Using splines to model liveweight patterns in a Heifer Management Study

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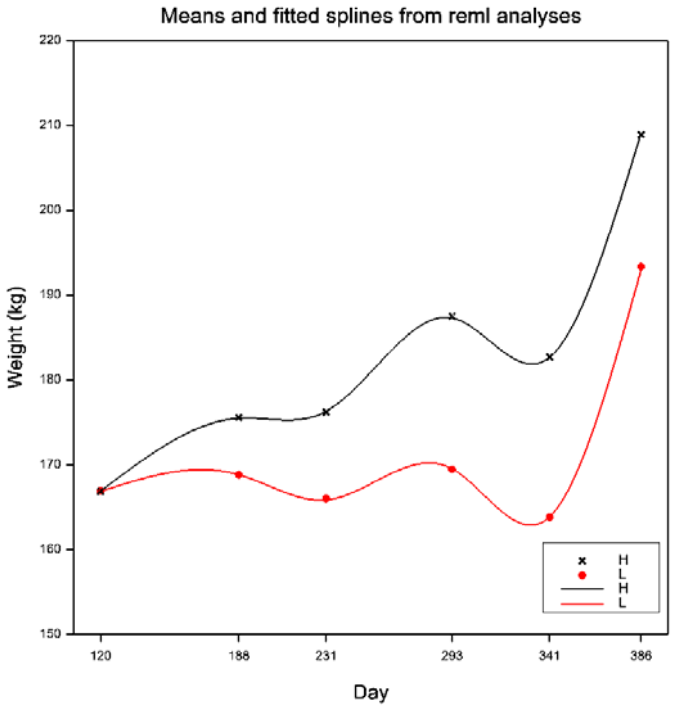
Presentation Overview

- Heifer Management Study Overview
- Experimental Design and Data Recorded
- Application of splines



Heifer Management Study Overview

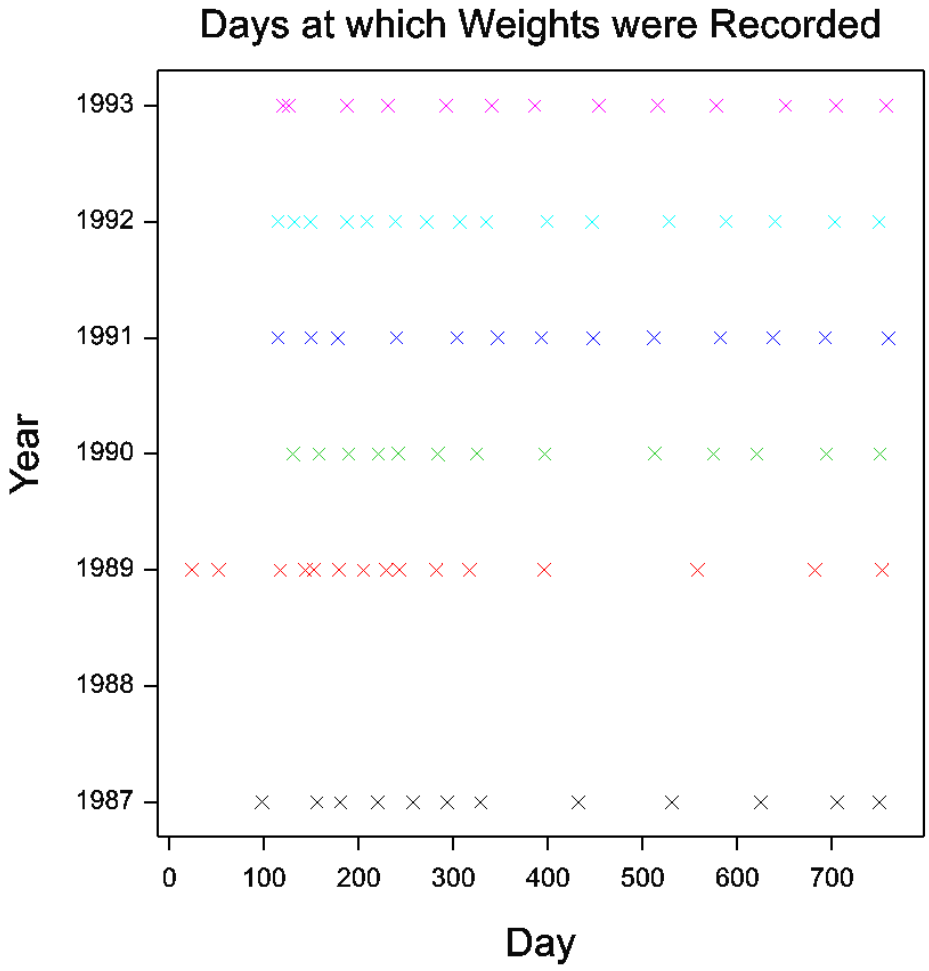
- Conducted at Swans Lagoon, North Queensland
- 6 cohorts of 200-300 heifers from 1987 and 1989 to 1993
- 6-12 years of data for each intake
- Data Recorded:
  - Over Time
    - **Weights**
    - Condition Scores
    - Hip Heights
    - Conception and Calving data
    - Selected Progesterone data
  - Pubertal data
- I have been analyzing the **weights**, condition scores and hip heights over the first 2 years of data

Experimental Designs

- Slightly different experimental designs for each year
- The heifers were split into weaner sizes, most commonly split into 3 groups: Small, Average and Big.
- Treatment Factors
  - Nutrition (Low or High)
  - Vaccinated (None or Androstenedione Vaccine)
  - Mating (Mated as 1 or 2 year olds)
  - Spay Group (None or Method/Time of Spaying)
- Other Factors
  - Paddocks
  - Replicates

Experimental Data

- Weights recorded ~14 times over the first 2yrs
- Unequal intervals between measurements which generally increased over time.

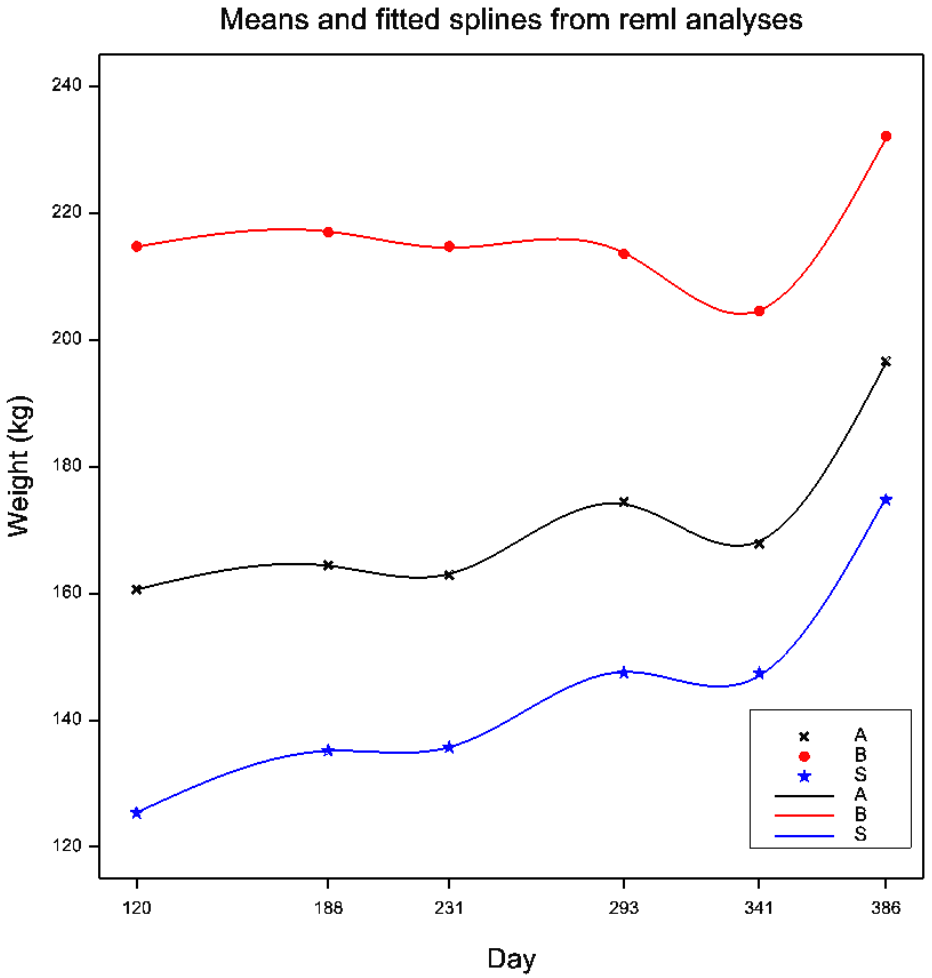


Seasonal Changes

- General weight patterns over 3 seasons
  - May-August (Cold/Wet) – Maintain
  - September-Break (Hot/Dry) - Lose
  - Break-April (Hot/Wet) – Gain
- Seasons varies over years
- Up to 100 days between weightings
- Total weight gain/loss between weight-ins may not be linear
- This also applies to condition scores

Why I used Splines?

- Offer a flexible way to investigate the shape of a relationship
- Show the shape of the relationship between weight and time
- Use a smooth non-linear relationship to minimize the impression of distinct linear gains or losses



How I Analysed my Data

- REML within GenStat
- Vcomponents
  - Fixed model terms
    - Treatment factors
    - Weaning weight covariate (WW2R)
    - Day
  - Random model terms
    - Heifer
    - Paddock 1
    - Heifer.day

```
"REML without spline"
vcomponents [fixed=vaccine+spaygp+(wsize+nutrn+r1+WW2R)*day;\
  factor=2] random=hn+pdk1+hn.day; constraints=positive
vstructure [terms=hn.day] model=identity,diagonal; factor=hn,day
reml [print=model,comp,means,deviance,Wald] wt
```

- Vstructure
  - Define the form of covariance structure
  - Allow for a changing variance

How I Applied Splines to my Data

- Re-did analysis including splines
- Time factor change
  - Original model: **day** as a time **factor**
  - Spline model: **D** was created as a continuous time **variable**
- Spline option used with vcomponents
  - Terms included the time variable D and factors which significantly interacted with D

```
"REML with spline"
vcomponents [fixed=vaccine+spaygp+(wsize+nutrn+r1+WW2R)*D; factor=4;\
  spline=D+D.(wsize+nutrn+r1)] random=hn+pdk1+hn.day
vstructure [terms=hn.day] model=identity,diagonal; factor=hn,day
reml [print=model,comp,deviance,Wald] wt
```

Graphing

- Factors found to have a significant interaction with day were graphed
- Vpredict: used to predict the means of each factor by day interaction
  - Data points: predicted from the REML analysis without splines
    - Means for each day weights were recorded

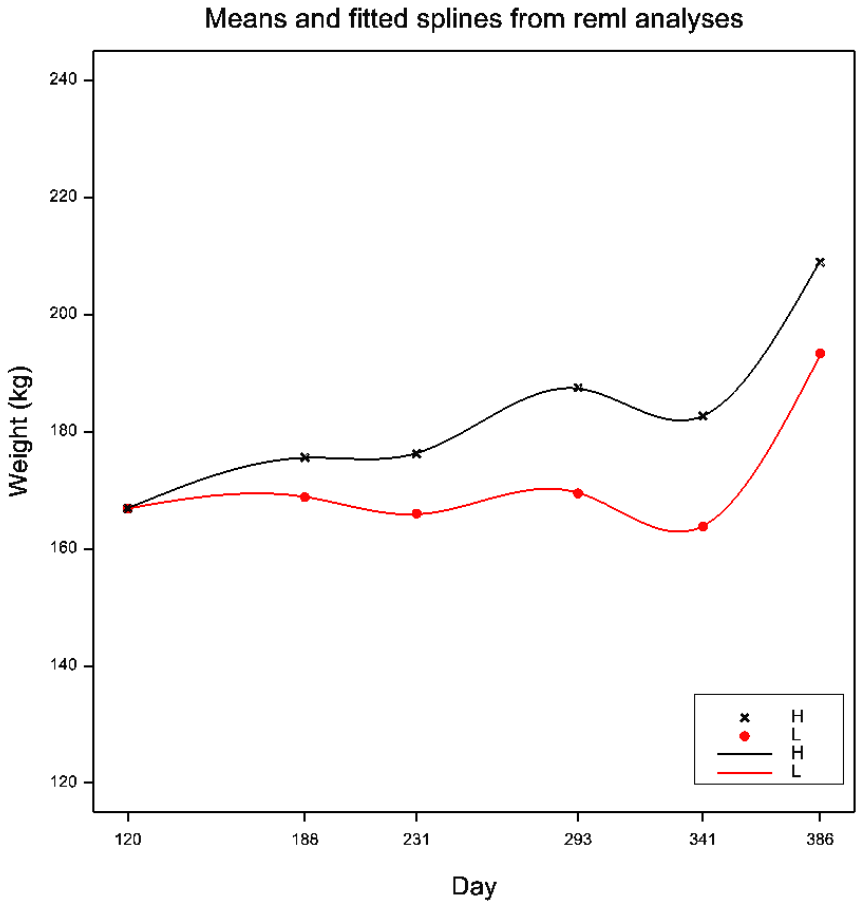
```
vpredict [print=*; pred=mntdtbl1] y,day
```

  - Splines: predicted from the REML analysis including splines
    - Means for each day between the first and last recording

```
vpredict [print=*; pred=mntdtbl2] y,D;*,!(120,121...386)
```

- Predicted means were saved and then graphed

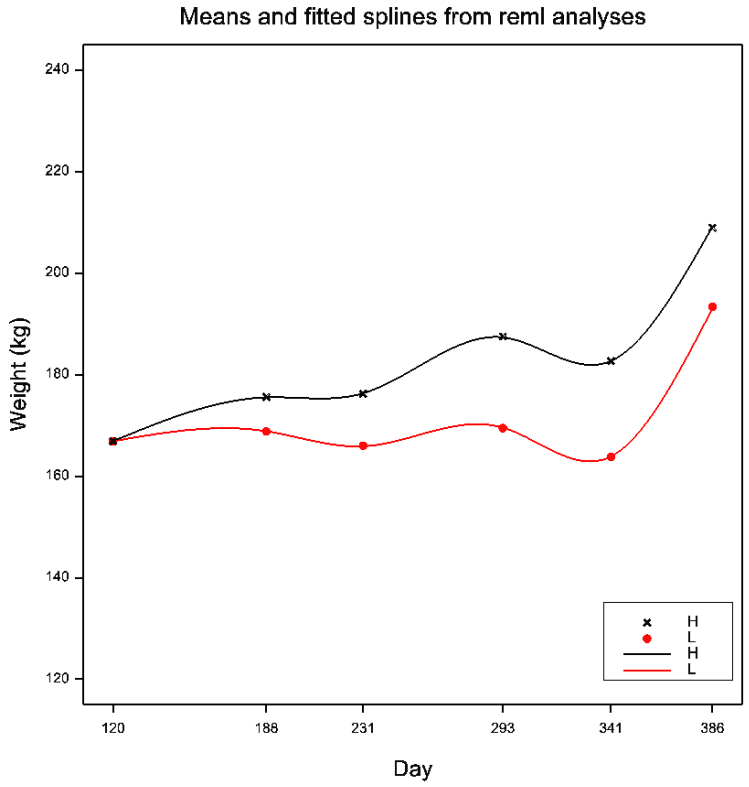
Graphs



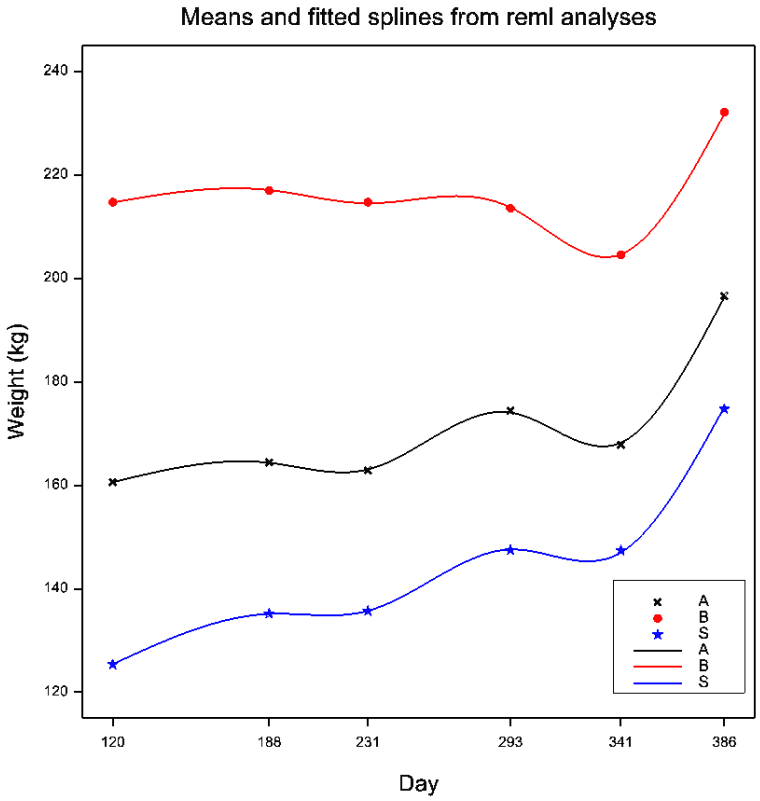
- Data Points
  - Mean values saved for each day the heifers were weighed
- Splines
  - Mean values saved for every day between day 120 and 386 and graphed as a smooth line

Example Graphs – Significant Factor Changes over Time

- 1993 Weights – Weaning to 1yo Mating



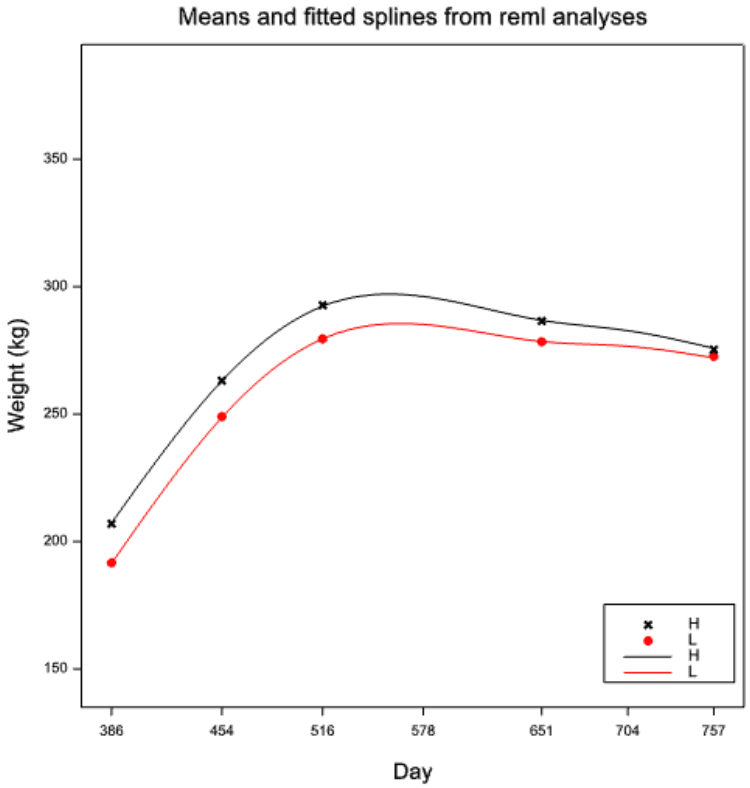
Weaner Size



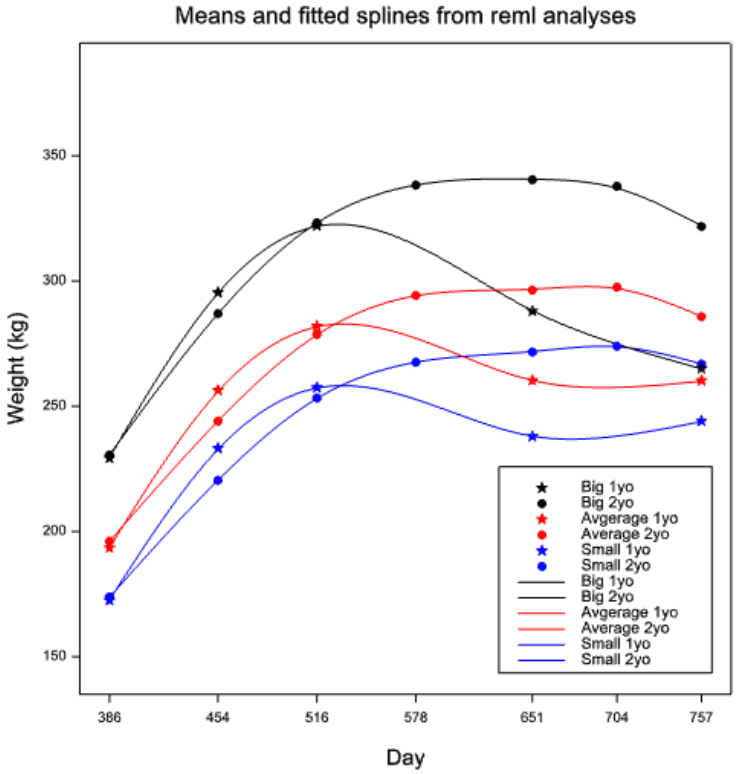
Nutrition

Example Graphs – Significant Factor Changes over Time

- 1993 Weights –1yo Mating to 2yo Mating



Nutrition



Weaner Size
by Mating

In conclusion:

- Splines have been a great visual aid in seeing the relationship trends between weights over time
- They have been great to see how the different levels of factors differ for the weight trends over time
- Splines make it much easier to visualise how the factors interact for more complex 3 way interactions