



Pupping rate estimates for New Zealand sea lions

Project: POP2006

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**Goal:
to estimate proportion of
cows that breed as a
function of age**

Definition of breeder

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

Use of behaviour comment field

Behaviour was codified into:

BIRTH, STILLBIRTH, DEADPUP, PREGNANT

NURSE, WITHPUP, CALL

X, YNURSE, XSUCKLING, DEAD

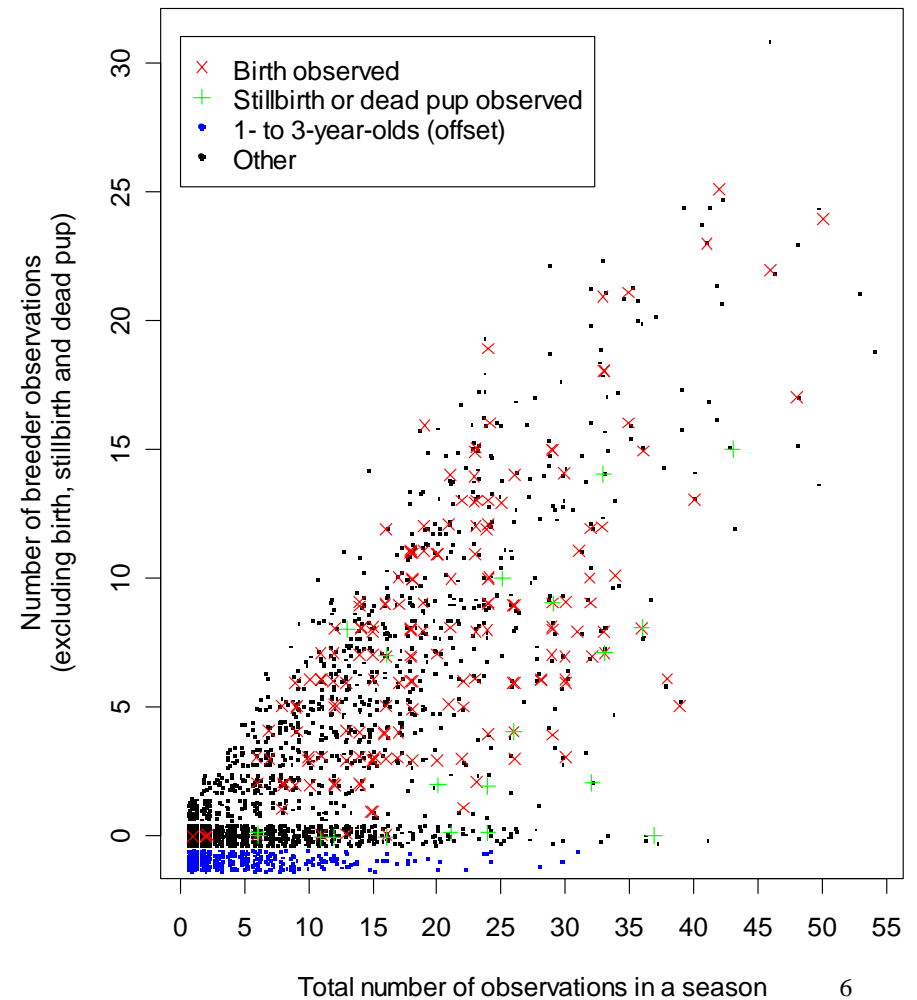
Enderby main behaviour frequencies

SEASON	BIRTH	CALL	DEAD	NURSE	WITH PUP	X
2000	15	12	4	250	264	1132
2001	17	16	12	245	296	1276
2002	22	10	28	237	344	2121
2003	3	34	3	393	612	2186
2004	31	34	1	509	617	2510
2005	35	1	2	127	191	2063
2006	22	11	-	299	278	1974
2007	29	13	-	473	351	2129

How do we distinguish exactly which cows bred and which did not?

- Most breeders can be unambiguously identified
- Each season a few are ambiguous (e.g. seen WITHPUP once)
- We have a modest number of definite breeders but very few definite non-breeders (YNURSE)

Probable breeder observations



Two approaches to estimating pupping rate

- Estimate a mixture of breeder and non-breeder statistical distributions of observations (that overlap slightly)
- Specify criteria that categorise all cows each season as breeders or non-breeders

Criteria for identifying breeder

- Base: (1) birth, stillbirth, dead pup **OR**
(2) ≥ 2 of nursing, with pup or calling pup
- Alt1 : (1) birth, stillbirth, dead pup **OR**
(2) ≥ 2 of nursing, with pup or calling pup **OR**
(3) ≥ 1 of nursing, with pup or calling pup **AND** ≥ 5 total observations
- Alt2 : (1) birth, stillbirth, dead pup **OR**
(2) ≥ 2 of nursing **OR**
(3) ≥ 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

Died or not observed?

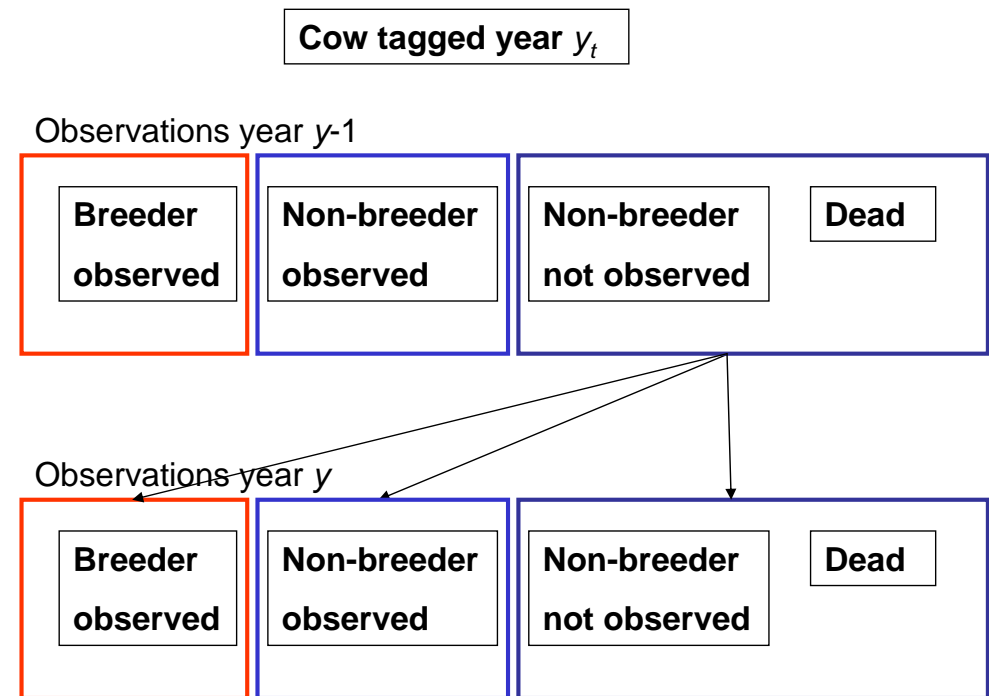
- Need to account for non-breeders that are alive but not sighted
- Can be done easily for individuals for the years before the last sighting
- If last sighting was before 2007 the cow may be dead or alive but not sighted
- We therefore estimate parameters for:

(1) **mortality**

(2) **observability**

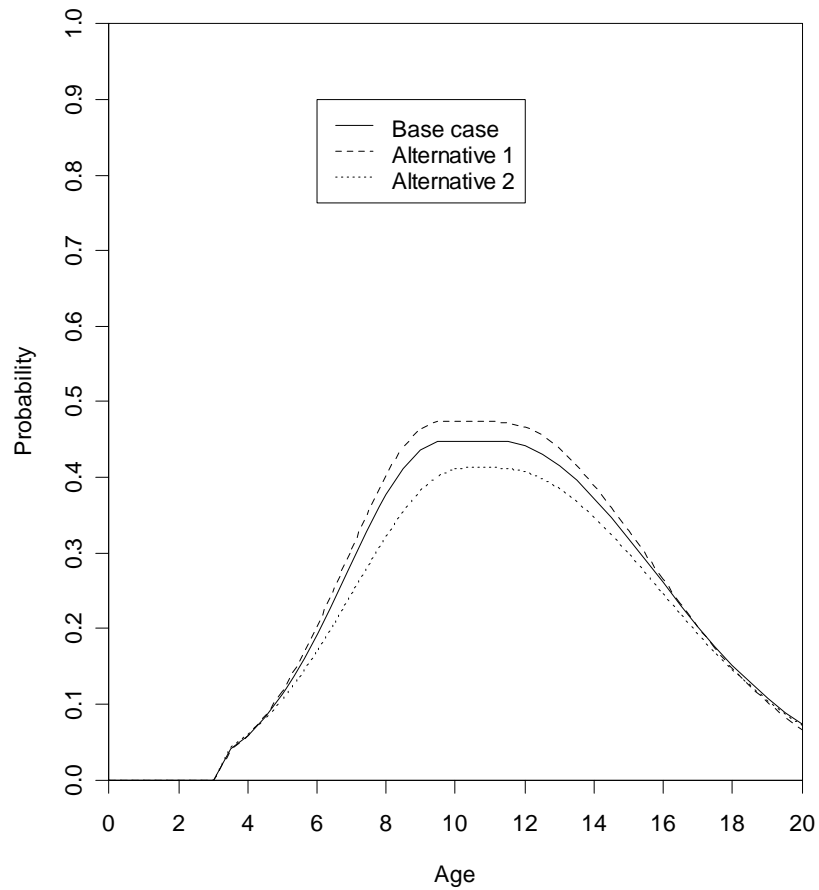
and treat the unseen cows as a combination of dead and non-observed non-breeders

Mortality and observability parameters



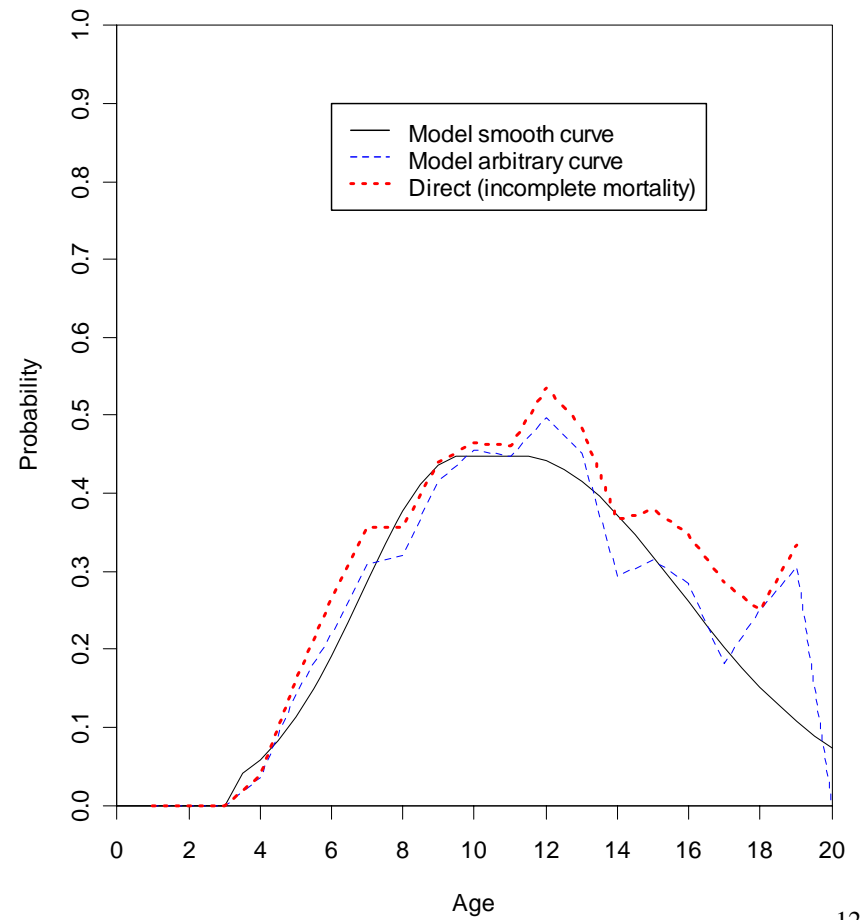
Pupping rate

Annual breeding probability for average cow



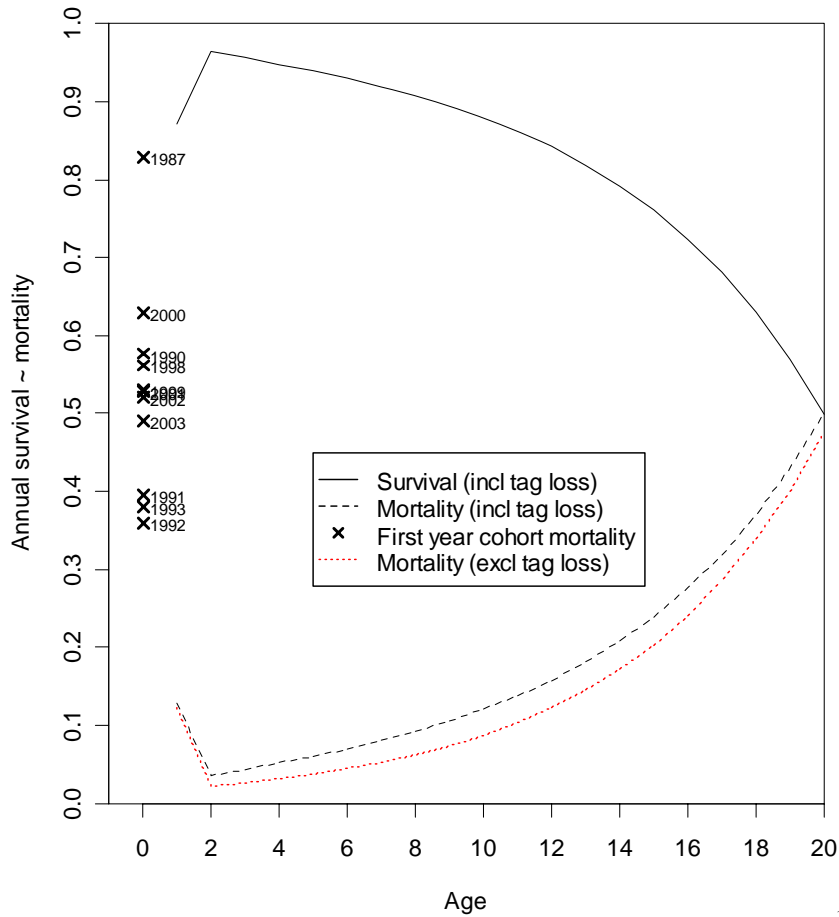
Other pupping rates

Annual breeding probability for average cow

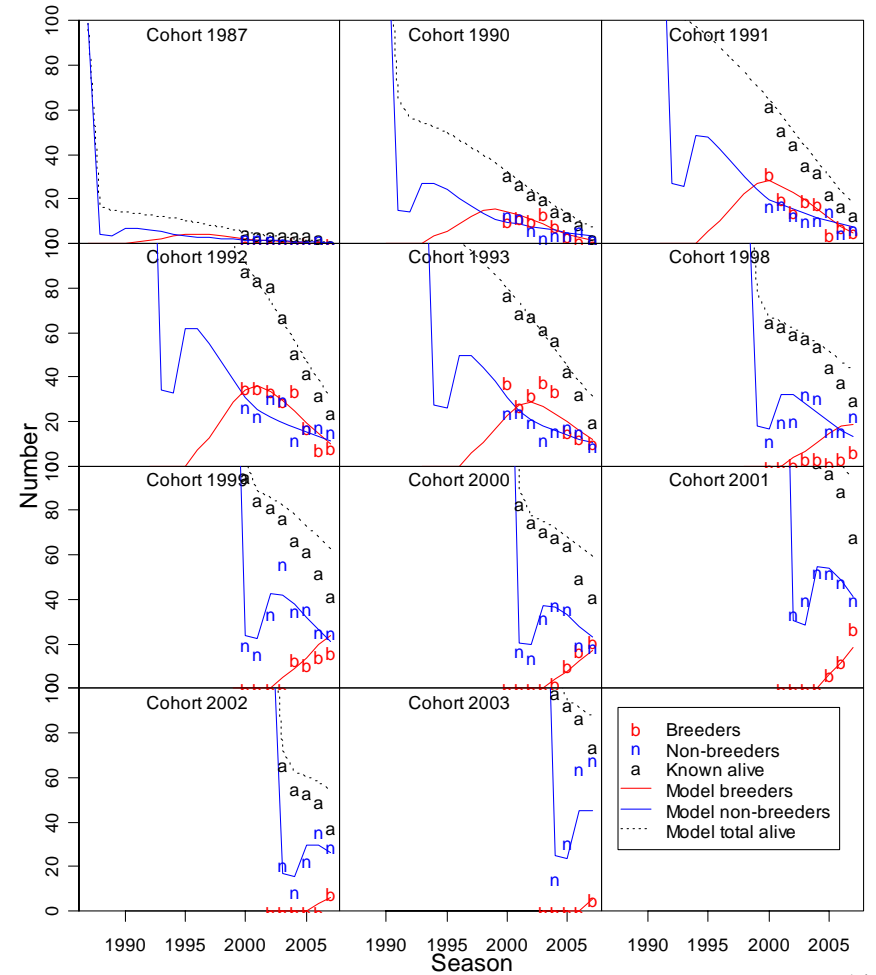


Mortality+tag loss and survival

Probability of surviving following year



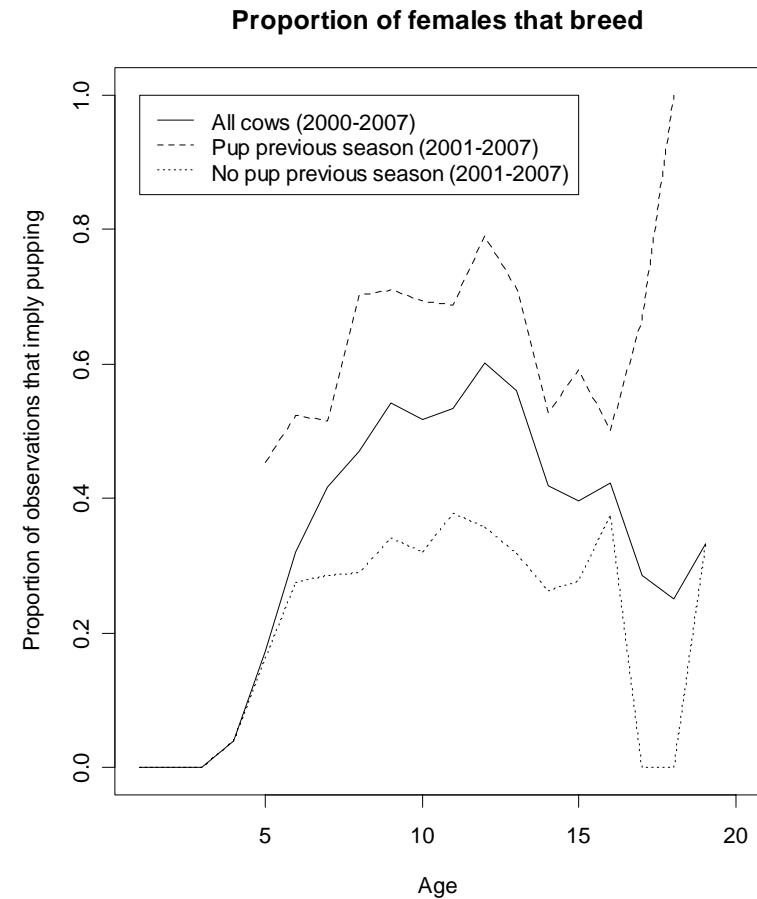
Predicted numbers observed



Developments

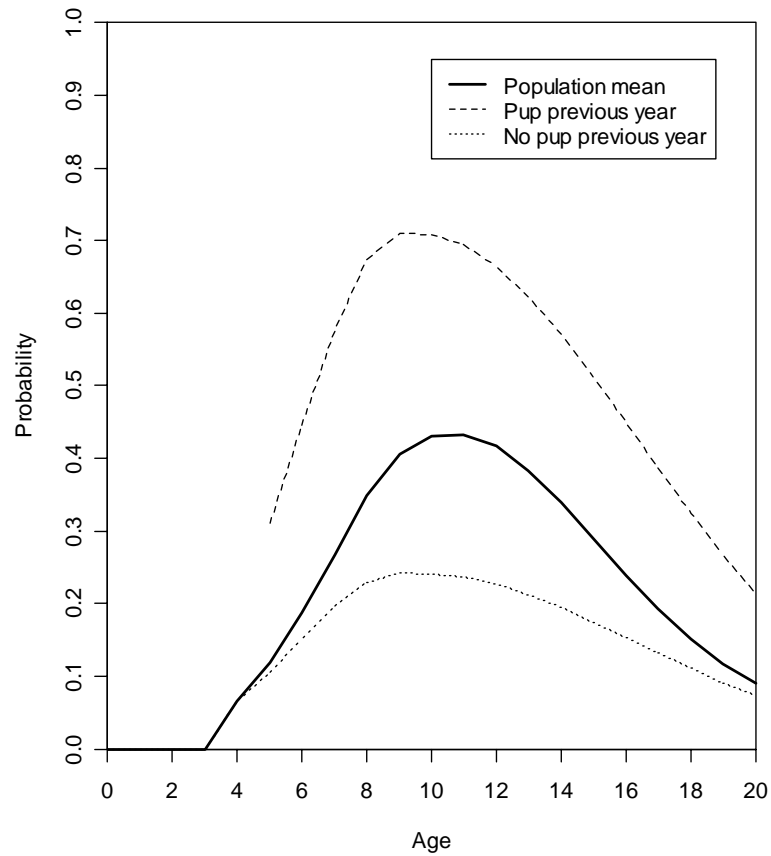
- Mixture model
- Credibility intervals
- High and low fecundity cows

Pupping rate conditional on last year (direct estimate)



Pupping rates from autocorrelated pupping model

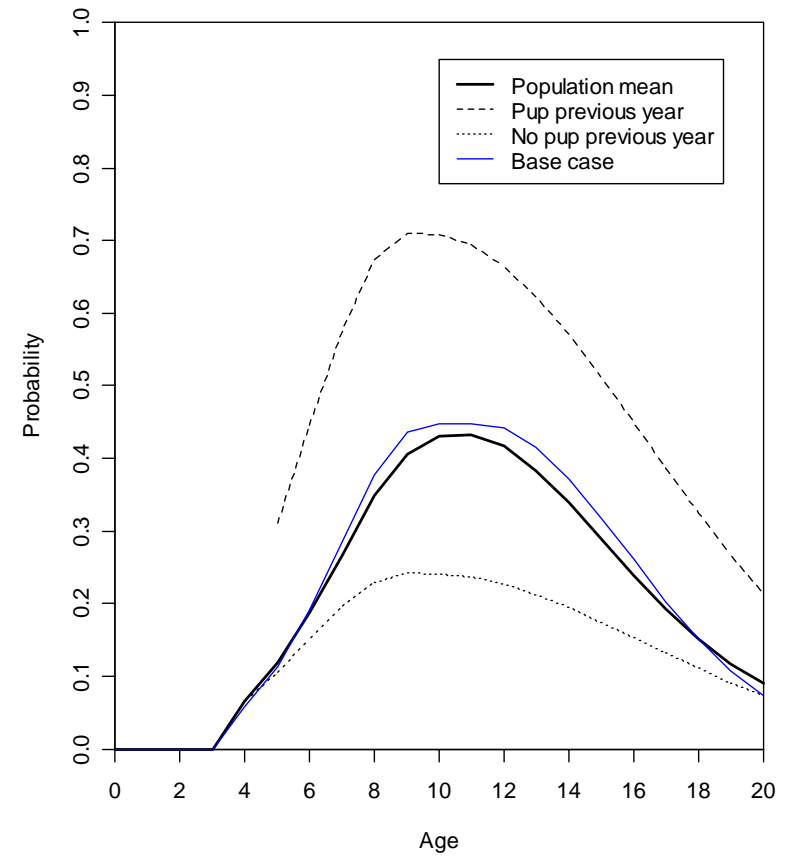
Breeding probability (autocorrelated pupping model)



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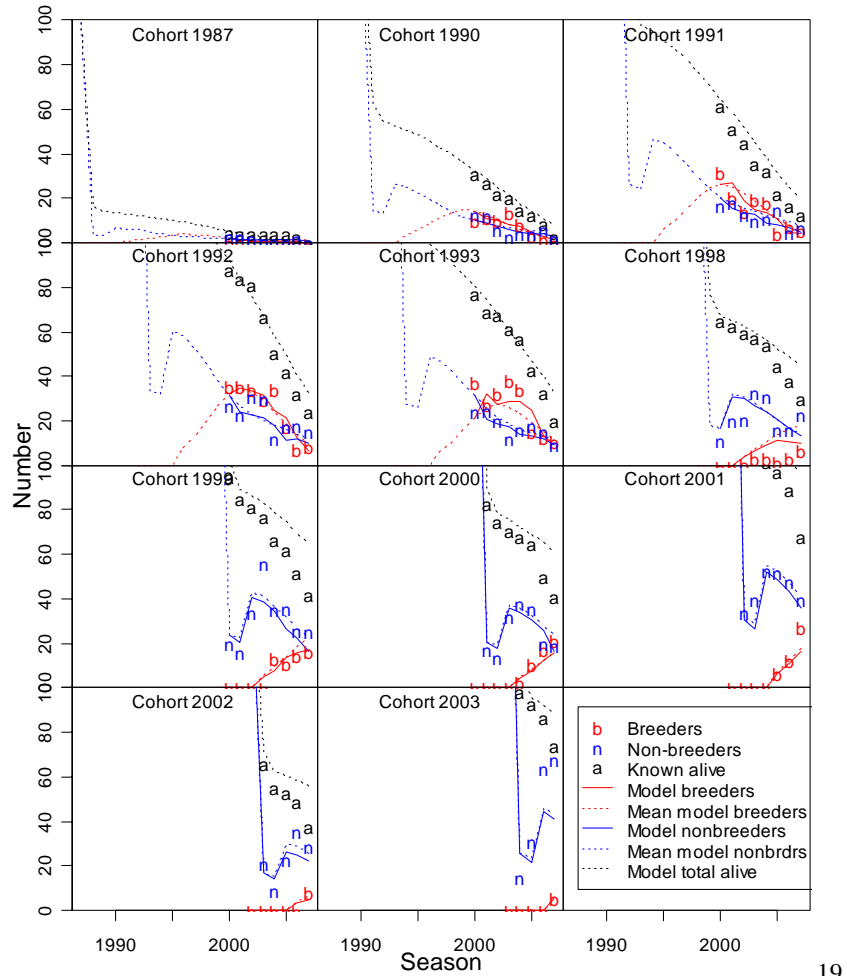
Pupping rates from autocorrelated pupping model

Breeding probability (autocorrelated pupping model)



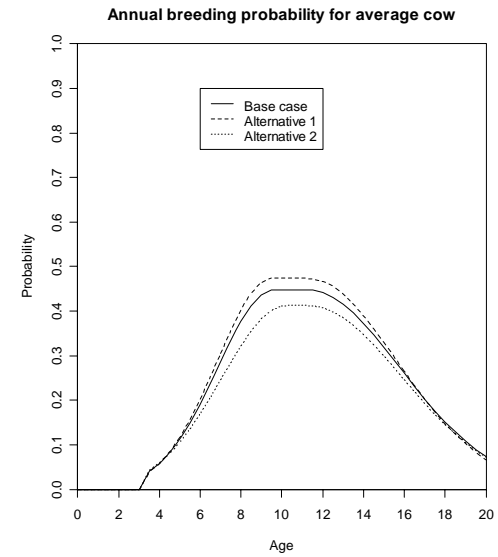
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Predicted numbers observed from autocorrelated model



Conclusions

Pupping rate



Developments

- Autocorrelated model
- Credibility intervals
- Mixture model