	35	0.708
N	F	106	26	0.534
O	M	119	42	0.529
M	F	153	68	0.52
W	F	155	53	0.482
\	M	149	69	0.379
	M	8	4	0.333
E	M	161	110	0.234
D	M	109	82	0.094
=	F	35	22	0.072
8	M	76	107	-0.147
^	M	8	11	-0.158
C	F	86	210	-0.249
P	M	56	211	-0.382
QB	F	5	21	-0.615
S	M	42	270	-0.668
H	F	14	566	-0.953
X	F	6	496	-0.965
L	F	0	87	-1

table S4. Results of permutation-based *t* tests between female PIs across reproductive periods.

		Gestation- Lactation	Lactation- Post weaning	Post weaning - Gestation
Females	1 st period Av +SD	0.21±0.77	0.33±0.74	-0.01 ± 0.66
	2 nd period Av +SD 2	0.33±0.74	-0.01 ± 0.66	0.21±0.77
	t-value	-0.964	3.43	-2.568
	p-value	0.18	0.001	0.0174
Males	1 st period Av +SD	0.54±0.46	0.46±0.61	0.46±0.58
	2 nd period Av +SD	0.46±0.61	0.46±0.58	0.54±0.46
	t-value	-0.226	-0.299	0.364
	p-value	0.58	0.603	0.621

table S5. Reproductive periods. As Wild Colony 1 did not undergo gestation the reproductive periods data was divided based on the Established Colony

Period/colony	Established Colony	Wild Control Colony 1**	Wild Control Colony 2
Gestation 1	Jan.-Jun. 2012	Apr.-Jun. 2012	Mar-May 2015
Lactation	Jul.-Sep. 2012	Jul.-Sep. 2012	Jun-Oct
Post-weaning	Oct.-Dec 2012	Oct.-Dec 2012	Nov-Feb 2016

table S6. Study 3 experimental groups. Experimental groups (n=4 per group), ranging from groups composed of 4 producers (4p) to four scroungers (4s). Baseline producers shaded in grey, scroungers in white. Abbreviations depict bat names.

Condition/ID				
4p	H	Eq	Z	Hm
3p1s	Eq	A	Z	Ne
3p1s	H	Hm	Z	Cir
2p2s	H	Z	::	Sq
2p2s	Eq	Hm	Cir	W
1p3s	H	Cir	::	W
1p3s	Eq	Ne	::	Sq
4s	::	Sq	W	Ne

movie S1. An example of an aggressive scrounging attempt on a bat returning to its colony with food. The video was taken in an urban colony that we monitor continuously. The colony hosts a roost which we built, but the individuals are wild and free to come and go. There is constant exchange of individuals between this colony and neighboring colonies. The producer holding a food item in its mouth is highlighted throughout.