

## **Pupping rate Estimates**

(Project: POP2006/01)

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## **Model development**

- Mixture model failed (please ignore the report)
- Data does not divide neatly into groups of breeders and non-breeders
- Must use decide which cows had a pup each year using the observations

## Definition of breeder

Cow that gives birth, including when the pup dies or is a stillbirth

## Relevant observations

- Birth, stillbirth, dead pup
- Nursing
- With pup, calling pup
- Frequency of observations

## Criterion for determining a breeder

Observation counts as percentage of total for probable breeders and probable non-breeders

Observed (number)	Number of observations							
	1	2	3	4	5-9	10-14	15-19	20+
Birth (174)	0.6	1.7	0	0	8.0	17.3	24.2	48.2
Stillbirth, pup died (19)	0	0	0	0	10.5	15.8	10.5	63.1
>2 breeder obs (682)	0	0	0	1.6	14.5	22.6	23.3	38.1
2 breeder obs (110)	0	7.3	13.6	10.0	47.3	13.5	2.7	5.4
1 breeder obs (151)	39.7	17.9	4.6	4.6	19.8	7.3	3.4	2.8
No birth or breeder obs (3158)	45.8	8.0	3.9	4.2	14.8	10.3	5.8	7.4

- I conclude that 2 or more breeder observations usually indicate an animal is a breeder.
- The frequencies suggest that a few non-breeders may be counted but also that a few breeders may be omitted.

## Criteria for identifying breeder

Base: (1) birth, stillbirth, dead pup **OR**  
 (2)  $\geq 2$  of nursing, with pup or calling pup

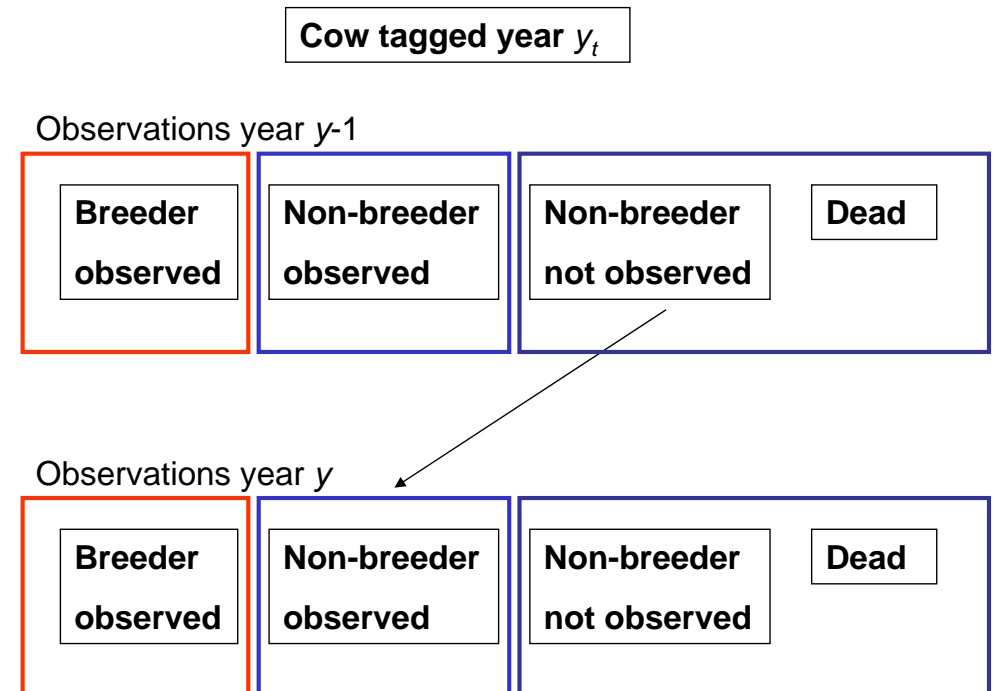
Alt1 : (1) birth, stillbirth, dead pup **OR**  
 (2)  $\geq 2$  of nursing, with pup or calling pup **OR**  
 (3)  $\geq 1$  of nursing, with pup or calling pup **AND**  $\geq 5$  total observations

Alt2 : (1) birth, stillbirth, dead pup **OR**  
 (2)  $\geq 2$  of nursing **OR**  
 (3)  $\geq 3$  of nursing, with pup or calling pup

In all cases all breeders are assumed to be seen

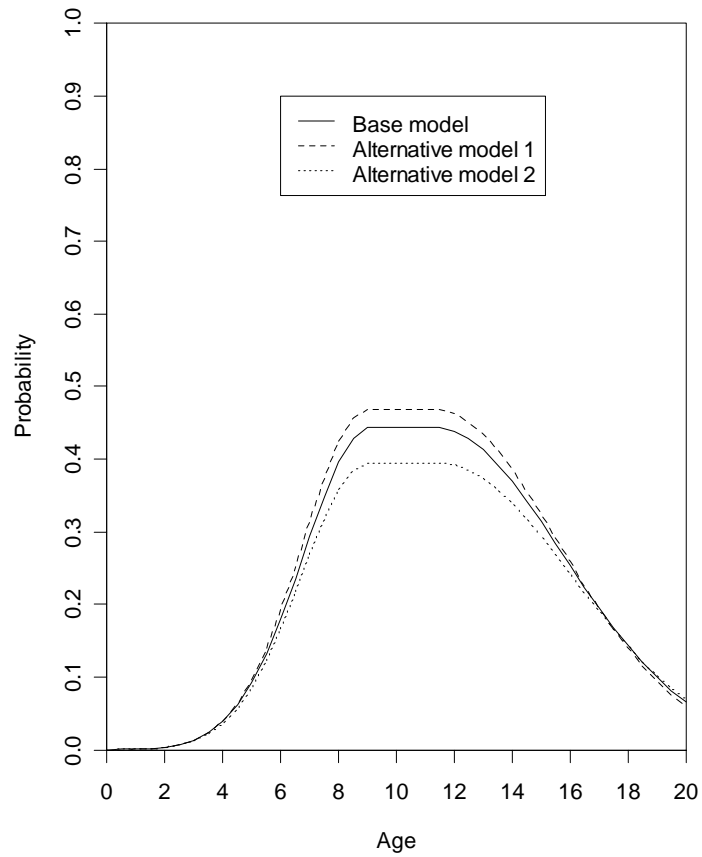
All others are non-breeders but not all non-breeders are seen

## Estimation by maximum likelihood



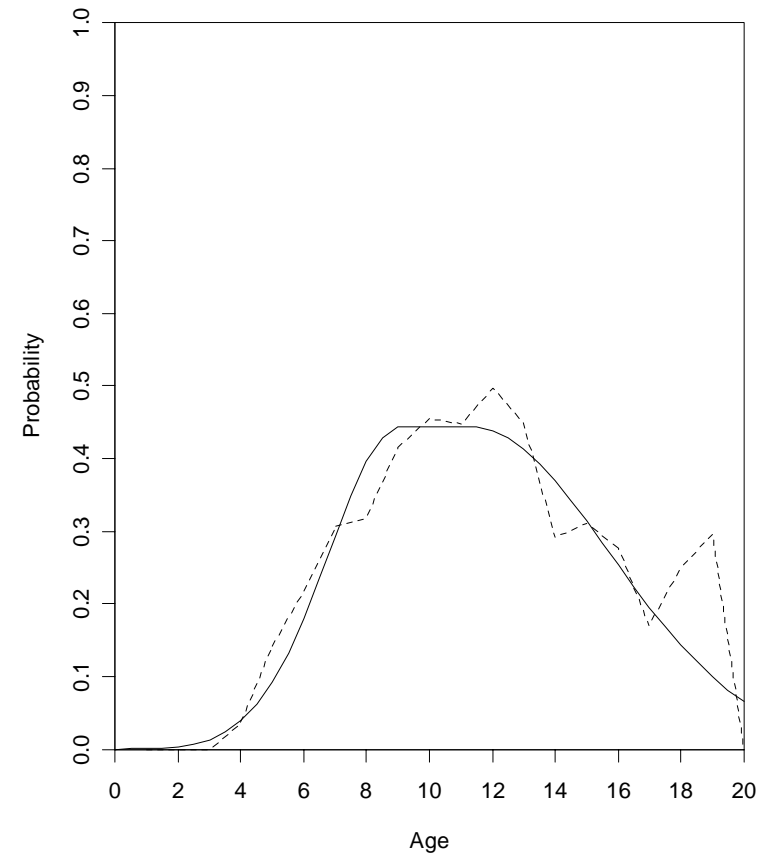
# Pupping rate curves

Annual breeding probability for average cow

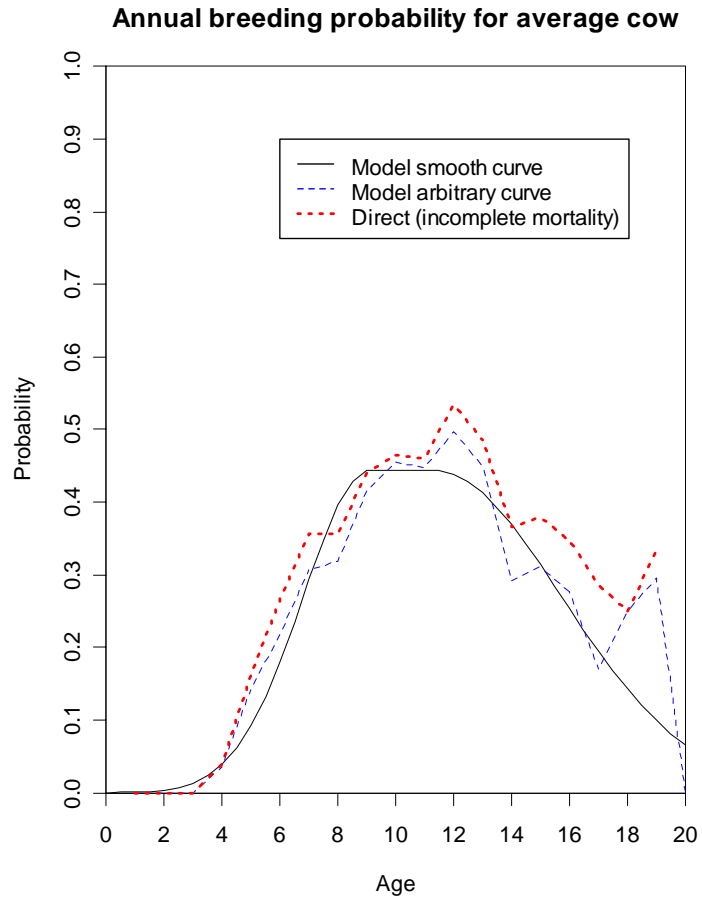


# Arbitrary pupping rate curve

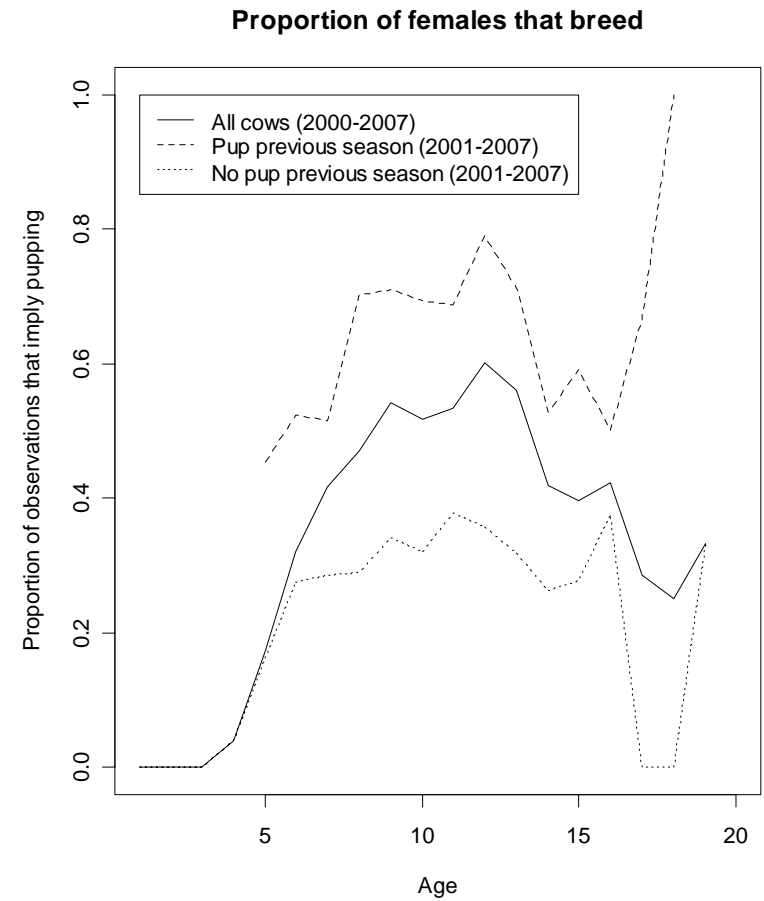
Annual breeding probability for average cow



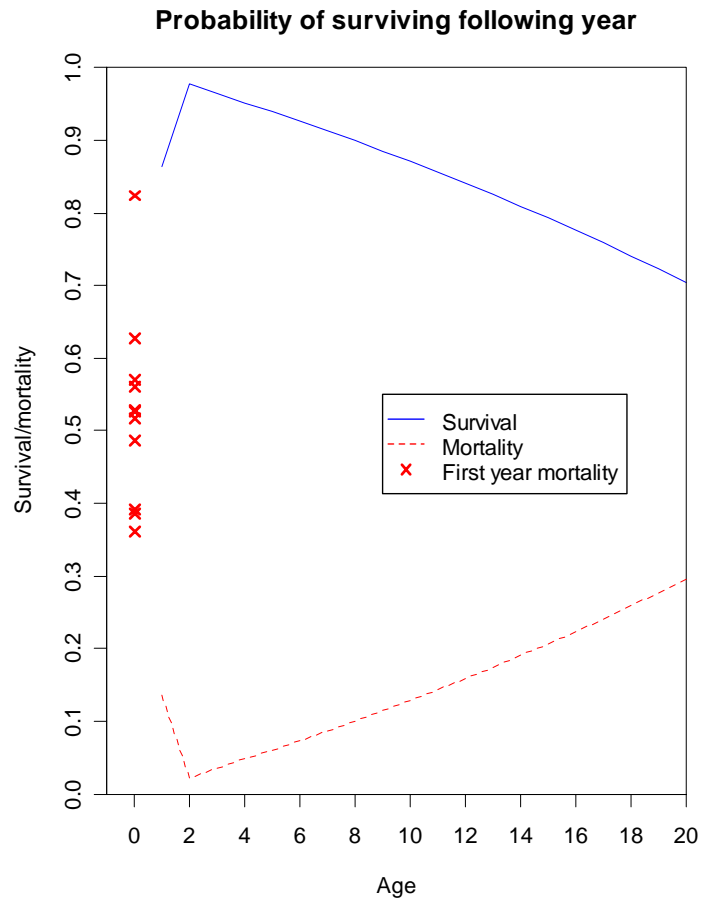
## Direct pupping rate curve estimate



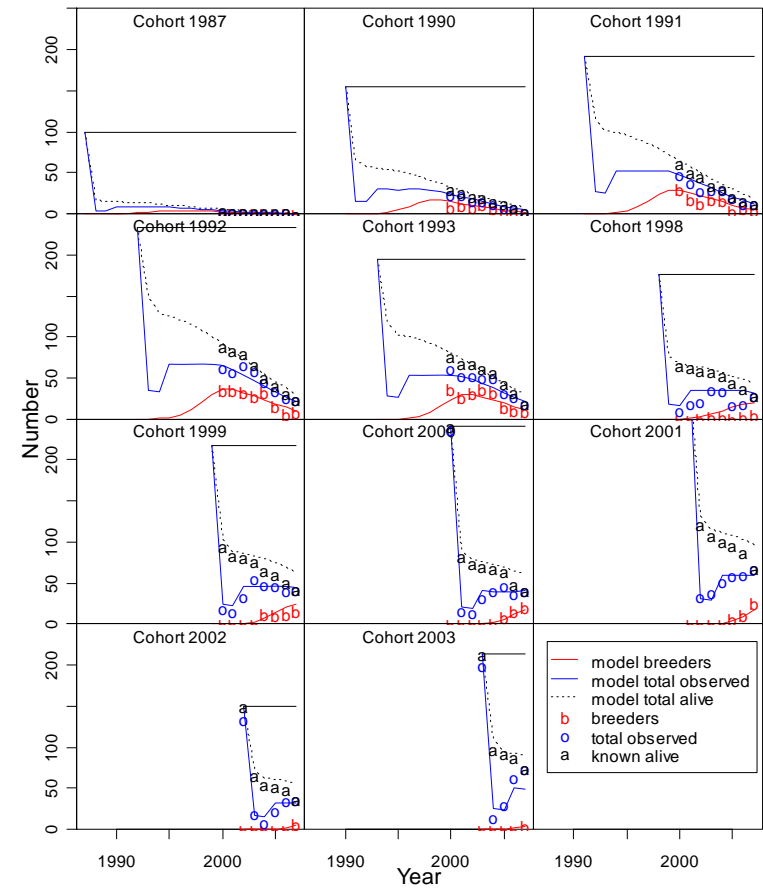
## High and low fecundity curves



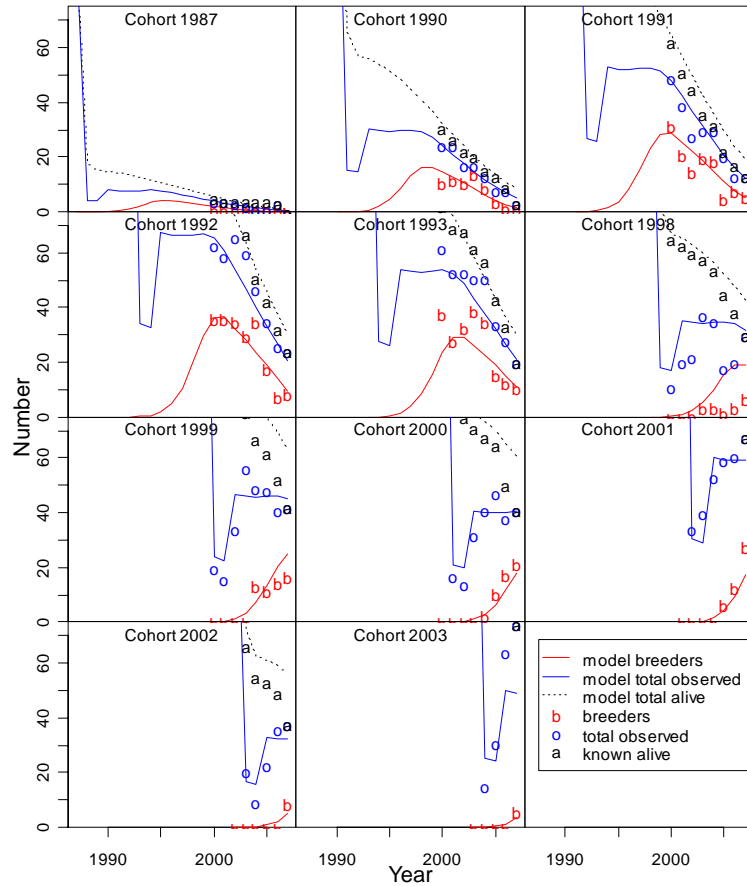
# Apparent mortality by age



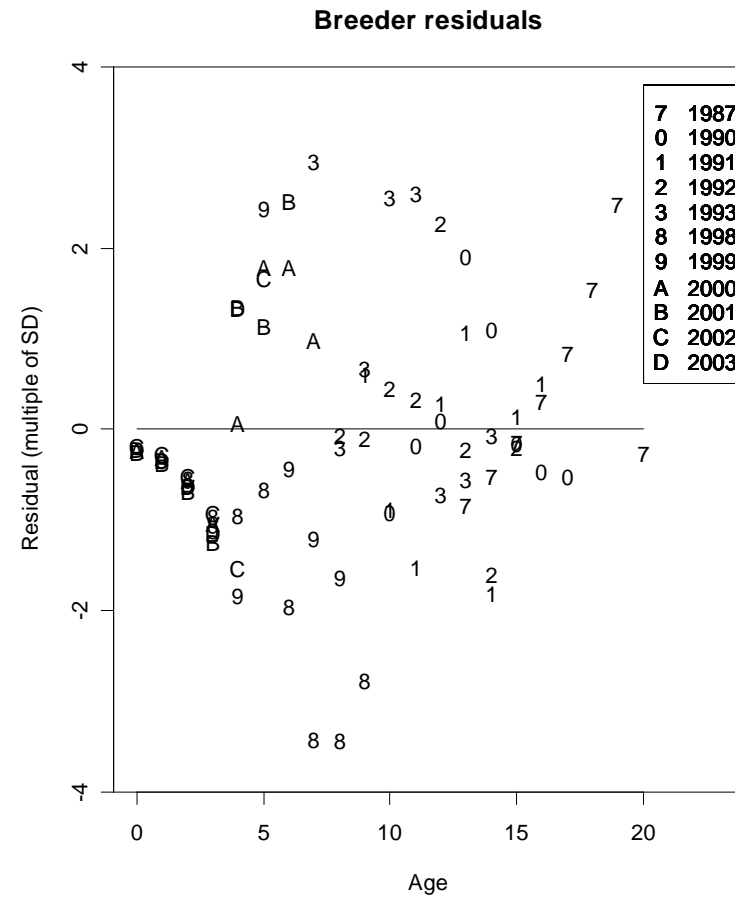
# Predicted numbers observed



## Predicted numbers observed (zoomed in)

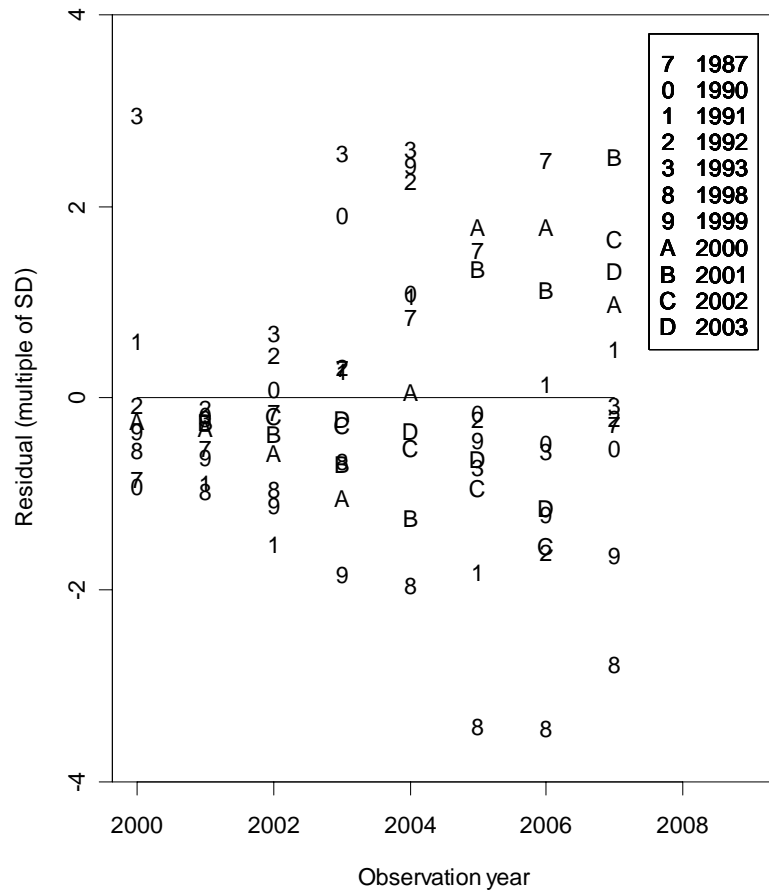


## Residuals



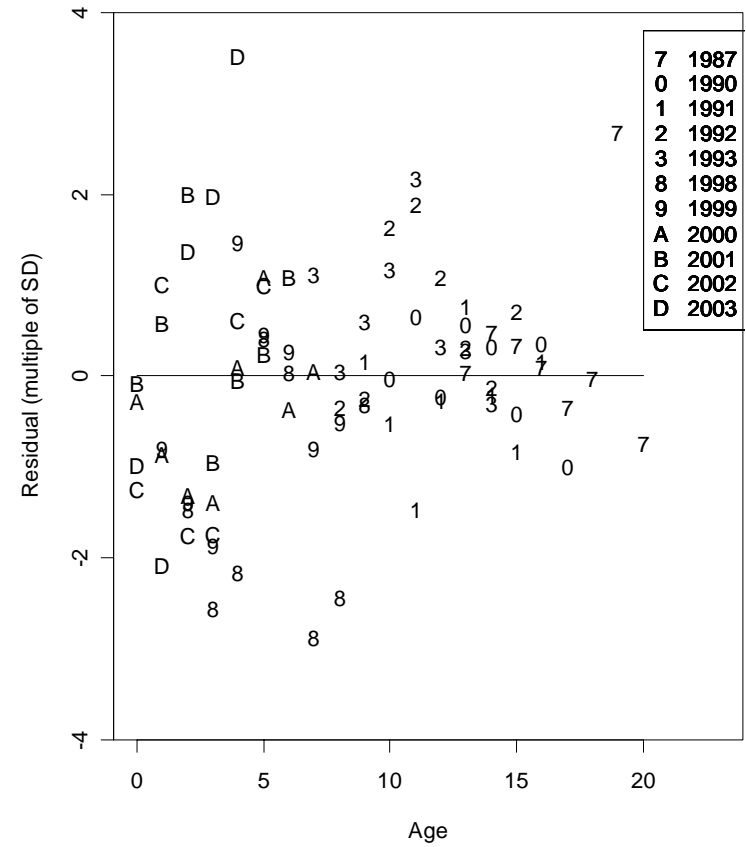
## Residuals II

Breeder residuals



## Residuals III

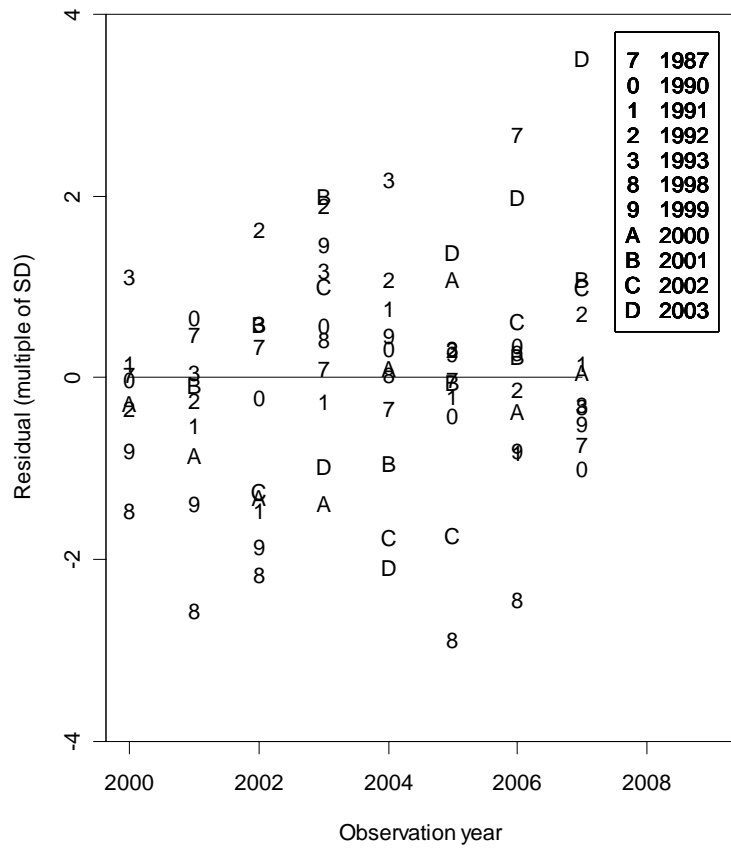
Residuals of total observed





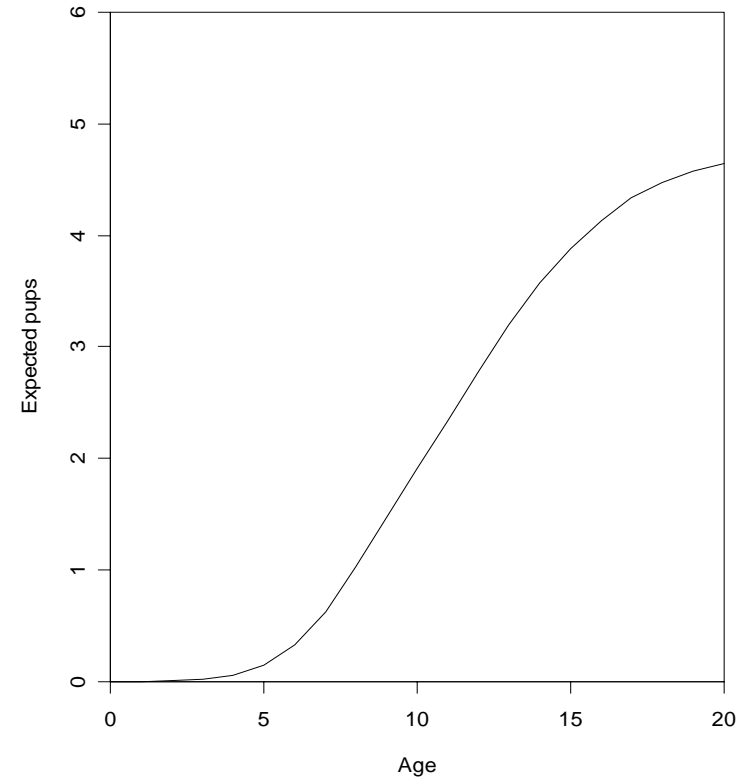
# Residuals IV

Residuals of total observed

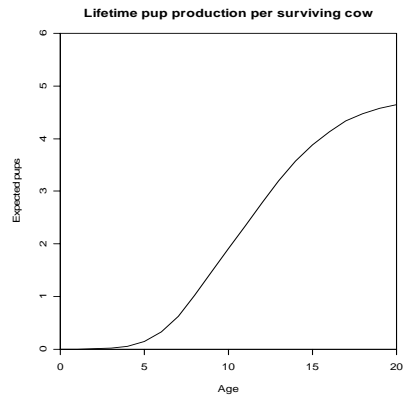


# Lifetime production of pups

Lifetime pup production per surviving cow



## Mortality includes tag loss



- Allowing for mortality, lifetime production calculates to 1.0 pup per cow
- This is impossible, proving that my mortality curve includes substantial tag loss effects
- The number of animals 1 y and older per pup calculates to 6.0
- Again this will be too low because the mortality curve includes substantial tag loss effects

## Estimated pupping rate curves

