Using genetic selection to improve lamb survival in extensive sheep production systems

J. Conington, K. Moore and C. Dwyer

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Lamb survival

- Pre-weaning lamb mortality 10-30%
- ↑ lamb survival from 1.3 to 1.4 lambs reared/ ewe is worth **~ £126M ~€139M**
- Good indicator of animal welfare

Lamb survival

UK - distinct sheep management practices

- Intensive – lowland/ upland indoor lambing
  - Managed on enclosed fields/paddocks
  - High input/output
  - Indicators of good survival e.g. lamb vigour* is more appropriate for these flocks
  - Suffolk breed record lamb vigour at birth

*MacFarlane et al 2010; Matheson et al 2011; 2012

Lamb survival

- Extensive – hill/upland, outdoor lambing
  - Flocks managed on open hill/ moorland, some ‘easy care’ / low input
  - Lambing not observed in most cases
  - Little/no human intervention around lambing time
  - Ewe and lambs’ own behaviours / adaptations critical to lamb survival*

*Dwyer 2005; Dwyer and Lawrence 2008.

Objectives

1. How to define lamb survival?

2. Which factors are critical to understanding/ implementing genetic analysis of lamb survival?

3. Can lamb survival be included into breeding programme alongside other traits ?

Methodology

- Blackface sheep data from Signet's *Sheepbreeder* recording scheme used for this study

- Data set 1 = 173,895 lamb records 1976 - 2011
  - 53,593 dams, 4,184 sires, 70 flocks
- Genstat analyses of statistical models to identify fixed effects and estimate survival odds.

- Data set 2 = 89,819 lamb records 2000-2011
  - 29,532 dams, 1943 sires, 29 flocks

Methodology

- GLMM in GENSTAT for binomial trait distribution
  - Regression fitted generates coefficients to predict a logit transformation of the probability of lamb survival

$$\text{Logit}(p) = b_0 + b_1X_1 + b_2X_2 + b_3X_3 \ldots b_nX_n$$

X_1= flock-year-season

X_2= sex

X_3= dam age

X_4= litter size

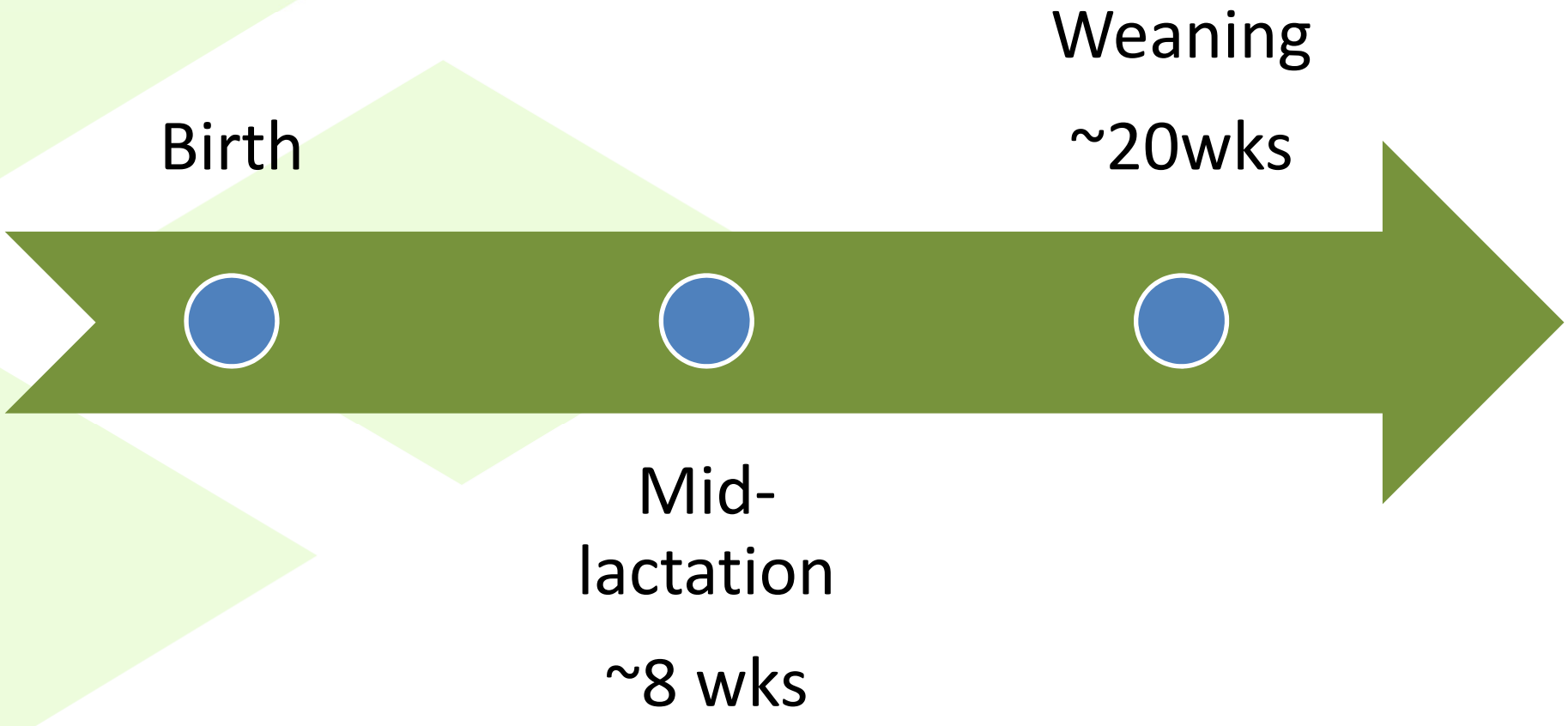
X_5= covariate lamb birth wt

Methodology

- Genetic parameters estimated using ASREML software
- Animal model univariate heritability for lamb survival
  - Logistic transformation 0/1; probit for 0/1/2
  - Direct & maternal genetic effects
- Bivariate analyses to estimate genetic correlations between lamb survival, live weights, fat and muscle depths

Definition of lamb survival?

Measurement opportunities are limited



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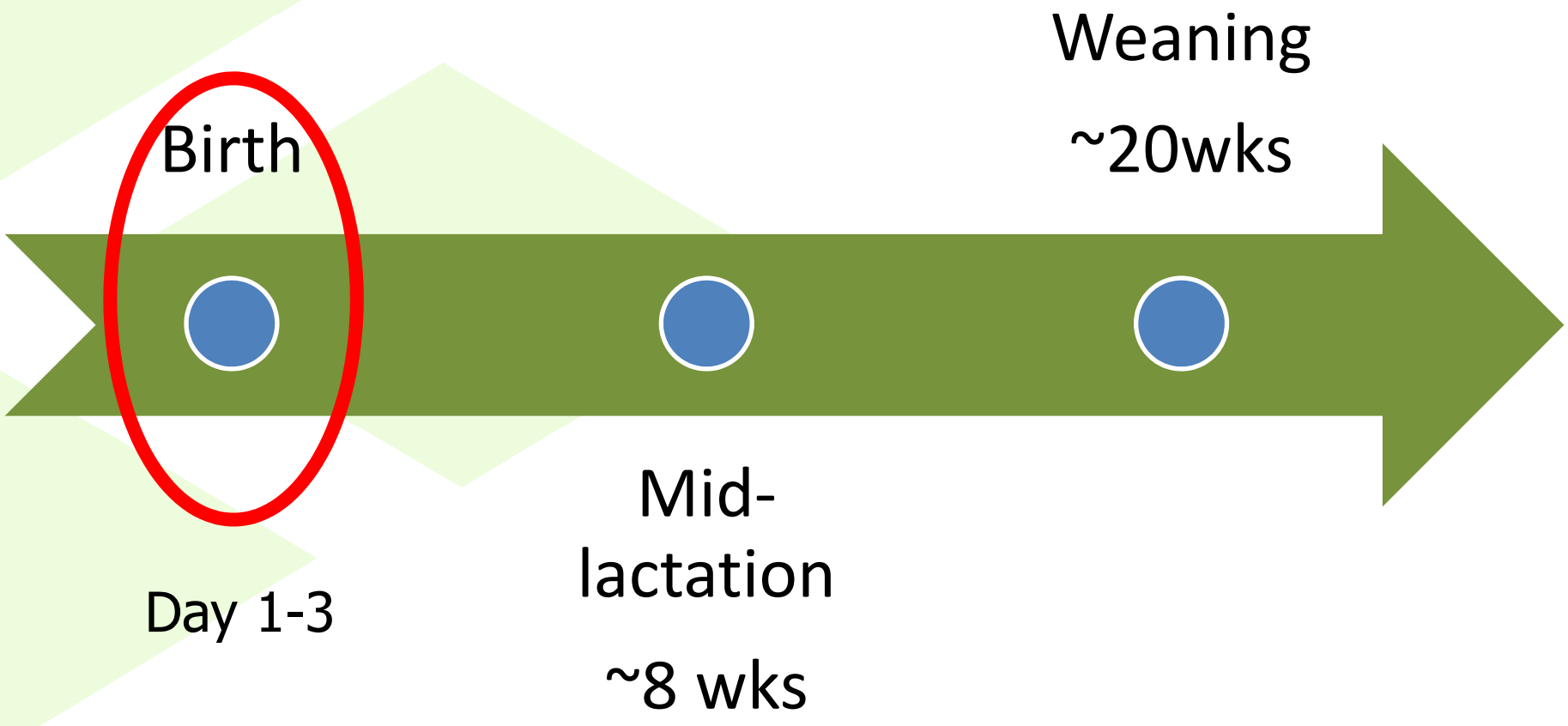
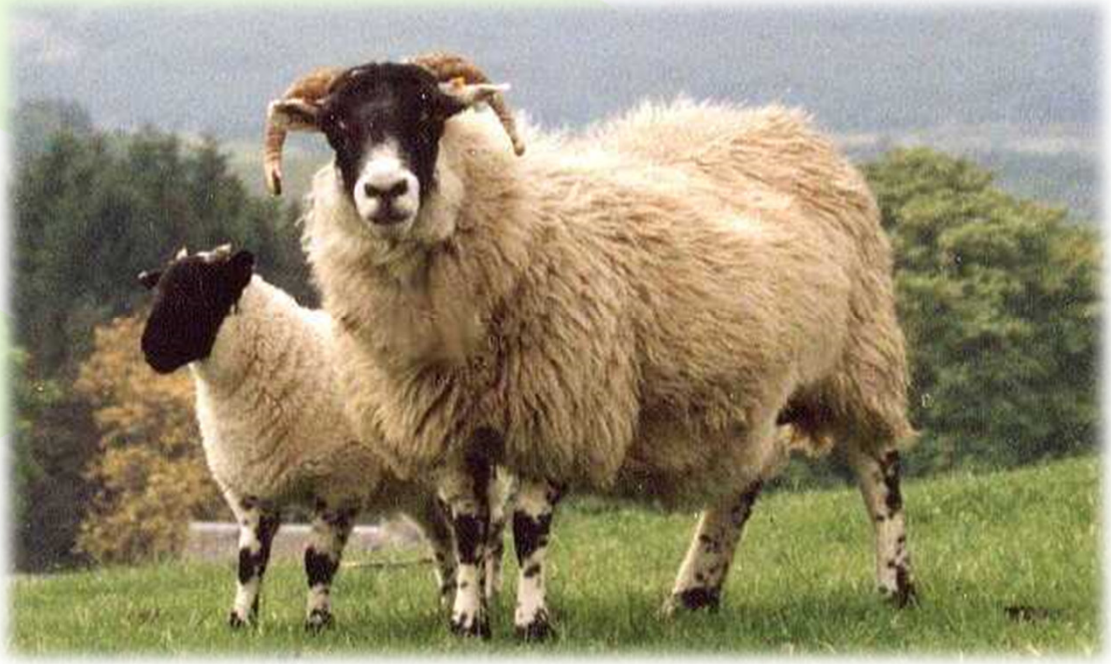


Lamb survival definitions

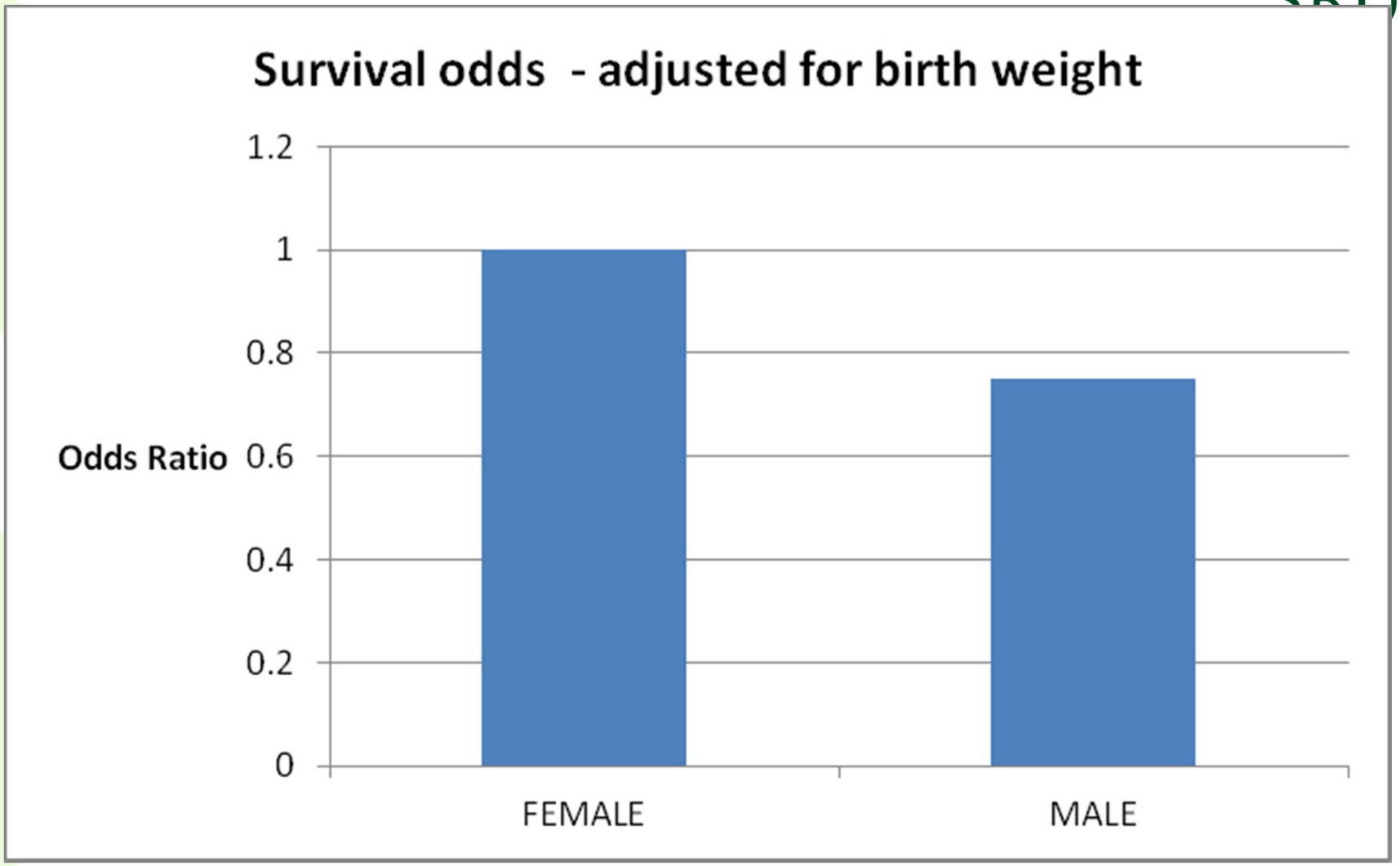
	0	1	2
SURV01	Dead - Born dead and lambs born alive but no subsequent live weights	Alive – lambs with live weights	-
SURV12	Dead - Born dead only	Dead -Born alive but no subsequent live weights	Alive – lambs with live weights

Results -% in each category

	0	1	2
Surv 0/1	12.2	87.8	-
Surv 0/1/2	5.5	6.7	87.8



Females have survival odds 1.3 that of male lambs

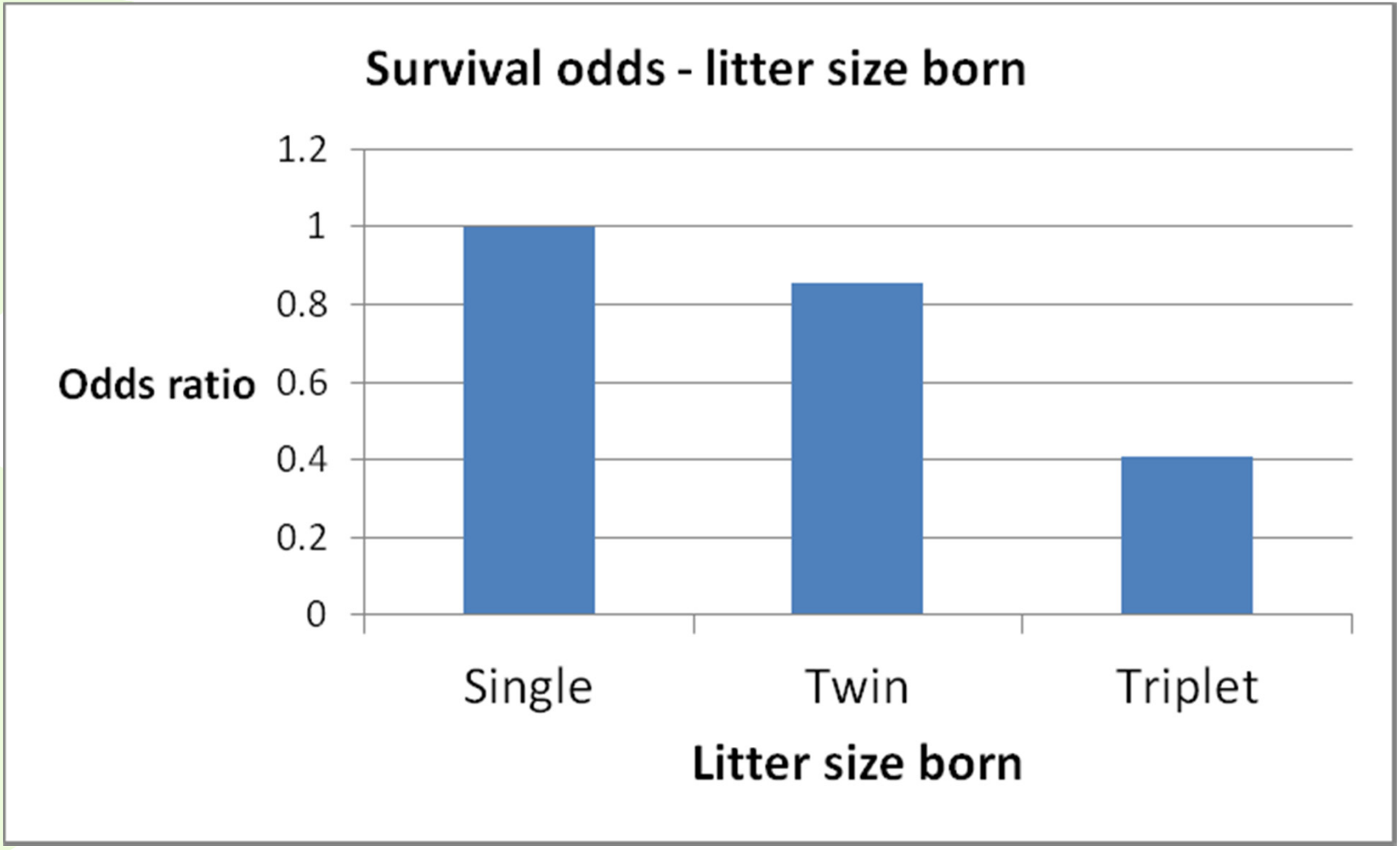


lcl= 0.70, ucl=0.79, s.e.d.= 0.03

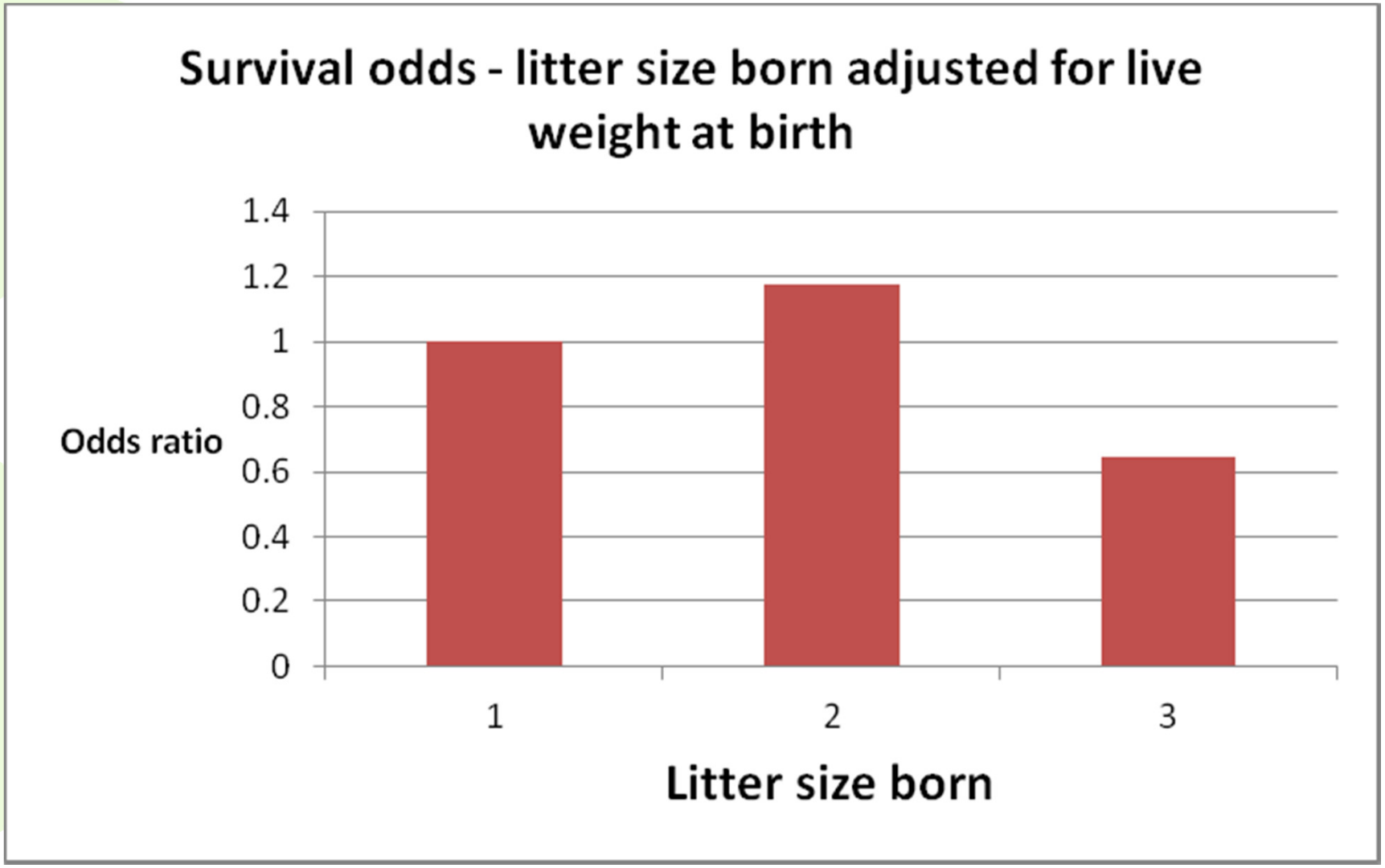
% Litter size born

Single	Twin	Triplet+
37.5	60	2.4

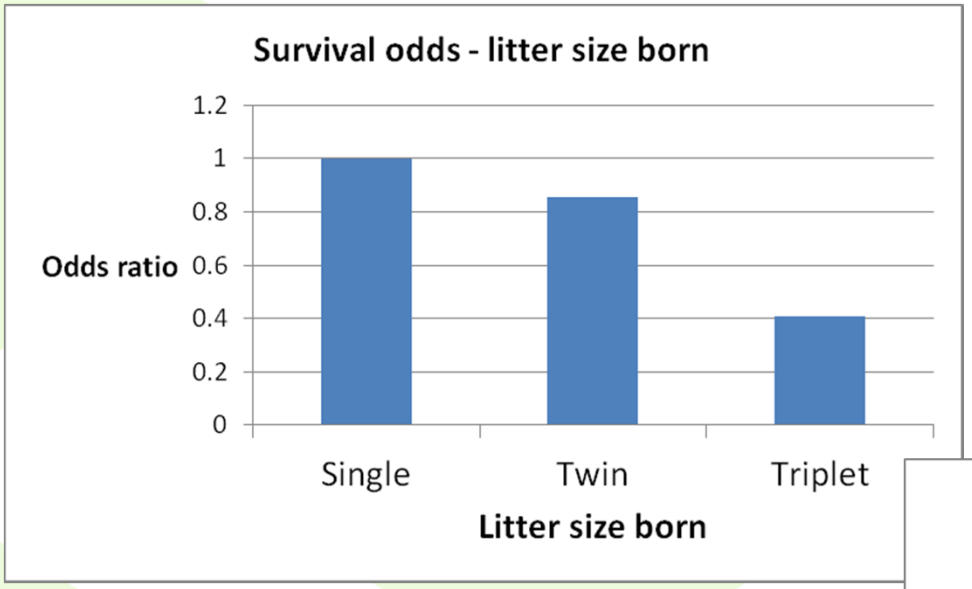
Survival odds and litter size



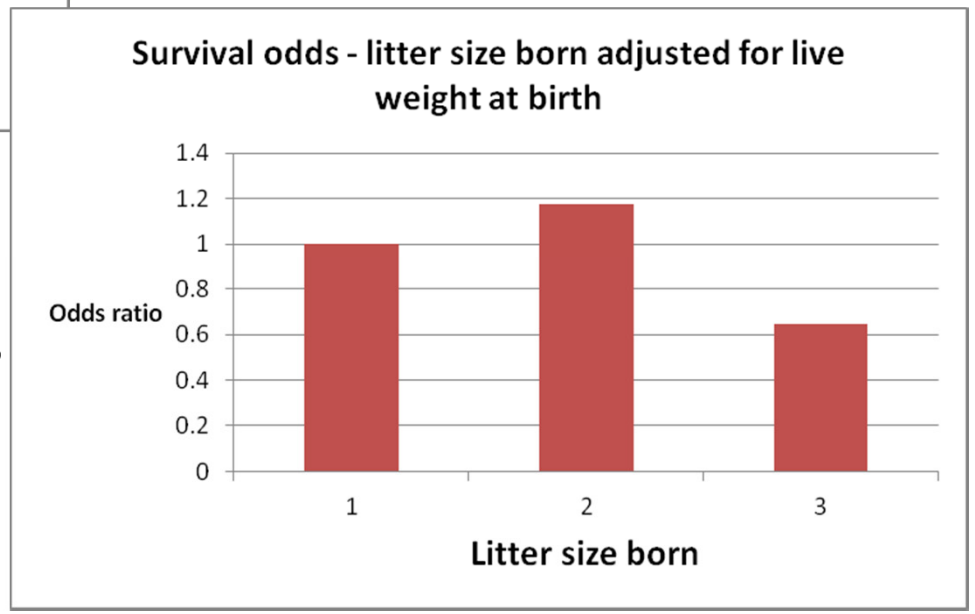
Survival odds and litter size accounting for differences in birth weight



Accounting for birth weight changes survival odds

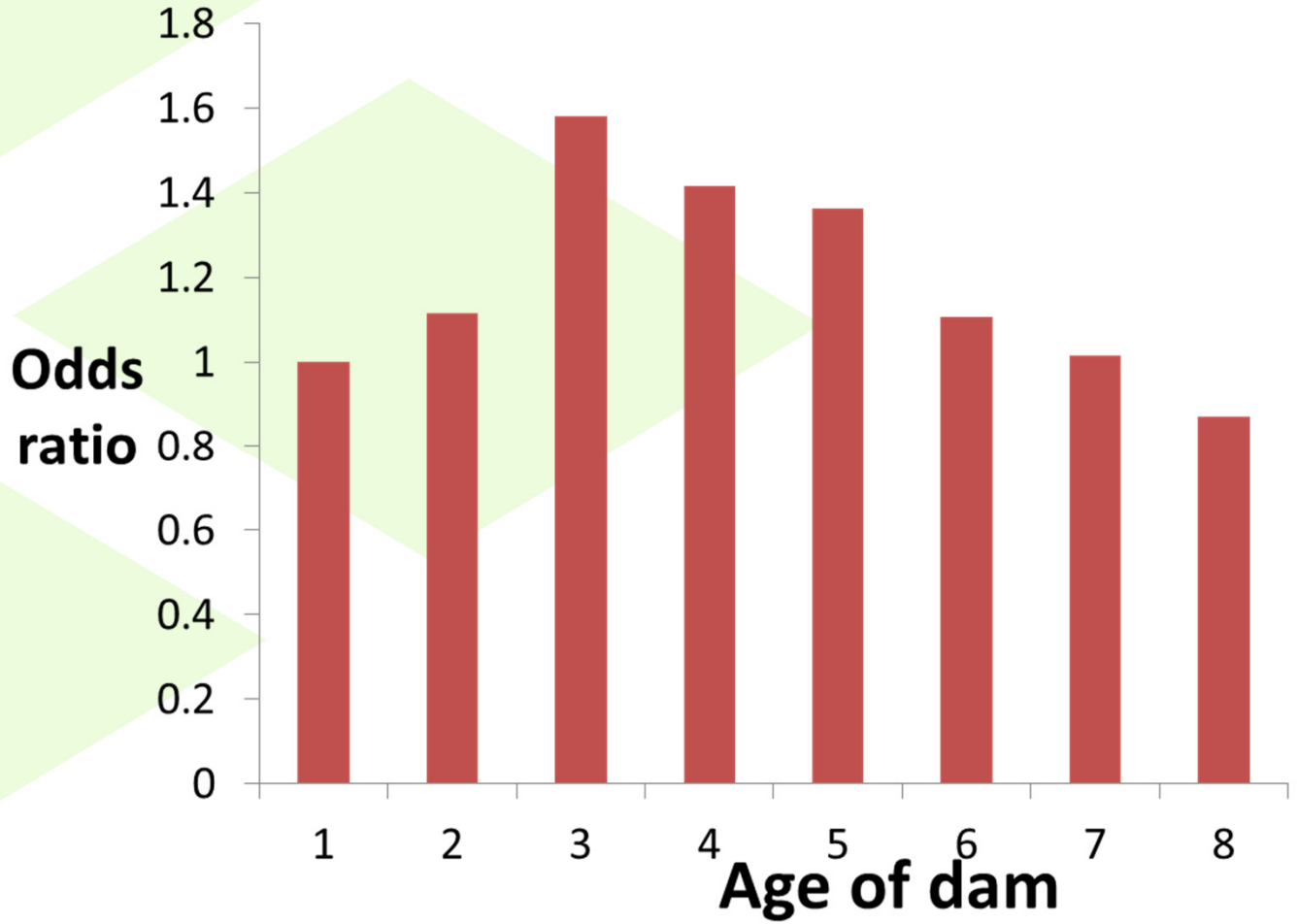


Probably reflects preferential treatment of twins in hill flocks

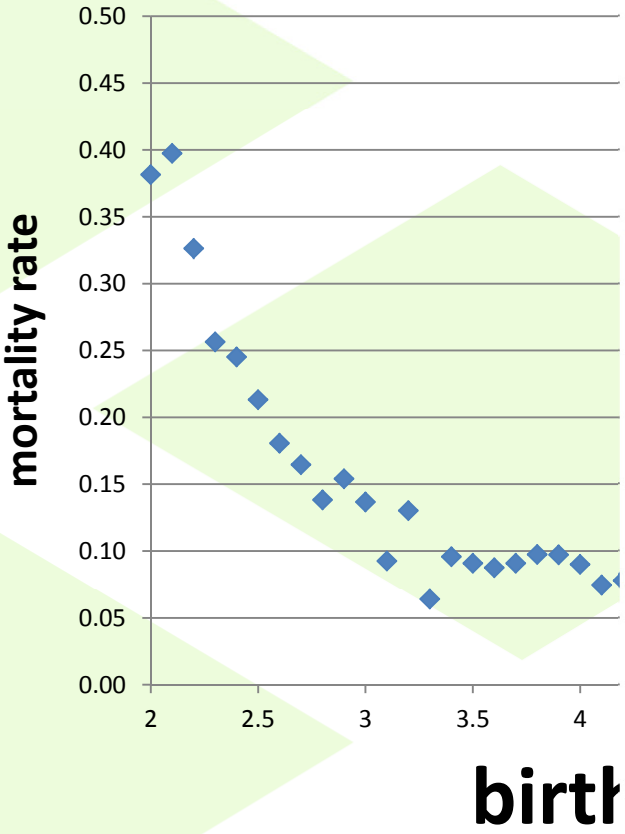


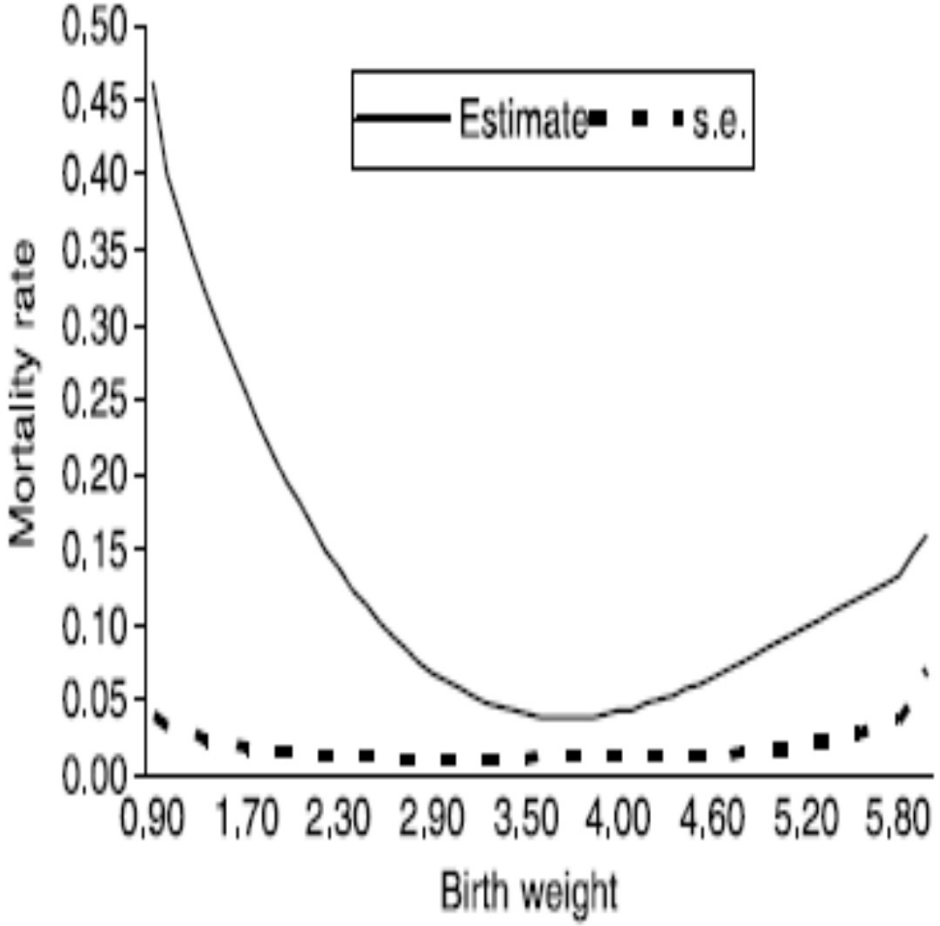
Lamb survival acc. dam age

Adjusted for diffs in lamb birth weight



Lamb birth weight and mortality





Sawalha et al., 2007 Animal 01, 1:151-157

Heritability

Model	direct	maternal
Direct & maternal genetic	0.01 (0.006)	0.08 (0.03)

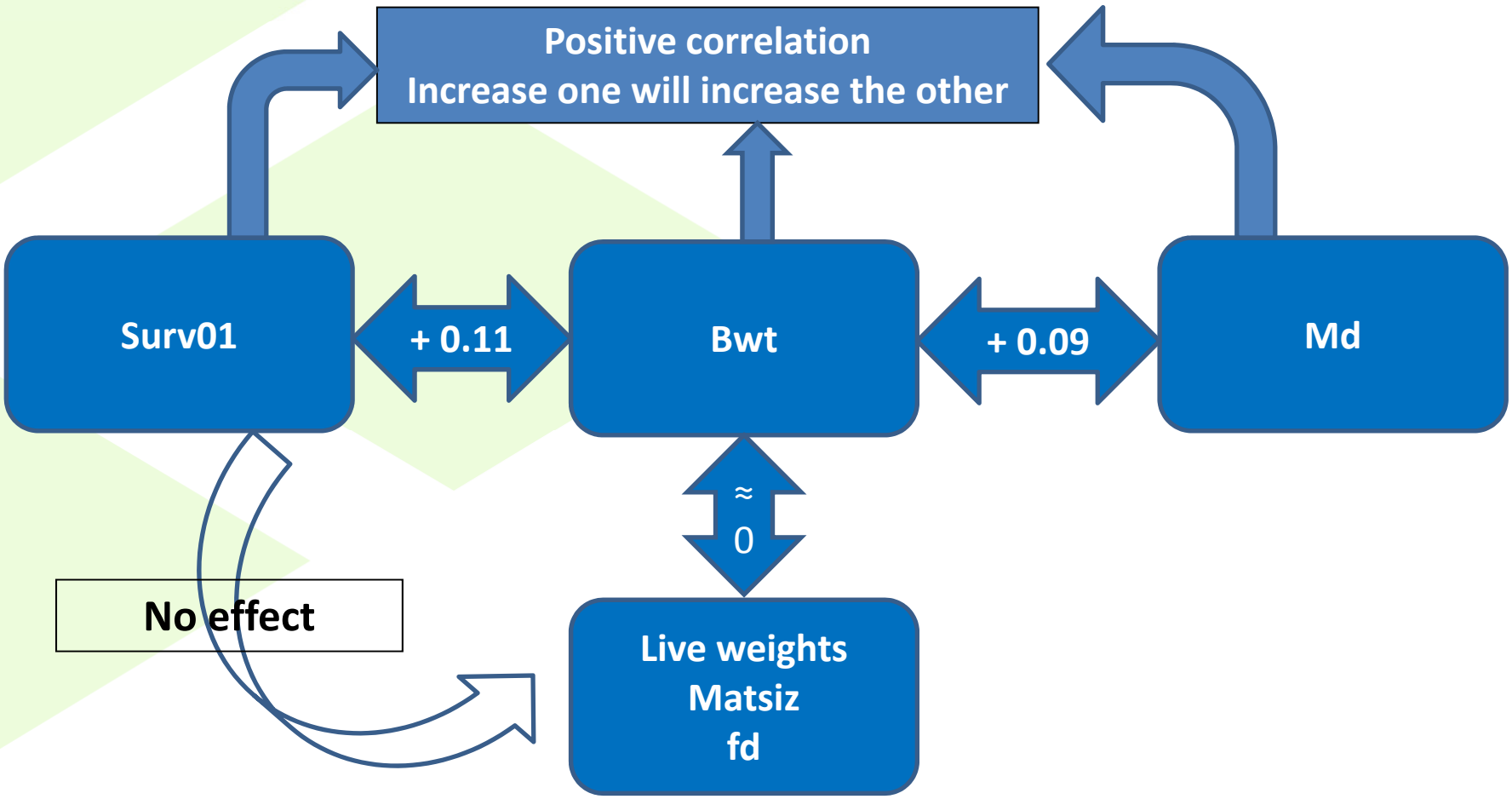
No difference between 0/1 and 0/1/2

Maternal component of lamb survival important.

Bivariate analyses with other traits

trait	No. recs	h^2	s.e
Bwt	20520	0.58	0.016
8 wk wt	23309	0.26	0.015
20 wk wt	16792	0.29	0.019
matsiz	2743	0.22	0.0528
Muscle	21516	0.41	0.016
fat	21516	0.42	0.016

Bivariate results



Conclusions

- Genetic basis to lamb survival is low but within published estimates for fitness traits

- Maternal genetic component important
  - maternal EBVs should be estimated for breeders
  - Rate of response to selection will be improved
  - No adverse effect on other traits

Conclusions (2)

- Increasing ewe longevity ⟶ higher lamb mortality
  - NB for low carbon farming systems

- Where possible, male lambs should be given preferential treatment
  - Similar to that already in place for twins

Acknowledgements

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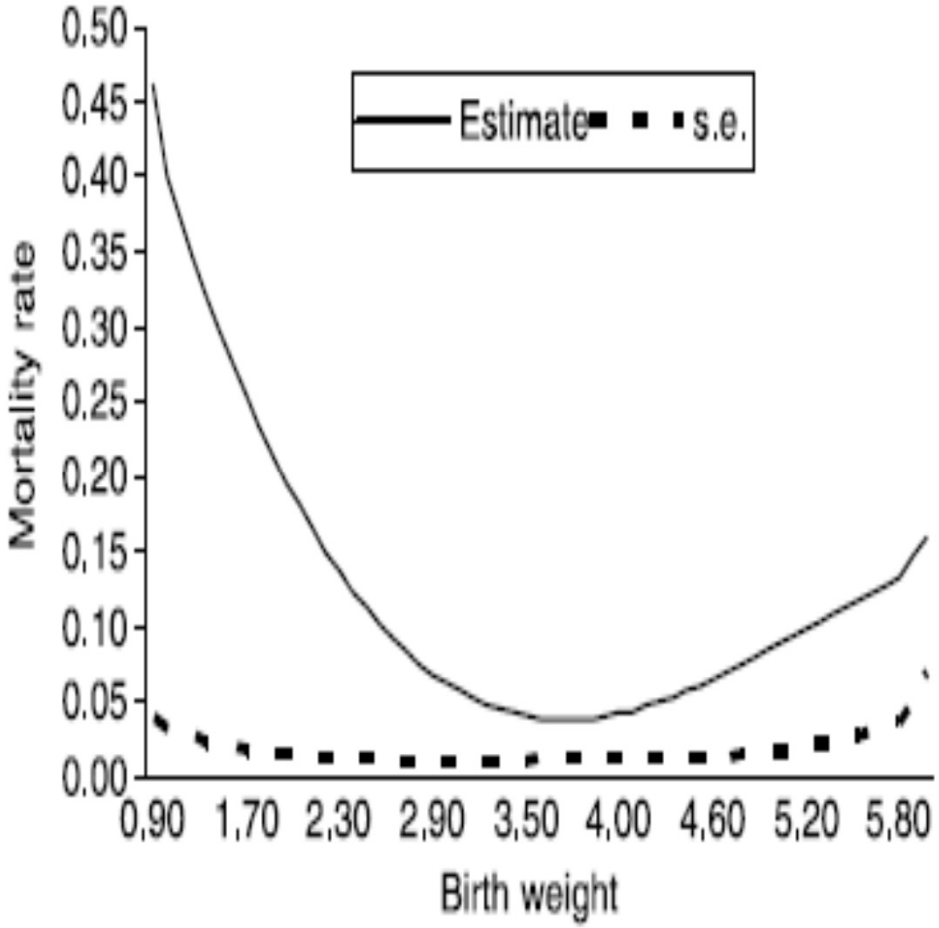
Birth weight and mortality rate in SAC's Blackface sheep –Sawalha et al, 2007



Heritability – different models

Model	h^2	s.e.
Direct	0.05	0.015