

# Supplemental Material for Brown et al.

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1. Posthumous care by mother

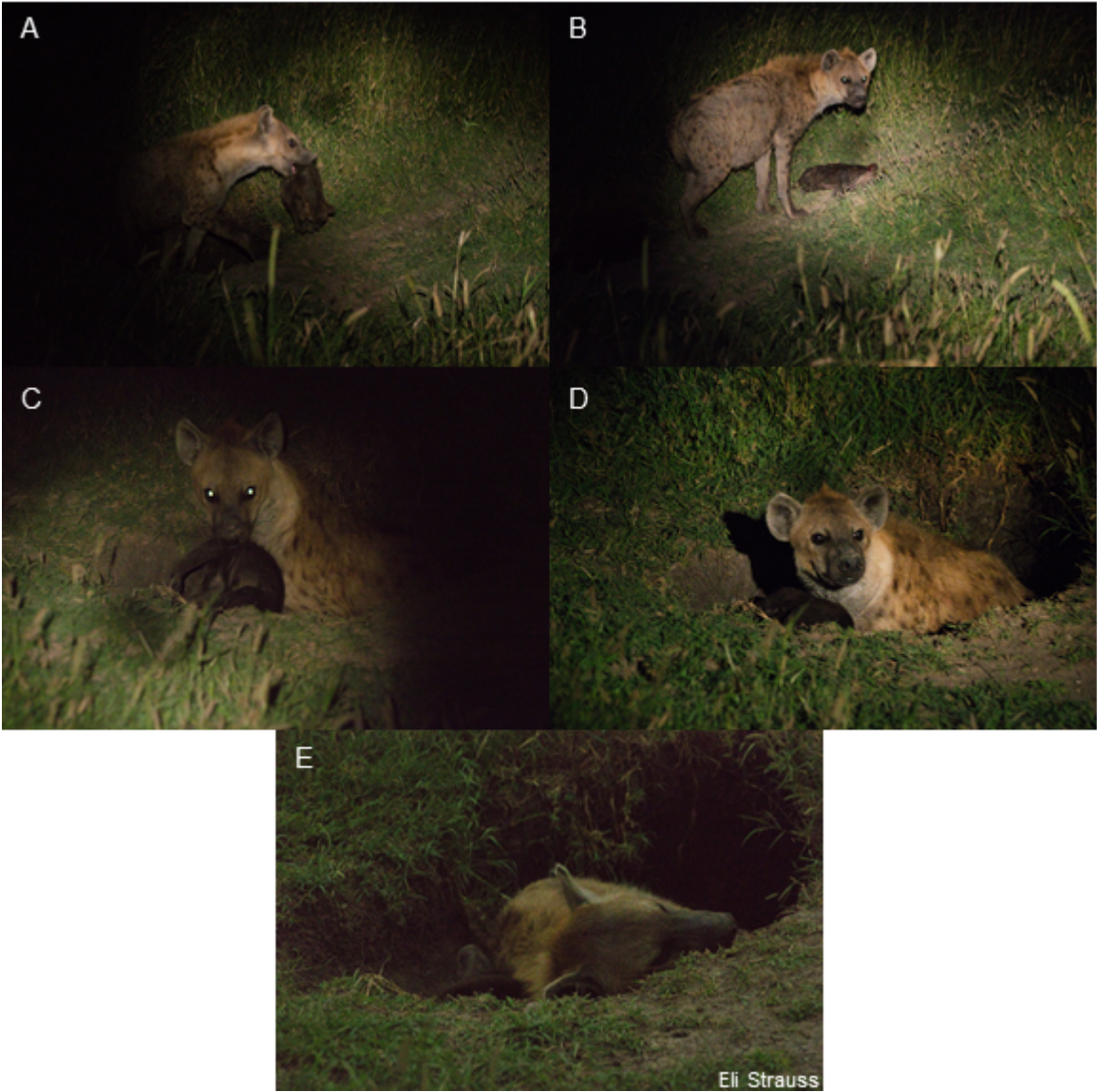


Figure S1. A mother caring showing poshumous care by defending it from others, moving it in and out of the den, and grooming it. Note the atypical way she is carrying her cub in panel A; cubs are typically carried by the nape of the neck, as in other carnivores. When observers left her, she was sleeping next to the body of her deceased cub (panel E).

## 2. Model detail and diagnostic for mortality ~ age at death

Here we used a multinomial model of mortality source as a function of age at death to understand the contribution of different mortality sources to overall mortality. This model was initialized with weak, uninformative priors, and four chains were run for 30000 iterations each (15000 warmup).

```
# Priors
prior_summary(fit)
```

##	prior	class	coef group resp	dpar nlpar
##	(flat)	b		muhuman
##	(flat)	b age_at_death		muhuman

```

##          (flat)          b          mulion
##          (flat)          b age_at_death    mulion
##          (flat)          b          muother
##          (flat)          b age_at_death    muother
##          (flat)          b          musiblicide
##          (flat)          b age_at_death    musiblicide
##          (flat)          b          mustarvation
##          (flat)          b age_at_death    mustarvation
## student_t(3, 0, 2.5) Intercept          muhuman
## student_t(3, 0, 2.5) Intercept          mulion
## student_t(3, 0, 2.5) Intercept          muother
## student_t(3, 0, 2.5) Intercept          musiblicide
## student_t(3, 0, 2.5) Intercept          mustarvation
## bound      source
##          (unknown)
##      (vectorized)
##          (unknown)
##      (vectorized)
##          (unknown)
##      (vectorized)
##          (unknown)
##      (vectorized)
##          (unknown)
##      (vectorized)
##          (unknown)
##          (unknown)
##          (unknown)
##          (unknown)
##          (unknown)

```

```
summary(fit)
```

```

## Family: multinomial
## Links: mustarvation = logit; mulion = logit; musiblicide = logit; muhuman = logit; muother = logit
## Formula: y | trials(1) ~ 1 + age_at_death
## Data: known.mortality.mom.alive (Number of observations: 66)
## Samples: 4 chains, each with iter = 30000; warmup = 15000; thin = 1;
##          total post-warmup samples = 60000
##
## Population-Level Effects:
##              Estimate Est.Error l-95% CI u-95% CI Rhat Bulk_ESS
## mustarvation_Intercept      -2.88      0.90    -4.79    -1.26 1.00    50801
## mulion_Intercept             -4.02      1.04    -6.24    -2.17 1.00    42895
## musiblicide_Intercept        -0.15      0.71    -1.56     1.24 1.00    44791
## muhuman_Intercept            -5.15      1.40    -8.20    -2.72 1.00    40295
## muother_Intercept            -1.04      0.69    -2.43     0.26 1.00    50117
## mustarvation_age_at_death      0.64      0.23     0.22     1.12 1.00    26098
## mulion_age_at_death           0.95      0.24     0.53     1.45 1.00    25263
## musiblicide_age_at_death      -0.47      0.38    -1.28     0.19 1.00    31527
## muhuman_age_at_death          0.97      0.27     0.49     1.54 1.00    26122
## muother_age_at_death          0.12      0.25    -0.38     0.60 1.00    27555
##              Tail_ESS
## mustarvation_Intercept    39332
## mulion_Intercept          37122
## musiblicide_Intercept     47705

```

```
## muhuman_Intercept          34513
## muother_Intercept          44319
## mustarvation_age_at_death  29220
## mulion_age_at_death        28857
## musiblicide_age_at_death   31187
## muhuman_age_at_death       28859
## muother_age_at_death       33805
##
## Samples were drawn using sampling(NUTS). For each parameter, Bulk_ESS
## and Tail_ESS are effective sample size measures, and Rhat is the potential
## scale reduction factor on split chains (at convergence, Rhat = 1).
```

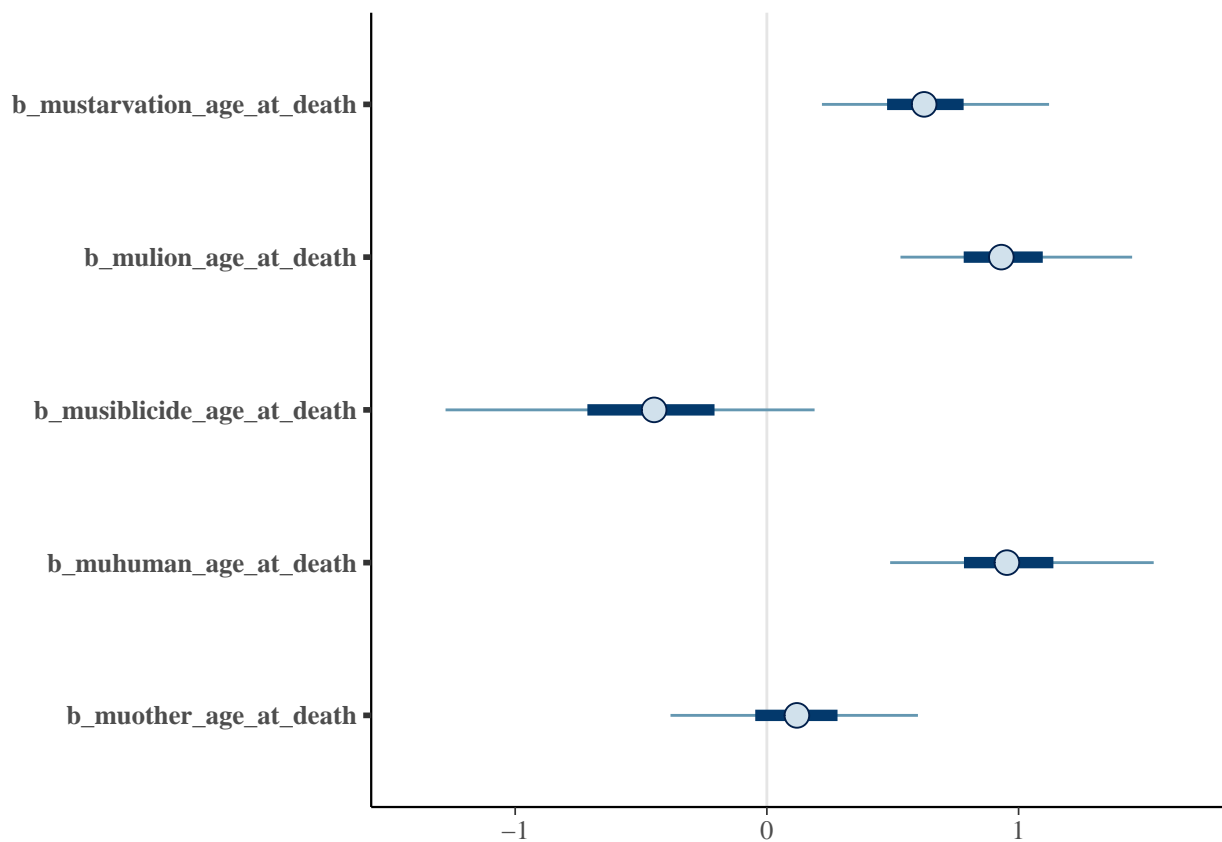


Figure S2. Interval plot showing parameter estimates and associated 50% and 95% credible intervals for the effect of age at death on the probability of different mortality sources. Infanticide is the reference level, so parameter estimates represent the log odds ratio of each mortality source relative to infanticide.

### 3. Model detail and diagnostic for moratlity ~ prey density

Here we used a multinomial model of mortality source as a function of prey density. This model was initialized with weak, uninformative priors, and four chains were run for 30000 iterations each (15000 warmup).

```
# Priors
prior_summary(prej_mod)
```

[illegible]

```
## Family: multinomial
## Links: mustarvation = logit; mulion = logit; musiblicide = logit; mudeathofmother = logit; muhuman
## Formula: y | trials(1) ~ 1 + prey_density
## Data: prey.test.data (Number of observations: 85)
## Samples: 4 chains, each with iter = 30000; warmup = 15000; thin = 1;
##           total post-warmup samples = 60000
##
## Population-Level Effects:
##
```

	Estimate	Est.Error	l-95% CI	u-95% CI	Rhat	Bulk_ESS
mustarvation_Intercept	-0.41	0.72	-1.83	0.97	1.00	37804
mulion_Intercept	-1.01	0.67	-2.36	0.29	1.00	32598
musiblicide_Intercept	-1.28	0.78	-2.84	0.21	1.00	36408

```

## mudeathofmother_Intercept      0.47      0.52     -0.54      1.51 1.00      28327
## muhuman_Intercept              -1.49      0.83     -3.18      0.09 1.00      35138
## muother_Intercept              -1.56      0.71     -3.01     -0.22 1.00      31631
## mustarvation_prej_density      -0.00      0.00     -0.01      0.01 1.00      24060
## mulion_prej_density             0.00      0.00     -0.00      0.01 1.00      21374
## musiblicide_prej_density        0.00      0.00     -0.00      0.01 1.00      23843
## mudeathofmother_prej_density    0.00      0.00     -0.00      0.01 1.00      19311
## muhuman_prej_density            0.00      0.00     -0.00      0.01 1.00      23521
## muother_prej_density            0.00      0.00      0.00      0.01 1.00      20326
##                               Tail_ESS
## mustarvation_Intercept         44911
## mulion_Intercept               40397
## musiblicide_Intercept          39729
## mudeathofmother_Intercept      38545
## muhuman_Intercept              40542
## muother_Intercept              38417
## mustarvation_prej_density       34203
## mulion_prej_density             27639
## musiblicide_prej_density        33687
## mudeathofmother_prej_density    24819
## muhuman_prej_density            32649
## muother_prej_density            25653
##
## Samples were drawn using sampling(NUTS). For each parameter, Bulk_ESS
## and Tail_ESS are effective sample size measures, and Rhat is the potential
## scale reduction factor on split chains (at convergence, Rhat = 1).

```

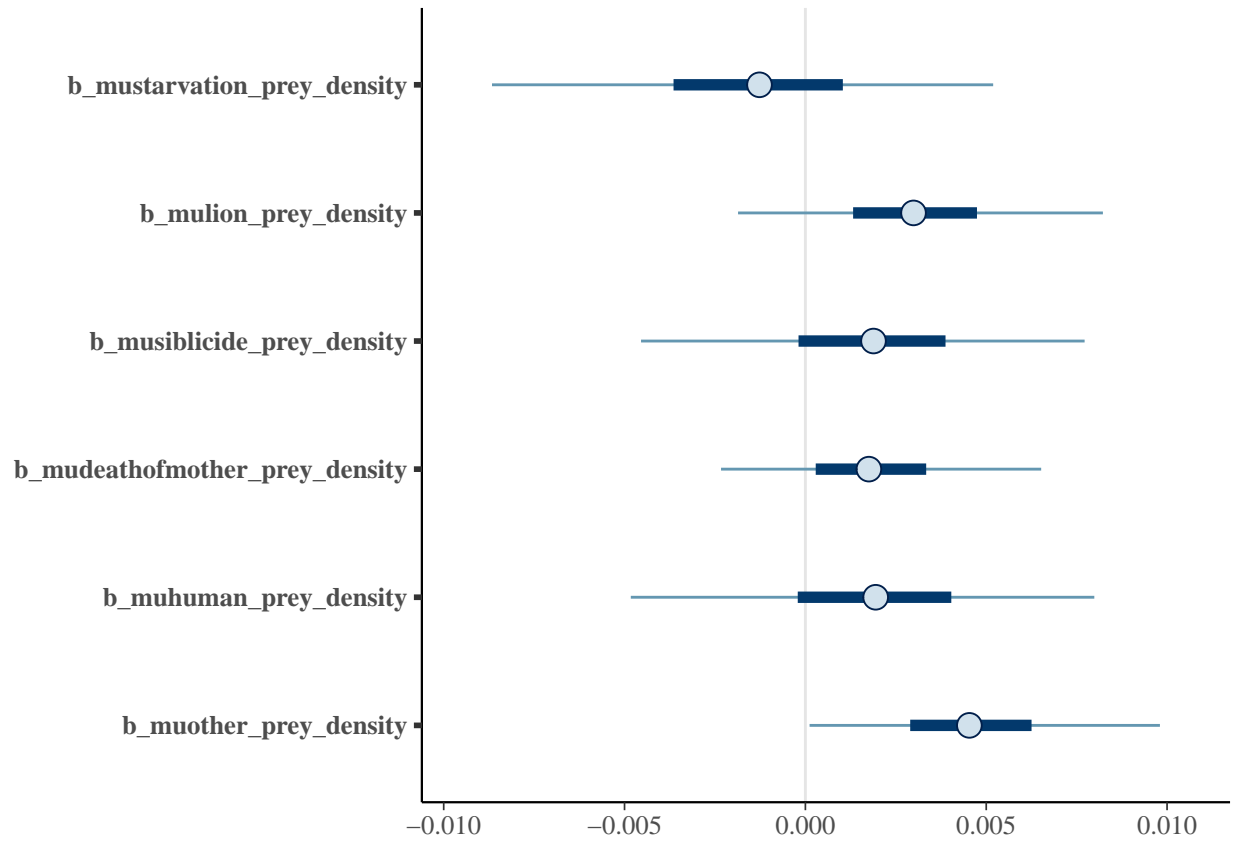


Figure S3. Interval plot showing parameter estimates and associated 50% and 95% credible intervals for the effect of prey density on the probability of different mortality sources. Infanticide is the reference level, so parameter estimates represent the log odds ratio of each mortality source relative to infanticide.

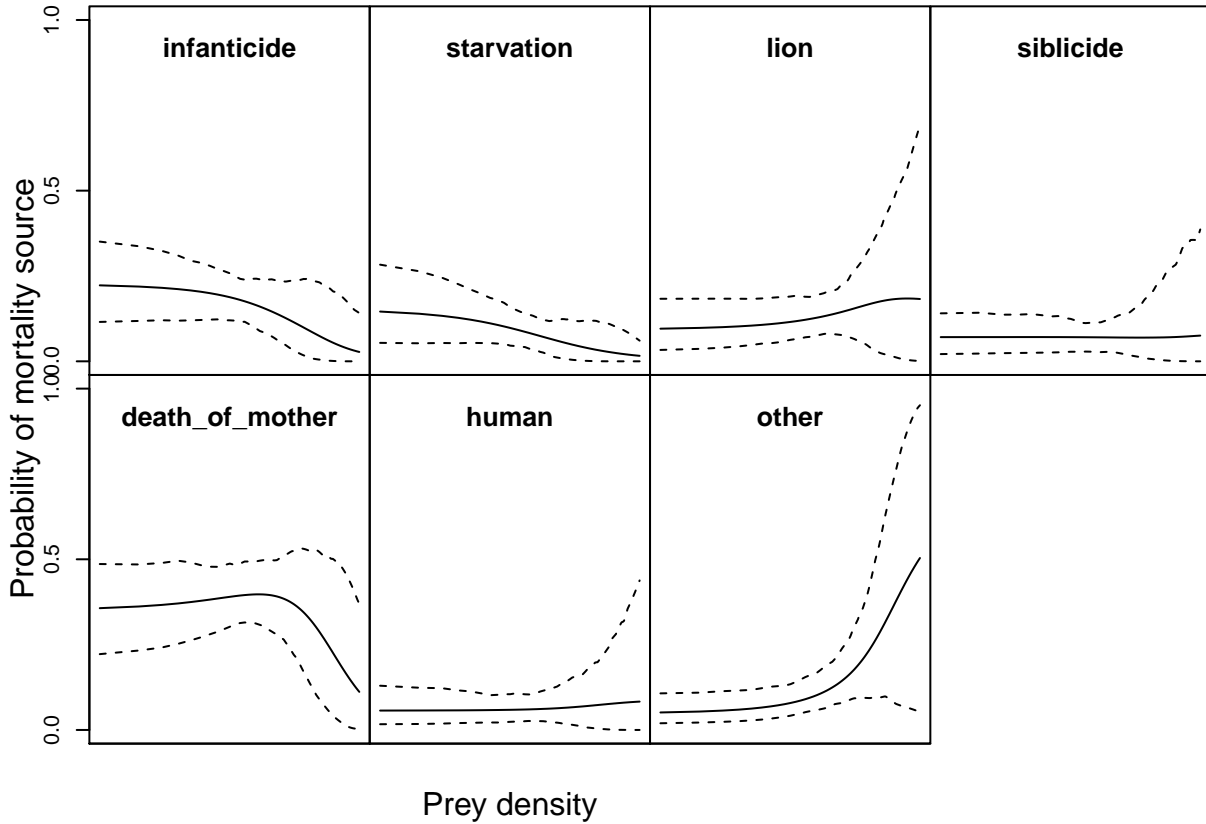


Figure S4. Predicted probability of mortality (with 95% prediction intervals) due to each source as a function of prey density.

#### 4. Model detail and diagnostic for mortality ~ cub density

Here we used a multinomial model of mortality source as a function of cub density. This model was initialized with weak, uninformative priors, and four chains were run for 30000 iterations each (15000 warmup).

```
# Priors
prior_summary(cub_density_mod)
```

##	prior	class	coef group resp	dpar nlpar
##	(flat)	b		mudeathofmother
##	(flat)	b cub_associates		mudeathofmother
##	(flat)	b		muhuman
##	(flat)	b cub_associates		muhuman
##	(flat)	b		mulion
##	(flat)	b cub_associates		mulion
##	(flat)	b		muother
##	(flat)	b cub_associates		muother
##	(flat)	b		musiblicide
##	(flat)	b cub_associates		musiblicide
##	(flat)	b		mustarvation
##	(flat)	b cub_associates		mustarvation
##	student_t(3, 0, 2.5) Intercept			mudeathofmother



```
## student_t(3, 0, 2.5) Intercept      muhuman
## student_t(3, 0, 2.5) Intercept      mulion
## student_t(3, 0, 2.5) Intercept      muother
## student_t(3, 0, 2.5) Intercept      musiblicide
## student_t(3, 0, 2.5) Intercept      mustarvation
## bound      source
##      (unknown)
##      (vectorized)
##      (unknown)
##      (vectorized)
##      (unknown)
##      (vectorized)
##      (unknown)
##      (vectorized)
##      (unknown)
##      (vectorized)
##      (unknown)
##      (vectorized)
##      (unknown)
##      (unknown)
##      (unknown)
##      (unknown)
##      (unknown)
##      (unknown)
##      (unknown)
```

```
summary(cub_density_mod)
```

```
## Family: multinomial
## Links: mustarvation = logit; mulion = logit; musiblicide = logit; mudeathofmother = logit; muhuman
## Formula: y | trials(1) ~ 1 + cub_associates
## Data: cub.density.test.data (Number of observations: 80)
## Samples: 4 chains, each with iter = 30000; warmup = 15000; thin = 1;
##          total post-warmup samples = 60000
##
## Population-Level Effects:
##
##          Estimate Est.Error 1-95% CI u-95% CI Rhat
## mustarvation_Intercept      -1.53      1.07   -3.72    0.50 1.00
## mulion_Intercept            -0.91      0.98   -2.89    0.98 1.00
## musiblicide_Intercept       -1.20      1.14   -3.51    0.98 1.00
## mudeathofmother_Intercept   -1.07      0.83   -2.72    0.55 1.00
## muhuman_Intercept          -1.74      1.23   -4.27    0.57 1.00
## muother_Intercept          -1.00      1.08   -3.18    1.08 1.00
## mustarvation_cub_associates  0.21      0.19   -0.16    0.59 1.00
## mulion_cub_associates       0.14      0.18   -0.22    0.50 1.00
## musiblicide_cub_associates  0.09      0.22   -0.35    0.50 1.00
## mudeathofmother_cub_associates 0.37      0.15    0.09    0.68 1.00
## muhuman_cub_associates     0.15      0.22   -0.29    0.58 1.00
## muother_cub_associates      0.08      0.21   -0.34    0.48 1.00
##
##          Bulk_ESS Tail_ESS
## mustarvation_Intercept    36249   41304
## mulion_Intercept          35179   44034
## musiblicide_Intercept     37354   42779
## mudeathofmother_Intercept 30108   40468
## muhuman_Intercept         41168   41901
## muother_Intercept         40039   45048
```

```
## mustarvation_cub_associates      25021    33355
## mulion_cub_associates            23806    32515
## musiblicide_cub_associates       26009    36455
## mudeathofmother_cub_associates   19926    25886
## muhuman_cub_associates           28946    34912
## muother_cub_associates           27125    36269
##
## Samples were drawn using sampling(NUTS). For each parameter, Bulk_ESS
## and Tail_ESS are effective sample size measures, and Rhat is the potential
## scale reduction factor on split chains (at convergence, Rhat = 1).
```

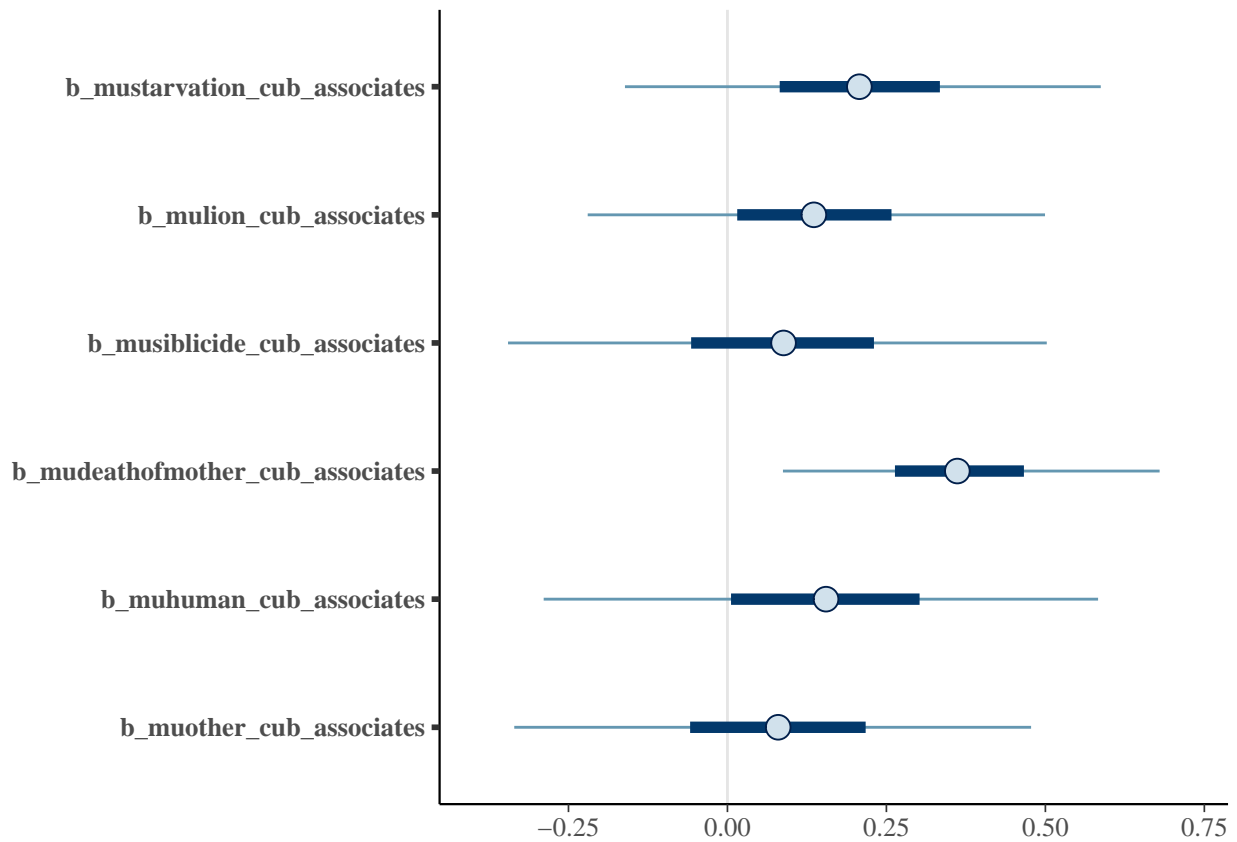


Figure S5. Interval plot showing parameter estimates and associated 50% and 95% credible intervals for the effect of cub density on the probability of different mortality sources. Infanticide is the reference level, so parameter estimates represent the log odds ratio of each mortality source relative to infanticide.

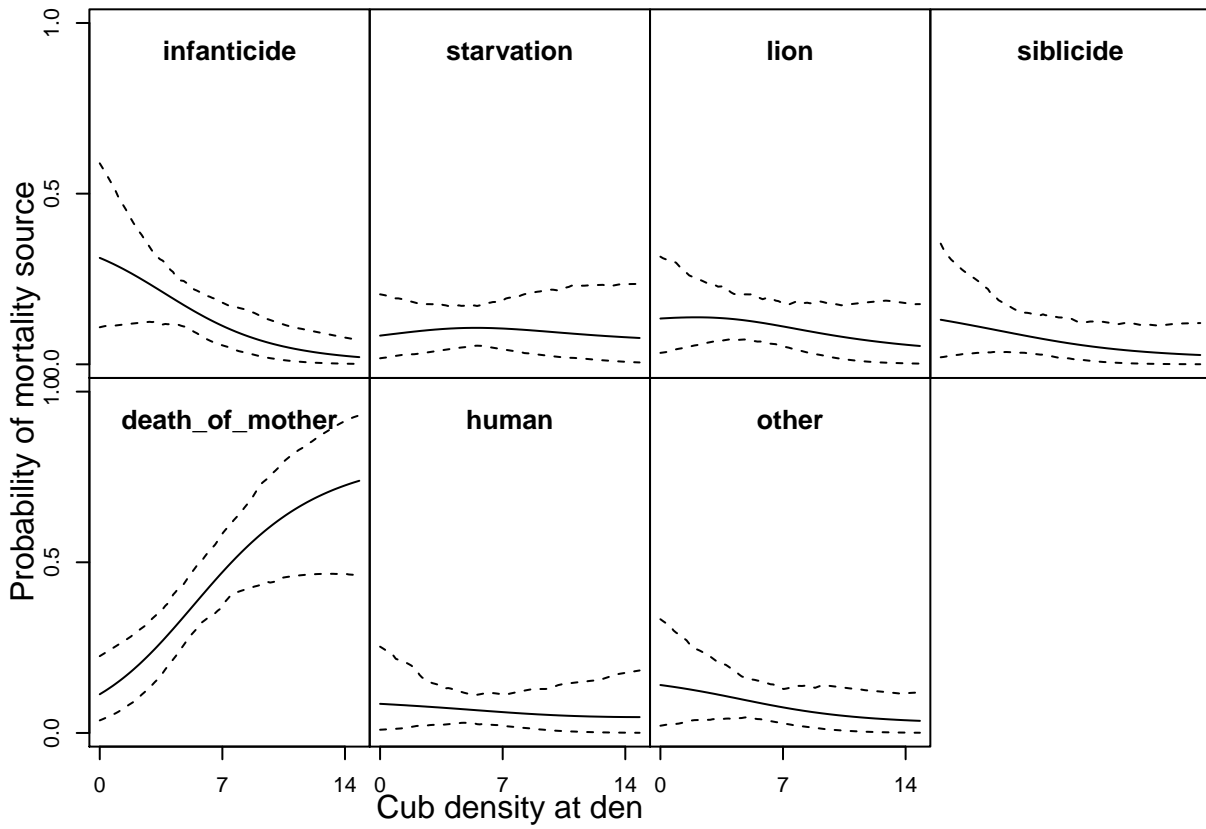


Figure S6. Predicted probability of mortality (with 95% prediction intervals) due to each source as a function of cub density.