Epidemiological Study of Culling in Dairy Goats in New Zealand

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Outline of presentation

- Introduction
- Objectives
- Materials and methods
- Results
- Discussion

Introduction

- ‘Culling’: the departure of [cows] from a herd because of sale, slaughter, salvage, or death’ (Fetrow et al. 2006)

- Much known about risk factors for culling and deaths in dairy cattle – can the same inferences be applied to dairy goats?

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Objectives

- Describe the demographics and production characteristics of dairy goats registered with the New Zealand Dairy Goat Co-operative

- Describe the pattern of culling in dairy goats registered with the New Zealand dairy Goat Co-operative

- Identify risk factors for culling in New Zealand dairy goats

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Materials and methods

Study population

- Source population: does with production records monitored by the New Zealand Dairy Goat Cooperative

- Eligible population: does born only after 01 January 2000
  - individuals followed until 31 December 2009 or until the date of removal from the herd, whichever occurred first
  - breeds represented: Saanen, Toggenburg, Alpine, and Nubian

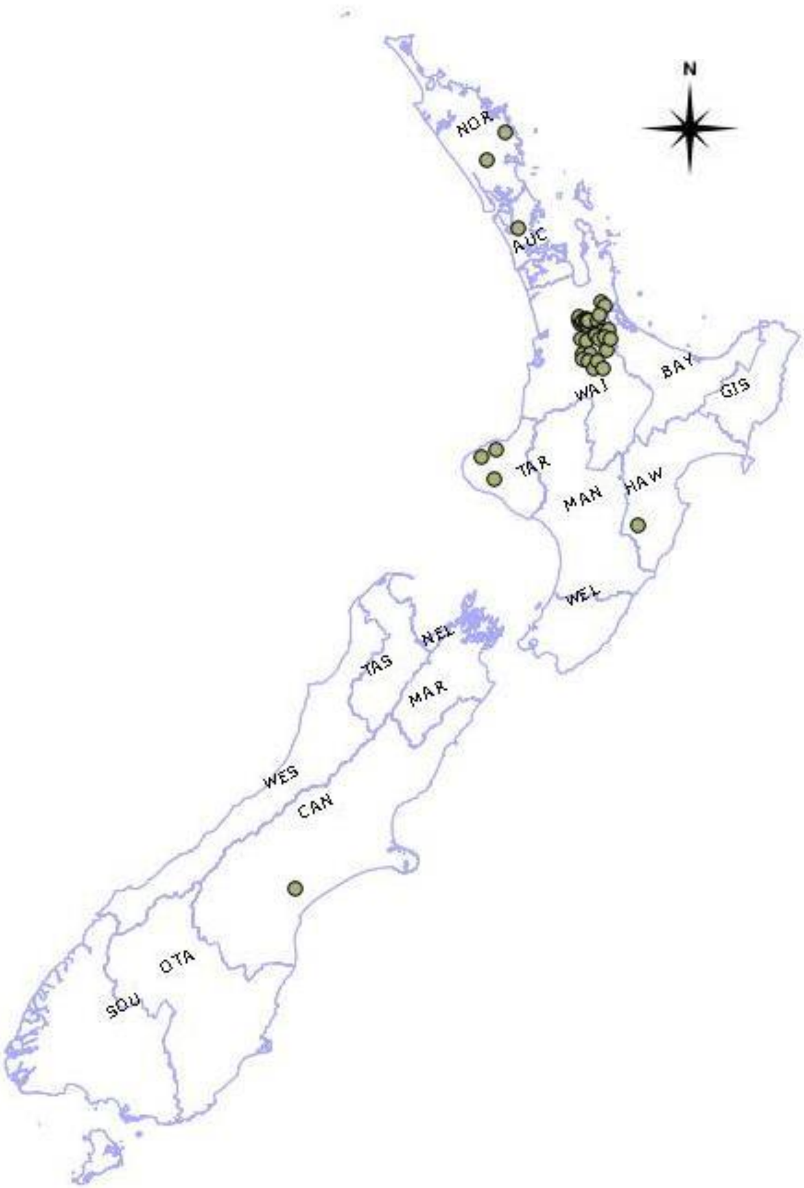
Saanen

Toggenburg

Alpine

Nubian

Map of New Zealand showing locations of farms used in this study



Key:

NOR- Northland

AUC- Auckland

WAI -Waikato

BAY- Bay of Plenty

GIS -Gisborne

TAR -Taranaki

MAN -Manawatu-Wanganui

HAW -Hawke's Bay

WEL -Wellington

NEL -Nelson

TAS -Tasman

MAR -Marlborough

WES -West Coast

CAN -Canterbury

OTA- Otago

SOU -Southland

Materials and methods

Outcome of interest

- Length of productive life (LPL)
  - culled animals: LPL = date of culling minus date of second kidding
  - censored animals: LPL = 31 Dec 2009 minus date of second kidding

- The study population comprised biographical and production details for 13,197 goats from 38 herds in the North Island

- Of this group 5,386 animals were culled; the remaining 7,811 animals were treated as censored observations

Materials and methods

Analytical methods

- Cox proportional hazards model

- Candidate explanatory variables:
  - L1 milk yield,
  - L1 fat + protein (≡ milksolids) yield,
  - proportion Saanen, Toggenburg, Nubian, Alpine

- A test for collinearity showed that milk volume and milksolids were highly correlated, so only milksolids used

Materials and methods

- All of the candidate explanatory variables were continuous

- Continuous variable first broken down into quartiles to create categorical variables

- The log-rank test was used to check if LPL varied by each level of each categorical variable

Materials and methods

- A Cox proportional hazards model was developed including all explanatory variables significant at the bivariate level

```
nzdga.cph01 <- coxph(Surv(lpl, status, type = "right") ~
nubian + alpine + saanen + toggenburg + ms.L1, method =
"breslow", data = dat)
```

Materials and methods

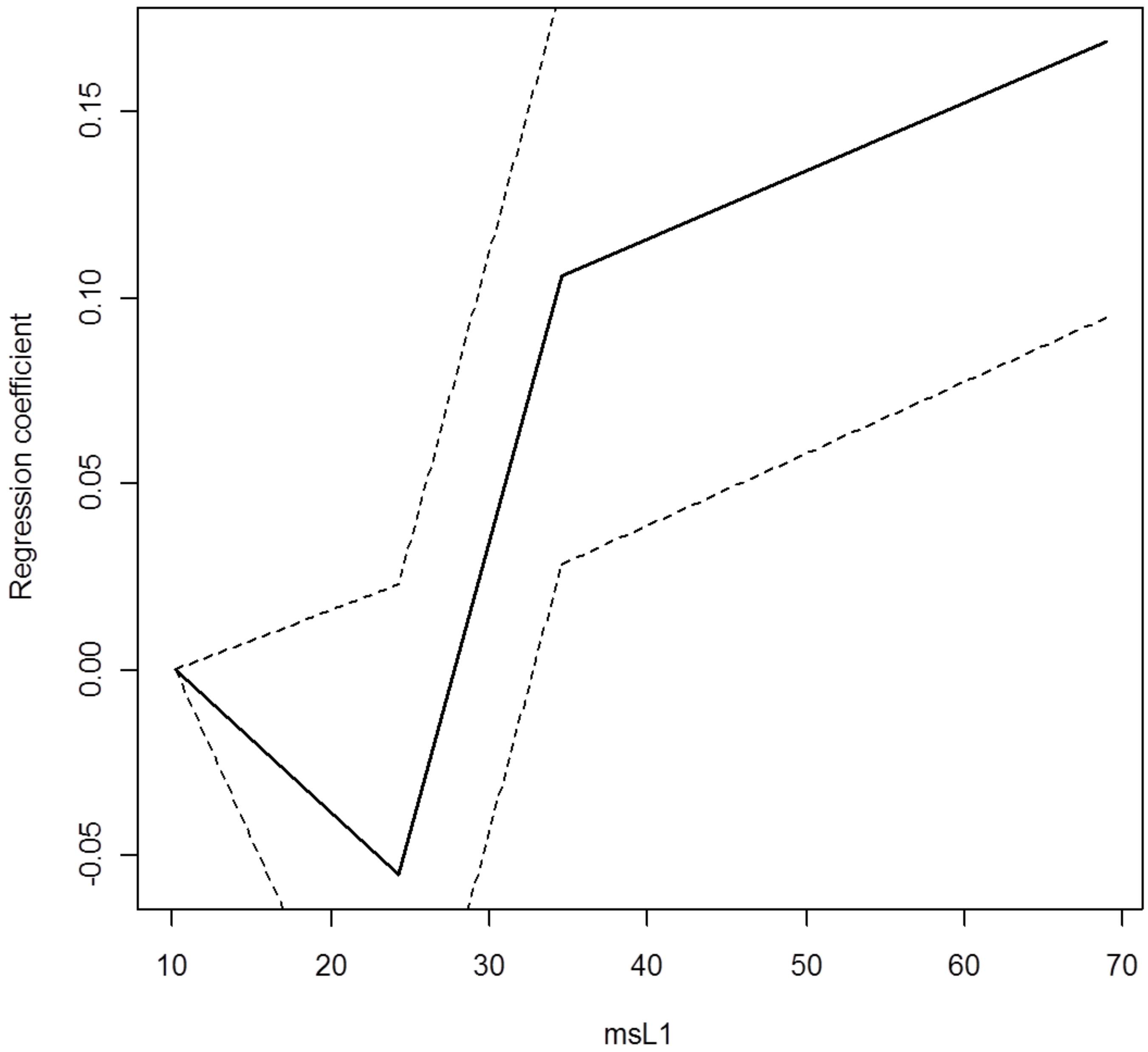
- Nubian and Alpine dropped

Breed	Category	Number
Nubian	Nubian = 0	13,011
	Nubian > 0	186
Alpine	Alpine = 0	13,030
	Alpine > 0	167

Materials and methods

- The relationship between first lactation milksolids yield and log hazard of culling was non-linear

Line plot showing estimated regression coefficients (and their 95% confidence intervals) for four quantiles of first lactation MS yield as a function of first lactation MS yield (kg).



Materials and methods

- First lactation milksolids yield therefore parameterised using a smoothed spline:

```
nzdga.cph02 <- coxph(Surv(lpl, status, type = "right") ~
saanen + toggenburg + pspline(ms.L1), method = "breslow",
data = dat)
```

Materials and methods

- Next step was to check the proportional hazards assumption

```
cox.zph(nzdga.cph02, global = TRUE)
```

```
                  rho    chisq        p
ps(ms.L1)2  -0.01031   0.1096   0.74064
ps(ms.L1)3  -0.01105   0.2296   0.63178
...
ps(ms.L1)13  0.01177   0.2718   0.60212
GLOBAL            NA  29.2599   0.00360
```

CONCLUSION: CPH ASSUMPTION VIOLATED !

Materials and methods

- So we have a covariate that itself did not change over time but its effect varied over time

- Solution: LPL was divided into two periods – less than or equal to 730 days and greater than 730 days (piecewise Cox model)

- Frailty (≡ random effect) term for herd included

```
nzdga.cph03 <- coxph(Surv(start, stop, event = status,
type = "counting") ~ I(pspline(ms.L1) * t1) +
I(pspline(ms.L1) * t2) + frailty(herd), method =
"breslow", data = dat.cp)
```

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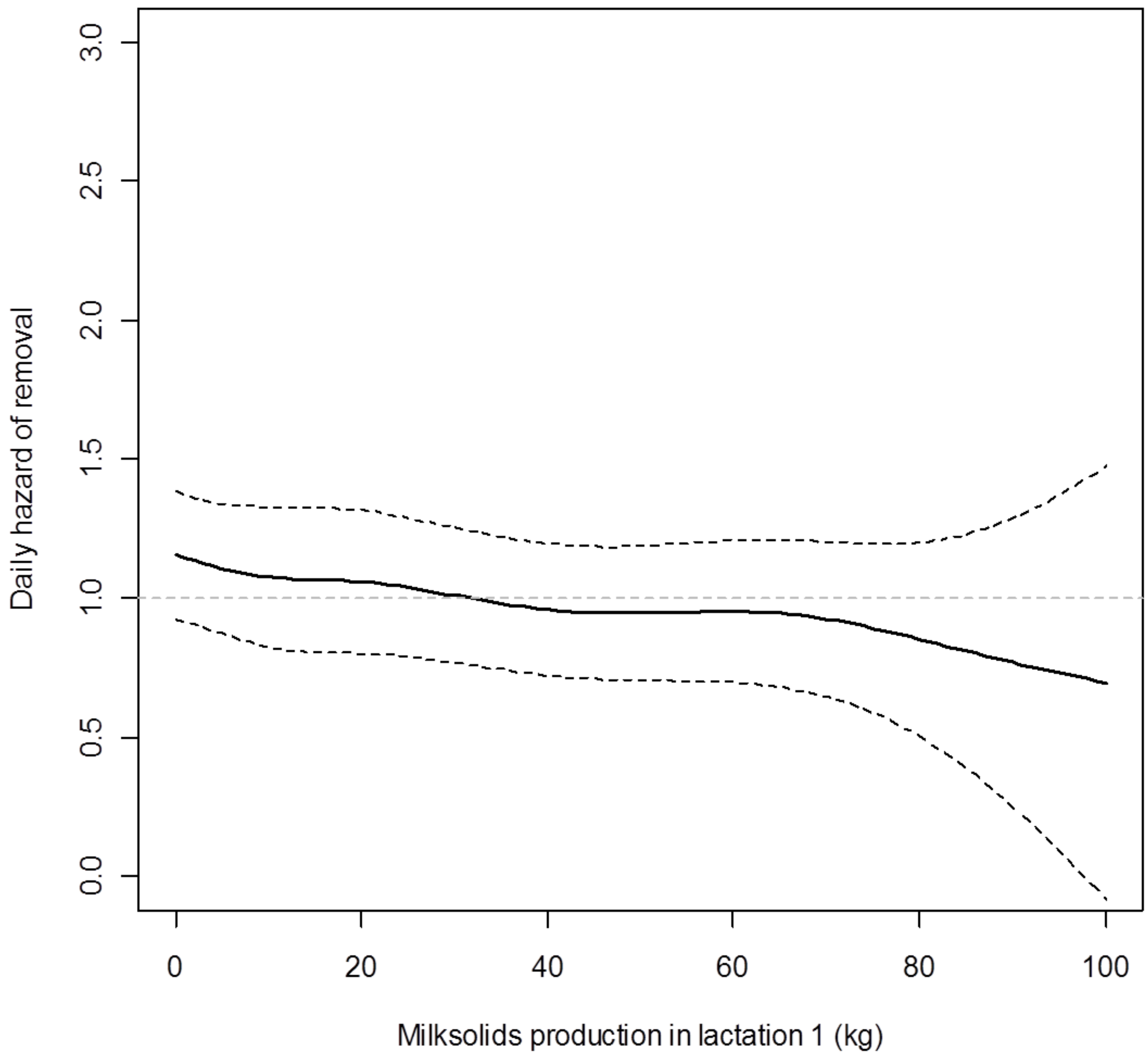
Regression coefficients from a Cox proportional hazards model of factors influencing length of productive life in New Zealand dairy goats

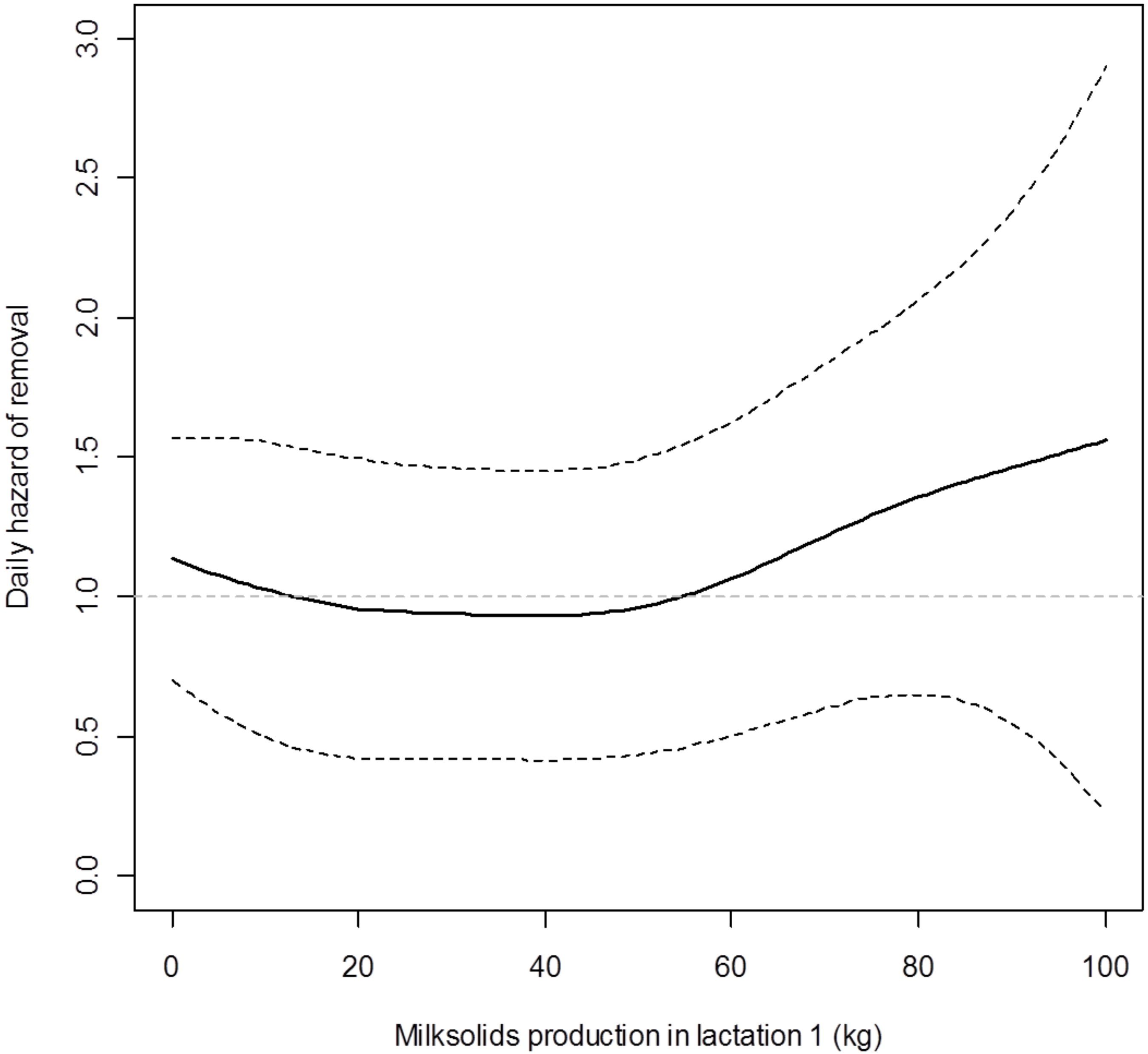
Variable	Coefficient (SE)	P	Hazard ratio (95%)
First lactation milksolids yield:			
Linear (0 to 730 days)	-0.0033 (0.0014)	0.02	-
Non-linear (0 to 730 days)		0.65	-
Linear (>730 days)	0.0014 (0.0016)	0.36	-
Non-linear (>730 days)	-	0.03	-

Effect of L1 MS yield on daily hazard of removal, 0 to 730 days (P < 0.05)



Interpretation: during the first two years after L1, you're less likely to be culled if you were a high producer in L1.

Effect of L1 MS yield on daily hazard of removal, > 730 days (P > 0.05)



Interpretation: beyond two years after L1, high L1 producers have an increased hazard of culling.

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Discussion

- In dairy cattle
  - first lactation milk yields have a significant, positive relationship on milk production in subsequent lactations (Stassen *et al.* 1991; Haworth *et al.* 2008)
  - high first lactation milk yields have been shown to have a negative effect on productive life (Pasman *et al.* 1995)

- This study demonstrates a **change** in the effect of first lactation milk yield on survival over time

- Unmeasured, herd-level effects had an important influence on LPL