RISK FACTORS FOR ADULT HIND CONCEPTION

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An holistic epidemiological approach called "health and production profiling" first described by Morris (1991) has been used to explore basic health problems and production in farmed red deer The background of this research has been published in the previous proceedings (Audigé *et al.*, 1993)

Reproductive performance of hinds is recognised as a major determinant of productivity and economic viability of commercial farms (Hamilton, 1988), and prelimary results of this study showed there was a wide range of reproductive success between farms (Audigé *et al.*, 1993) Updated reproduction data including the 1993 year, yet unpublished, showed 84% of 791 yearling (YH) and and 96 9% of 3745 adult hinds (AH) conceived at mating, with 63 4% and 90 3%, respectively, conceiving early (before May 1) over two years

McNamus and Thompson (1993) stated that when chosing a breeding programme, it is crucial to identify breeding objectives and consequently, selection criteria that will help meet these objectives They also recognised that it was not known wether the ability of hinds to conceive early was related to management practices or if it was a heritable factor The reproductive success of farmed hinds combine high pregnancy rates, low abortion rates, early birth, and low neonatal and postnatal mortality rates, leading to high weaning rates Thus, the number of calves produced per hind mated can be used as one monitor of farm performance Mating management strategies must therefore be set up very carefully because only a good start will permit a good end result Management strategies however, may differ depending on whether farmers want to prioritise rates (and thus allow for late conception) or weaning weights, or both

In this health and production study, analyses were carried out to identify risk factors associated with the likelihood of conceiving *per se* or conceiving early (before May 1) for both yearling and adult hinds This paper presents results only for adult hinds

MATERIALS AND METHODS

A 2-year observational study was conducted on 15 commercial red deer farms in the North Island of New Zealand About 2700 hinds were individually monitored for reproductive success in each of the two years During farm visits in March 1992 and 1993, each hind was scored for body condition prior to mating The composition of mating groups from hind tag identification, mating management practices, grazing history and food allowance for each hind were recorded In June, all hinds mated were pregnancy tested by ultrasound using a rectal probe, 15 to 70 days after sire stags were withdrawn from hinds Hinds were classified as having conceived before May 1st (ADVC), after May 1st or as being not pregnant, using foetal and placental measurements (Revol and Wilson, 1991) Hinds conceiving early or late were recorded (CONC)

Risk factors potentially affectıng ADVC and CONC were identıfied and classıfied according to the area of data collectıon they described Codes and description of each group of variables (or varıable block) are presented in Table 1 The first block includes indivıdual hind characteristics and mating management strategıes (animal management block), whereas the second block includes grazing management and environmental factors Grazing management and environmental factors were calculated for the period between March 15 and May 1, and between March 15 and June 1, as potential rısk factors for ADVC amd CONC, respectively Data from both years of study were combined

Preliminary data analyses were carried out to identıfy associations between single descriptive variables and early conception (ADVC) or overall conception (CONC) Categorical variables were analysed wıth the Chi-square test of association, while continuous and ordinal varıables were analysed with the T-test Varıables whıch showed sufficient evidence of an association in these analyses (p<0 20) were ıncluded in multivariable logistic stepwise regressıon analyses (Hosmer and Lemeshow, 1989) with a 5% sıgnificance limit for inclusion and removal from the model A series of path models were formulated to identify risk factors which had statistically significant direct and ındirect effects on each outcomes (Pedhazur, 1982, Curtis et al , 1988) For each final model, the deviance is reported as a goodness of fit statıstıc For each model, the proportionate reduction in devıance observed when ıncludıng significant rısk factors ın the model compare with an intercept only model is ınterpreted as the proportion of varıance in the data "explained" by the variables included in the model

All statistical analyses were carried out wıth the computer package SAS (SAS Instıtute Inc , Cary, NC, USA)

RESULTS

Statistical significance of association of categorical varıables wıth both outcomes, and unadjusted odds ratios of variables selected for multivariable analysıs are presented in table 2

Table 2 : Significance level of univariate Chi-square tests of association between dichotomous explanatory variables and the ability of adult hinds to conceive before May 1 (ADVC) or to conceive (CONC), and unadjusted Odds ratios and confidence intervals of variables selected for multivariable analysis

Rısk factor	Conception (CONC)					Early conception (ADVC)				
code***	Number of deer	Chı-square P value	Unadjusted Odd Ratıo* OR	95%CI		Number of deer	Chı-square P value	Unadjusted Odd Ratıo* OR	95%CI	
Animal management block										
AGE2**	2603	0 005	1 91	1 20	3 03	2601	0 000	2 04	1 48	2 81
NZ100**	2596	0 000	4 77	3 01	7 58	2594	0 000	2 80	1 94	4 05
WET**	2554	0 000	3 28	1 98	5 46	2552	0 000	3 09	2 11	4 51
SSIRE1	2603	0 059	0 53	0 27	1 04	2601	0 005	0 53	0 33	0 83
EXP1	2563	0 000	2 30	1 48	3 58	2561	0 003	1 64	1 18	2 29
WAP1	2603	0 031	2 20	1 06	4 58	2601	0 049	1 55	1 00	2 41
CHS1	2603	0 001	2 13	1 35	3 37					
Environment and grazıng management block										
RSWH5	2603	0 274				2427	0 029	0 58	0 36	0 95
RSWH10	2603	0 000	0 34	0 22	0 51	2427	0 022	0 70	0 51	0 95
OTHERST	2603	0 974				2573	0 517			
FSUP	2603	0 036	0 63	0 41	0 97	2601	0 181	0 77	0 53	1 13

* Unadjusted Odds Ratıos and theır 95% confidence lımıts (95%CI) of rısk factors selected for multıvarıable analysıs (p<0 20 or varıable forced ınto the model on bıologıcal ground)

** Indıvıdual hınd rısk factors

*** Rısk factor codes are presented ın table 1

Note Number of hınds conceıvıng 2513 and conceıvıng early 2405

Table 1 : Signification of codes of risk factor for adult hind conception status

Risk factor Code	Unit*	Description
1st BLOCK : Animal management		
Individual hind characteristics		
AGE2	D	Hind over 3 years old at mating
NZ100	D	Pure New Zealand type hind
WET	D	Hind wet at weaning prior to the mating under investigation
BSCM		Pre-mating body condition score (from 1(lean) to 5 (fat) with half unit increments)
W4	kg	Live weight on April 1
GR46	g/d	Growth rate between April 1 and June 1
Mating management		
WEAN	day	Number of days between February 15 and weaning
STAG	day	Number of days between February 15 and first joining with sire stag(s)
AH1		Number of adult hinds in the mating mob at start of mating
SSIRE1	D	Single sire mating
RATIO1	Hinds/sire	Hinds to sire stag ratio
EXP1	D	Use of at least one experienced sire stag for mating
YS1	D	Presence of yearling sires only
NZ1	D	Presence of only New Zealand origin red sire stag
WAP1	D	Presence of only wapiti type sire stag
BACK1	D	Use of at least one back-up stag before May 1
CHS1	D	Use of at least one back-up stag by end of mating
REMD	day	Number of days between April 1 and the date mating was terminated
2nd BLOCK : Environment and grazing management factors**		
Grazing management		
ISWH	cm	Mean initial pasture sward height
RSWH5	D	Mean residual pasture sward height below 5 cm
RSWH10	D	Mean residual pasture sward height over 10 cm
CLOVER	1-3	Pasture clover score during the grazing interval
PASTT	1-3	Average pasture type score
MACRO	D	Hinds grazing in at least one paddock with macrocarpa
STOCK		Number of times the mob composition was changed
SHIFT		Number of times deer were shifted between paddocks
DEER		Average number of deer in the mob during the grazing interval
FAREA	Ha	Mean grazed paddock area
DEER/Ha	Deer/Ha	Average number of deer per deer-fenced hectare (stocking rate in paddocks)
M%AH	%	Mean percentage of adult hinds in the mob over the grazing interval
OTHERST	D	Paddocks shared with other stock than deer at least one day
FSUP	D	Food supplementation before the end of May
Environmental variables		
SUR	%	Percentage of time spent in paddocks close to road, buildings or houses
TOPO	1-3	Average topography score
TREES	0-3	Average tree score
SHELT		Average paddock shelter score
AVMIT	degree C	Average of minimum temperatures
AVMAT	degree C	Average of maximum temperatures
AVMMT	degree C	Average of daily temperature ranges (maximum-minimum)
RAIND	mm/d	Daily average rainfall
SUN	%	Average percentage of sun
AVWIND		Paddock average wind exposure index

* D = Dichotomous variable (Yes = 1 / No = 0)

** Calculations were performed for the grazing interval between March 15 and May 1 for the study of hind conception before May 1 (ADVC), and between March 15 and June 1 for the study of hind overall conception (CONC)

Table 3 : Range of all values, number of cases, mean and standard deviation of continuous and ordinal risk factors statistically associated with the ability of hinds to conceive early (ADVC) in a preliminary univariate analysis (T-test P value <0.20)

Risk factor code*	Unit**	T-test P value	Range of all values Minimum	Maximum	ADVC=1 Number of deer	Mean	SD	ADVC=0 Number of deer	Mean	SD
1st BLOCK . Animal management										
Hind individual characteristics										
W4**	kg	0.009	68.00	144.50	1876	97.98	10.03	164	95.80	11.29
BCSM**		0.012	1.00	5.00	2242	3.25	0.71	179	3.10	0.84
Mating management practices										
STAG	day	0.000	42.00	91.00	2405	72.97	12.01	196	77.24	9.20
RATIO1	hinds/stag	0.071	8.00	82.00	2405	38.78	14.76	196	40.78	14.91
AH1		0.072	4.00	150.00	2405	50.64	31.73	196	46.43	28.05
WEAN	day	0.269	10.00	75.00	2405	28.21	14.44	196	29.39	12.72
2nd BLOCK : Environment and grazing management factors										
Grazing management										
FAREA	Ha	0.015	0.82	25.86	2405	6.41	6.23	196	5.30	5.02
SHIFT		0.022	1.00	9.00	2382	2.59	1.94	191	2.94	2.56
ISWH	cm	0.039	3.50	20.00	2249	13.15	3.56	178	12.57	4.24
M%AH	%	0.057	9.76	100.00	2405	95.66	12.85	196	93.80	16.77
STOCK		0.070	1.00	6.00	2382	1.60	0.82	191	1.71	0.97
DEER/Ha	Deer/Ha	0.150	2.24	43.10	2405	14.99	8.71	196	15.94	8.80
CLOVER	1-3	0.187	1.00	2.00	2275	1.48	0.42	186	1.53	0.42
DEER		0.189	10.38	301.92	2405	64.11	59.77	196	58.33	51.32
Environmental factors										
TREES	0-3	0.003	0.00	3.00	2405	1.14	1.11	196	0.89	0.99
AVMIT	Degree C	0.008	3.30	9.00	2382	6.85	1.20	191	7.09	1.20
SUR	%	0.013	0.00	100.00	2405	32.57	42.85	196	40.96	45.14
SHELT		0.039	2.89	40.00	2405	18.69	9.19	196	17.33	8.84
TOPO	1-3	0.046	1.00	3.00	2405	1.78	0.69	196	1.68	0.68
AVMAT	Degree C	0.110	14.40	21.23	2382	17.64	1.85	191	17.87	1.96
SUN	0-1	0.164	0.29	0.70	2382	0.45	0.12	191	0.44	0.11

SD = Standard Deviation
* Risk factor codes are described in table 1
** Unit reported as 0-1 means "ranges from 0 to 1"

Table 4 : Range of all values, number of cases, mean and standard deviation of continuous and ordinal risk factors statistically associated with the ability of hinds to conceive (CONC) in a preliminary univariate analysis (T-test P value <0.20)

Risk factor code*	Unit**	T-test P value	Range of all values Minimum	Maximum	CONC=1 Number of deer	Mean	SD	CONC=0 Number of deer	Mean	SD
1st BLOCK : Animal management										
Hind individual characteristics										
BCSM		0.001	1.00	5.00	2339	3.25	0.72	84	2.96	0.89
Mating management practices										
STAG	day	0.008	42.00	91.00	2513	73.19	11.90	90	76.30	10.72
REMD	day	0.010	29.00	78.00	2513	46.41	13.57	90	42.63	15.96
2nd BLOCK : Environment and grazing management factors										
Grazing management										
DEER/Ha	Deer/Ha	0.000	3.77	66.03	2513	19.57	14.46	90	27.94	21.39
SHIFT		0.000	1.00	14.00	2513	4.25	2.94	90	6.47	4.78
PASTT	1-3	0.068	1.00	3.00	2513	2.22	0.55	90	2.31	0.48
MSWH	cm	0.232	2.10	17.10	2485	10.05	2.80	90	10.45	3.16
STOCK		0.120	1.00	7.00	2513	2.94	1.04	90	3.11	1.20
FAREA	Ha	0.160	0.77	26.84	2513	6.85	6.20	90	5.96	5.82
Environmental factors										
SUN	0-1	0.000	0.26	0.65	2513	0.43	0.12	90	0.38	0.11
RAIND	mm	0.001	1.04	4.74	2513	2.96	0.96	90	3.32	0.96
SUR	%	0.005	0.00	100.00	2513	30.00	37.12	90	42.87	41.34
AVMIT	C	0.011	3.21	8.26	2513	6.25	1.29	90	6.61	1.29
SHELT		0.036	2.73	40.00	2513	18.84	8.52	90	16.82	8.87
TOPO	1-3	0.042	1.00	3.00	2513	1.80	0.64	90	1.67	0.57
AVMMT	C	0.135	6.88	15.15	2513	10.17	1.99	90	9.86	1.86
TREES	0-3	0.173	0.00	3.00	2513	1.11	0.99	90	0.96	0.97

SD = Standard Deviation
* Risk factor codes are described in table 1
** Unit reported as 0-1 means "ranges from 0 to 1"

Table 5 : Beta coeficient estimates and adjusted Odd ratios of risk factors predicting likelyhood of adult hinds early conception status and goodness of fit of component models

Total number of hinds incuded in the analysis 2601
Number of hinds conceiving before May 1 (ADVC) = 2405

1st BLOCK
Animal management

Deviance: Intercept only	Model deviance	% of variability explained by the model
1390 69	1283 97	7 67

Risk factors*	Coeficient estimates	Std error	p value	Adjusted OR	95%CI	
AGE2	0 417	0 189	0 028	1 52	1 26	1 83
NZ100	0 657	0 220	0 003	1 93	1 55	2 40
WET	0 962	0 223	0 000	2 62	2 09	3 27
BCSM	0 239	0 113	0 034			
WEAN	-0 026	0 006	0 000			
STAG	-0 043	0 010	0 000			
RATIO1	-0 015	0 005	0 004			
EXP1	0 401	0 178	0 024	1 49	1 25	1 78
WA1	0 581	0 245	0 018	1 79	1 40	2 29

2nd BLOCK
Environment and grazing management

Deviance: Intercept only	Model deviance	% of variability explained by the model
1390 69	1342 25	3 48

Risk factors*	Coeficient estimates	Std error	p value	Adjusted OR	95%CI	
SHIFT	-0 135	0 039	0 001			
ISWH	0 067	0 024	0 004			
AVMAT	-0 150	0 044	0 001			
CLOVER	-0 451	0 200	0 025			
M%AH	0 010	0 005	0 043			
SUR	-0 004	0 002	0 036			
TREES	0 260	0 078	0 001			
OTHERST	-0 644	0 225	0 004	0 53	0 42	0 66

2nd BLOCK
Environment and grazing variables controled by animal management factors

Deviance: Intercept only	Model deviance	% of variability explained by the model
1390 69	1271 54	8 57

Risk factors*	Coeficient estimates	Std error	p value	Adjusted OR	95%CI	
NZ100	0 842	0 213	0 000	2 32	1 88	2 87
WET	1 138	0 217	0 000	3 12	2 51	3 88
BCSM	0 282	0 110	0 010			
WEAN	-0 021	0 007	0 002			
STAG	-0 036	0 009	0 000			
RATIO1	-0 013	0 005	0 013			
EXP1	0 454	0 185	0 014	1 57	1 31	1 89
ISWH	0 101	0 026	0 000			
RSWH10	-0 574	0 202	0 005	0 56	0 46	0 69
CLOVER	-0 551	0 196	0 005			

* Risk factor codes are described in table 1
Note Adjusted Odds ratios are presented only for dichotomous risk factors
The percentage of variability in the data explained by each model is the proportion of reduction in deviance when variables are included in the model over the deviance of an intercept only model

Table 6 : Beta coeficient estimates and adjusted Odds ratios of risk factors predicting likelihood of adult hinds conception status and goodness of fit of component models

Total number of hinds incuded in the analysis 2603
Number of hinds conceiving (CONC) = 2513

1st BLOCK
Animal management

Deviance		
Intercept only	Model deviance	% of variability explained by the model
782 48	703 32	10 12

Risk factors*	Coeficient estimates	Std error	p value	Adjusted OR	95%CI	
NZ100	1 0972	0 2563	0 0001	3 00	2 32	3 87
WET	1 2168	0 2975	0 0001	3 38	2 51	4 55
BCSM	0 6206	0 1620	0 0002			
EXP1	0 8183	0 2395	0 0006	2 27	1 78	2 88
CHS1	0 6859	0 2446	0 0050	1 99	1 55	2 54

2nd BLOCK
Environment and grazing management

Deviance		
Intercept only	Model deviance	% of variability explained by the model
782 48	706 14	9 76

Risk factors*	Coeficient estimates	Std error	p value	Adjusted OR	95%CI	
SHIFT	-0 339	0 059	0 000			
STOCK	0 915	0 190	0 000			
RSWH10	-0 720	0 287	0 012	0 487	0 365	0 649
AVMIT	-0 545	0 113	0 000			
RAIND	0 410	0,177	0 021			
SUR	-0 012	0 004	0 002			
SHELT	-0 052	0 018	0 003			

2nd BLOCK
Environment and grazing variables controled by animal management factors

Deviance		
Intercept only	Model deviance	% of variability explained by the model
782 48	677 67	13 39

Risk factors*	Coeficient estimates	Std error	p value	Adjusted OR	95%CI	
WET	1 317	0 305	0 000	3 733	2 753	5 063
BCSM	0 575	0 165	0 001			
NZ100	0 612	0 302	0 043	1 843	1 363	2 492
EXP1	0 763	0 288	0 008	2 144	1 607	2 860
SHIFT	-0 225	0 047	0 000			
STOCK	0 807	0 207	0 000			
AVMIT	-0 338	0 116	0 004			
FAREA	-0 059	0 022	0 008			
SUR	-0 010	0 004	0 009			

* Risk factor codes are described in table 1
Note Adjusted Odds ratios are presented only for dichotomous risk factors
The percentage of variability in the data explained by each model is the proportion of reduction in deviance when variables are included in the model over the deviance of an intercept only model

Range of all values, means and standard deviations of continuous or ordinal risk factors statistically associated with outcome variables are presented in tables 3 and 4

Null hypothesis path diagrams for each block of selected variables and their respective final diagrams are presented in figures 1 and 2 for the analysis of early conception and in figures 3 and 4 for the analysis of conception The overall final diagram of risk factors for early conception is presented in figure 5, whereas that of risk factors for conception is presented in figure 6 Beta coeficients and their standard errors of component models predicting the likelihood of conception or early conception, and adjusted odds ratios of categorical risk factors are presented in table 5 and 6

Final path diagrams present significant ($p<0\ 05$) paths of association between risk factors, which allow the identification of direct and indect effects on the outcome For instance, early weaning was identified as having a positive direct effect on early conception and a positive indirect effect through a positive effect on BCSM, as BCSM had a positive influence on early conception

DISCUSSION

Path analysis is a valuable epidemiological tool used to investigate the multiple interrelationships that exist among a set of correlated variables It enables an insight into associations and helps understanding the structure of the data By conducting separate analyses for each block of explanatory variables, the most important risk factors within each block can be identified, even if they do not remain in the overall final model because of marginal significance

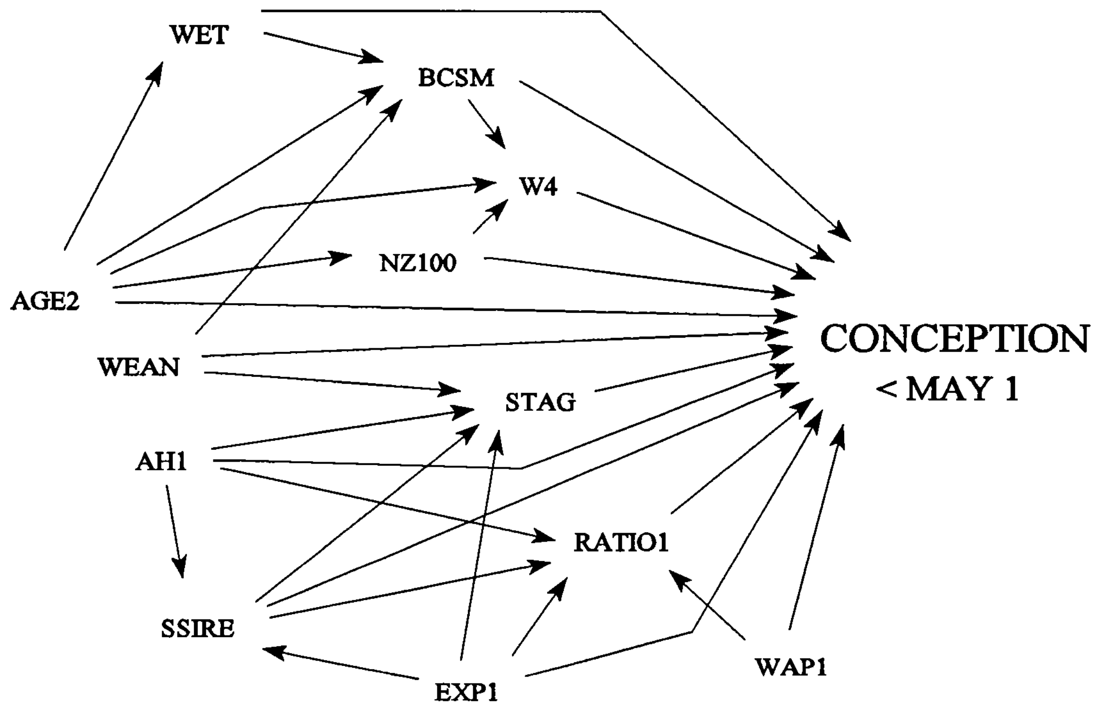
Individual hind characteristics appeared to play a significant role in achievement of conception (early or not), with hinds wet at weaning being approx 2-3 times more likely to conceive than dry hinds Individual premating bodyweight was not identified as significant in this analysis probably because most weights were over a threshold that was identified around 65-70 kg more than 10 years ago (Hamilton and Blaxter, 1980) It appears that pre-mating body condition rather than weight *per se* is one of the major risk factors influencing conception This observation is in accordance with studies in wild deer populations (Mitchel and Lincoln, 1973, Albon et al , 1986) and supports previous suspicion that adult hinds on farms should be in good physical condition (Yerex, 1982, Heydon et al , 1992) The relationship found in this analysis was based on the assumption that there is a linear relationship between BCSM and the likelihood of conception, but that may not be the case Further preliminary analysis suggest there may be a threshold BCSM between 2 5 and 3 under which the probability of conception drops

Pure New Zealand hinds appeared to have a higher probability of conception, but it is beleived this may be partly mediated through age as hinds over 2 years were 5 times more likely to be pure New Zealand hinds than younger adult hinds AGE2 was also identified as indirectly influencing conception through WET and BCSM It is recognised that lacation puts yearling hinds under higher nutritional stress than adults, thus lowering their body condition disproportionately Thus AGE2 has a total positive effect on conception higher than the direct positive effect indentified in these analyses

These results also suggest a beneficial influence of weaning and introducing stags with hinds early This supports the observation in the wild environment that hinds in lactation at mating have a delayed onset of oestrus (Guinness et al , 1978), which may be caused by the increased

Figure 1 Null hypothesis and final path diagrams of animal management risk factors, and final path diagram of animal and grazing management risk factors for early conception in adult hinds (before May 1) (see Table 1 for codes)

1 NULL HYPOTHESIS PATH DIAGRAM



2 FINAL PATH DIAGRAM

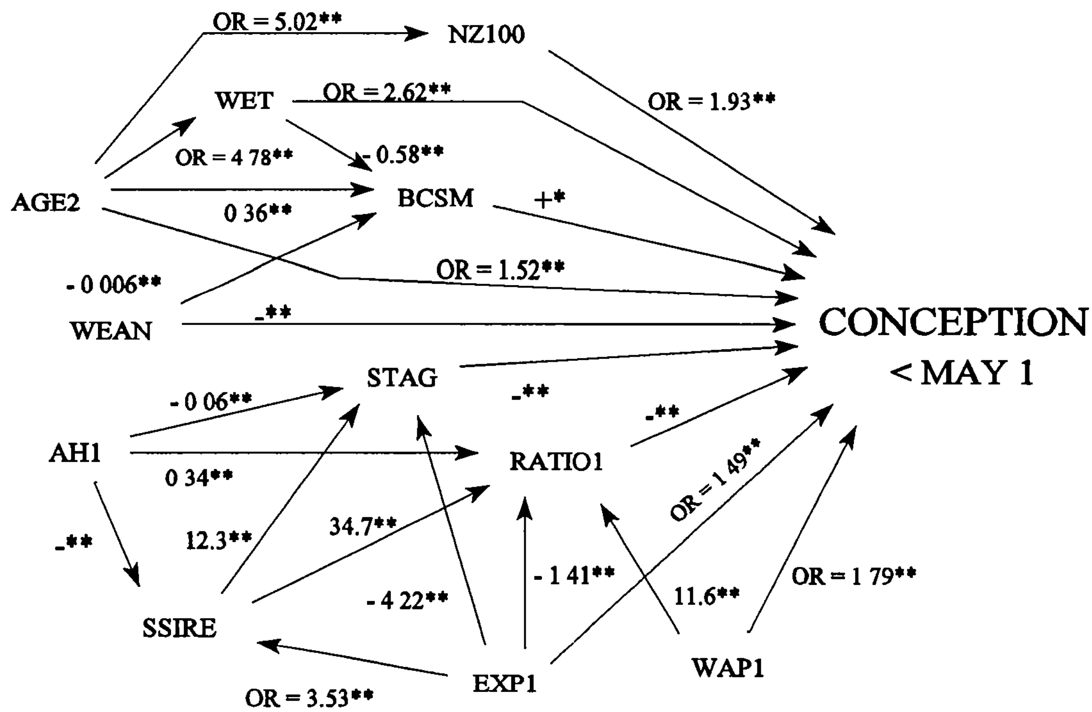
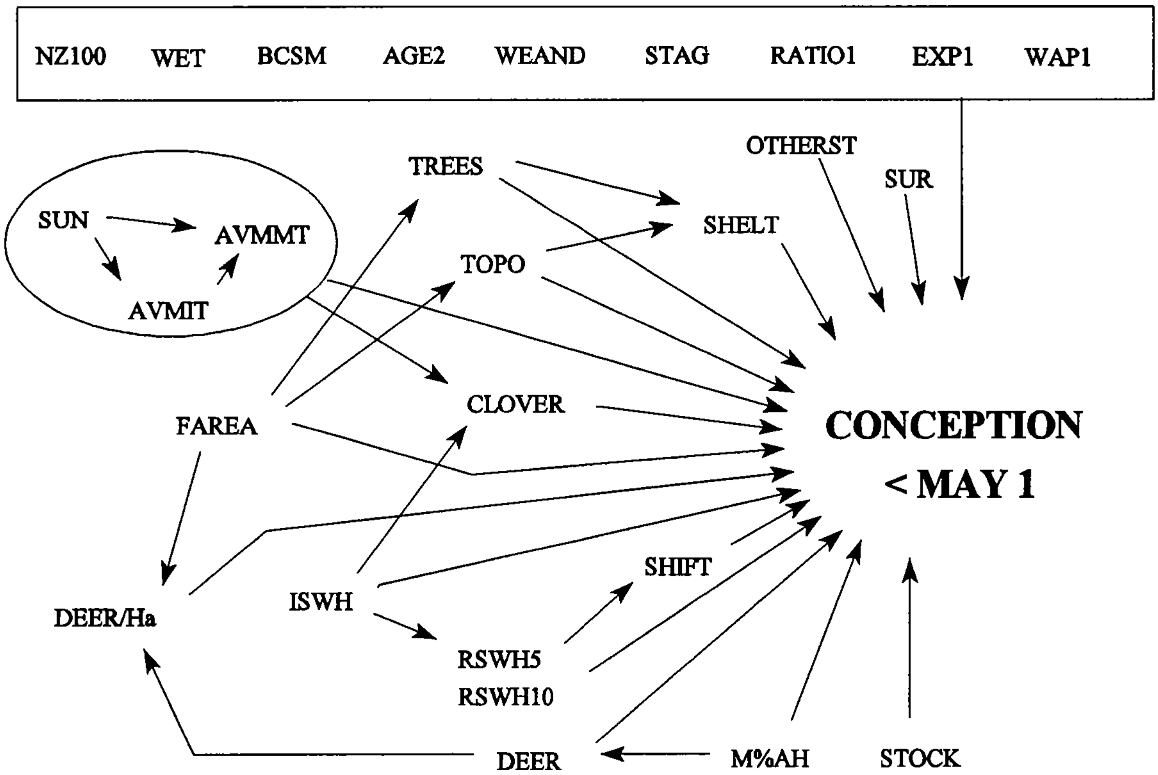


Figure 2 Null hypothesis and final path diagrams of environment and grazing management risk factors for early conception in adult hinds (before May 1) (see Table 1 for codes)

1 NULL HYPOTHESIS PATH DIAGRAM



2 FINAL PATH DIAGRAM

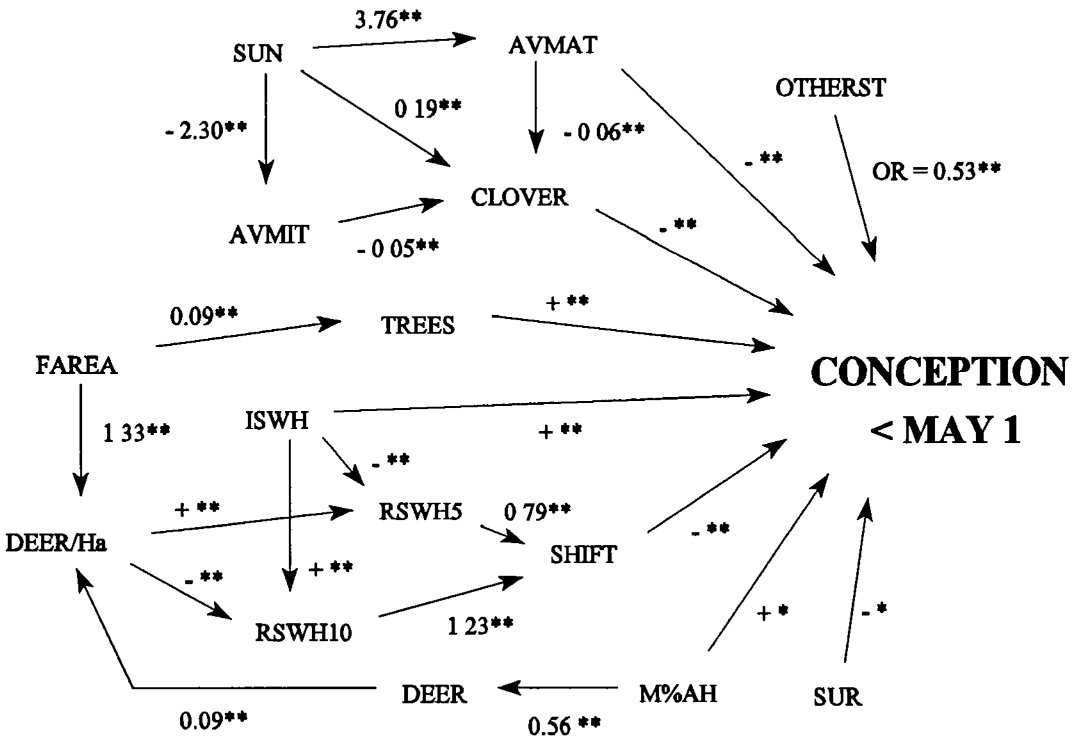
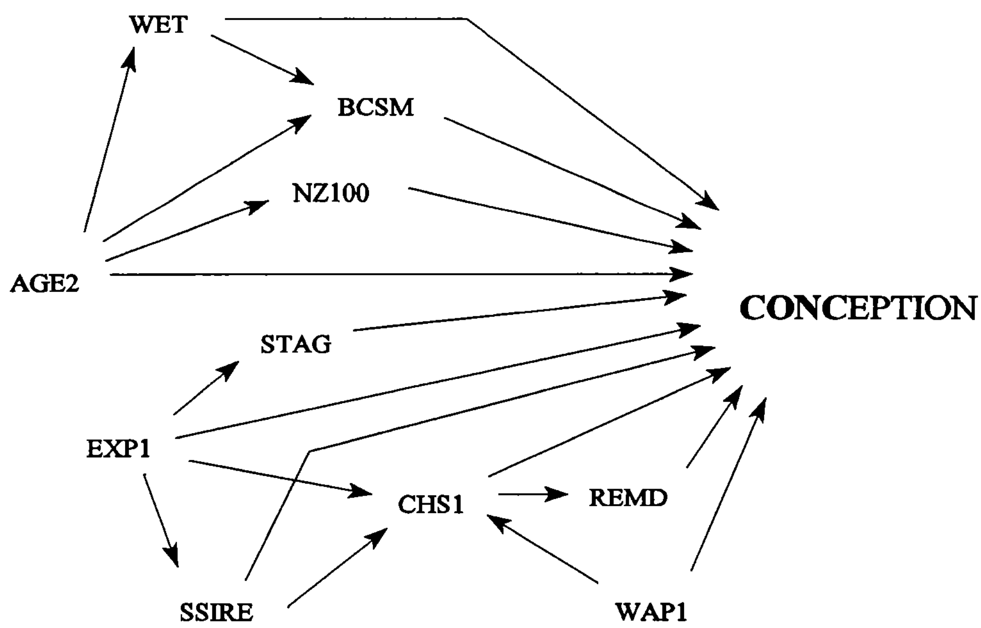


Figure 3 Null hypothesis and final path diagrams of animal management risk factors for conception in adult hinds (see Table 1 for codes)

1 NULL HYPOTHESIS PATH DIAGRAM



2 FINAL PATH DIAGRAM

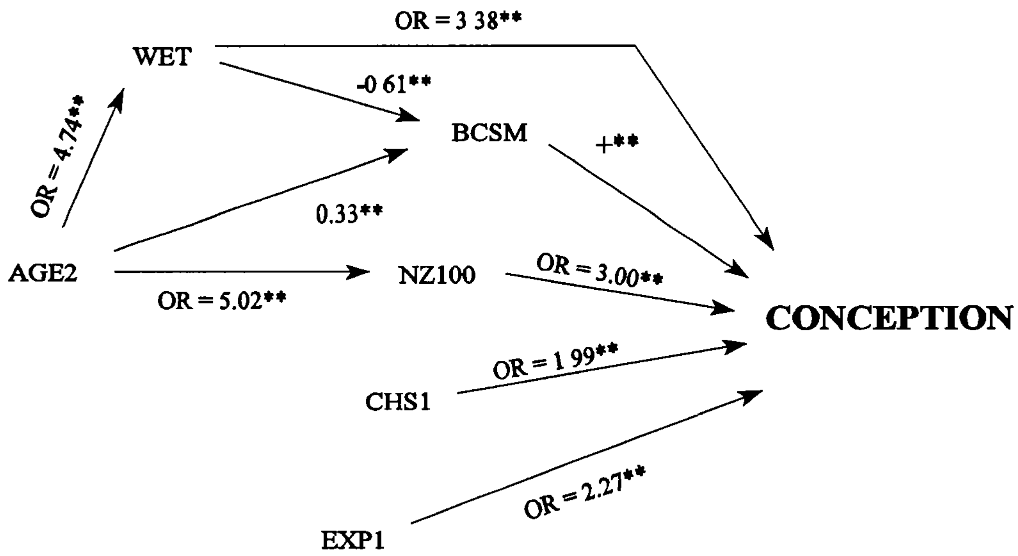
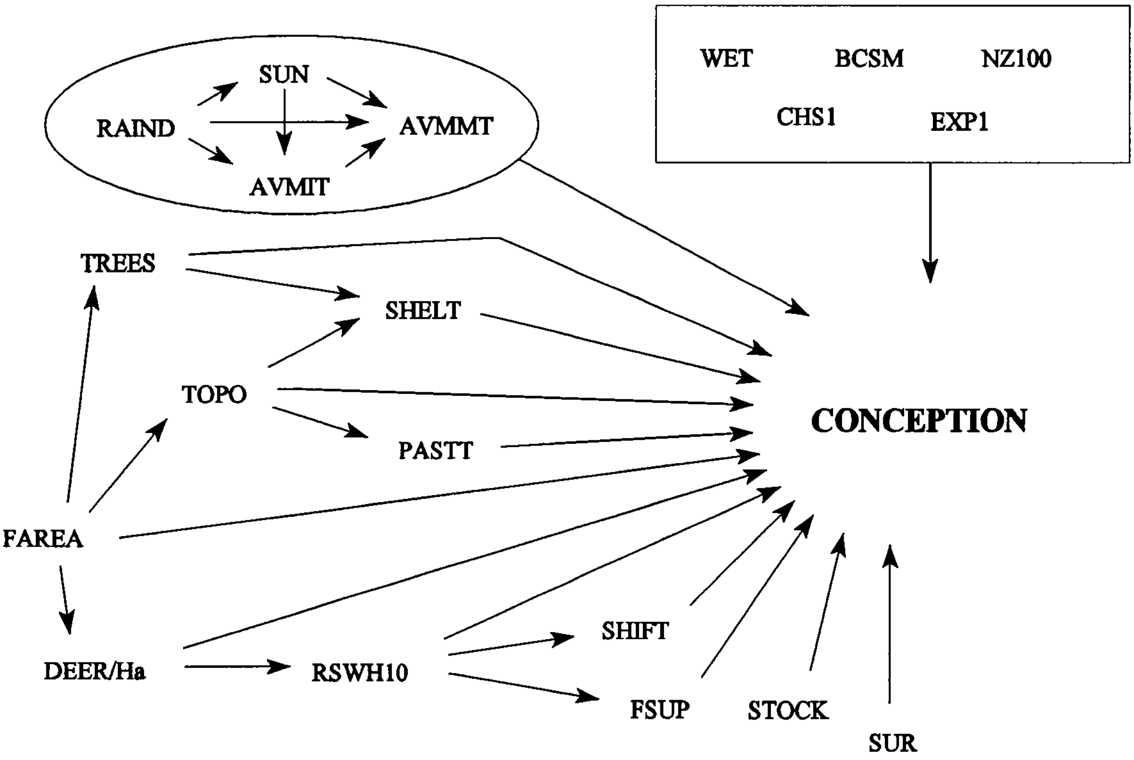


Figure 4 Null hypothesis and final path diagrams of environment and grazing management risk factors for conception in adult hinds (see Table 1 for codes)

1 NULL HYPOTHESIS PATH DIAGRAM



2 FINAL PATH DIAGRAM

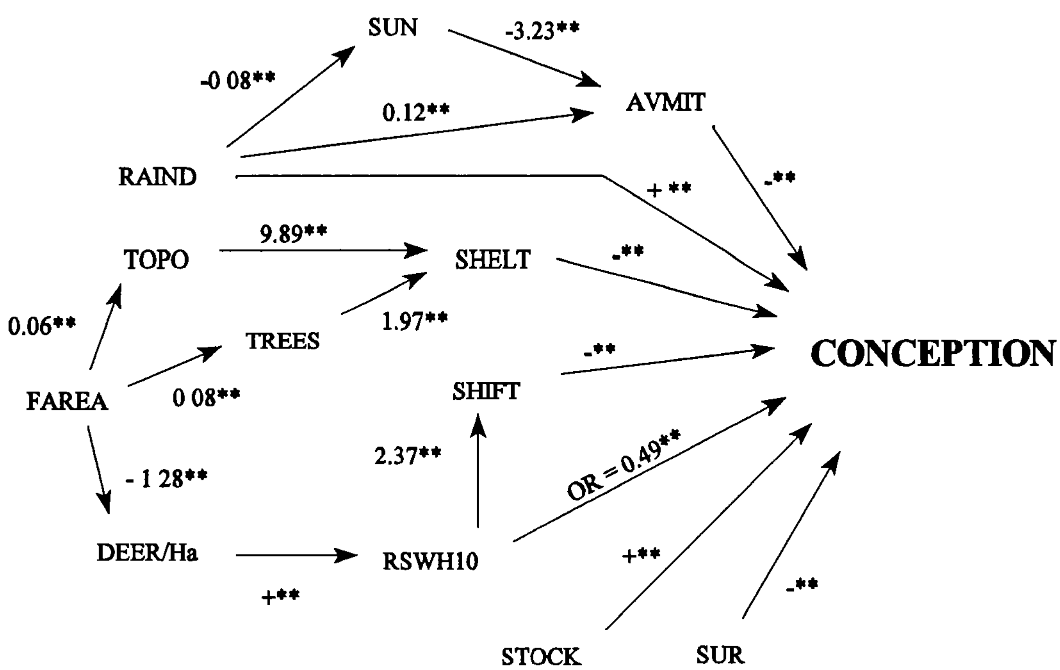


Figure 5 Overall final path diagrams of animal, grazing management and environmental risk factors for early conception in adult hinds (see Table 1 for codes)

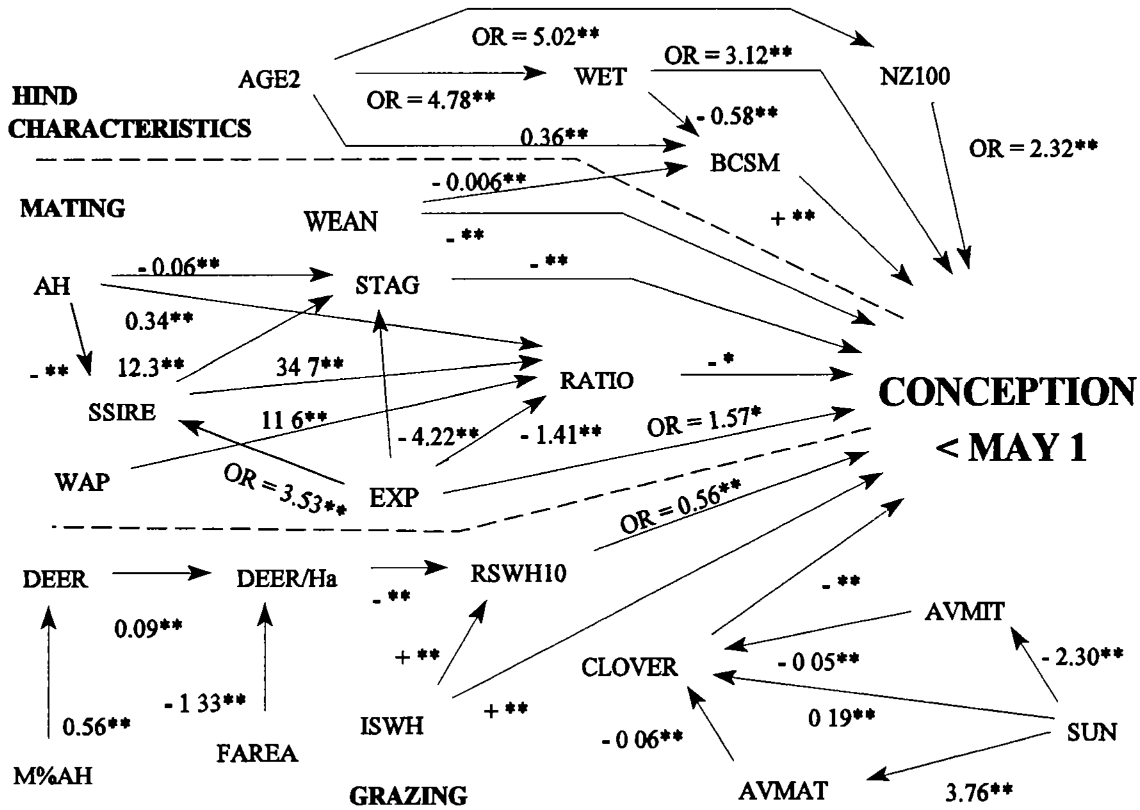
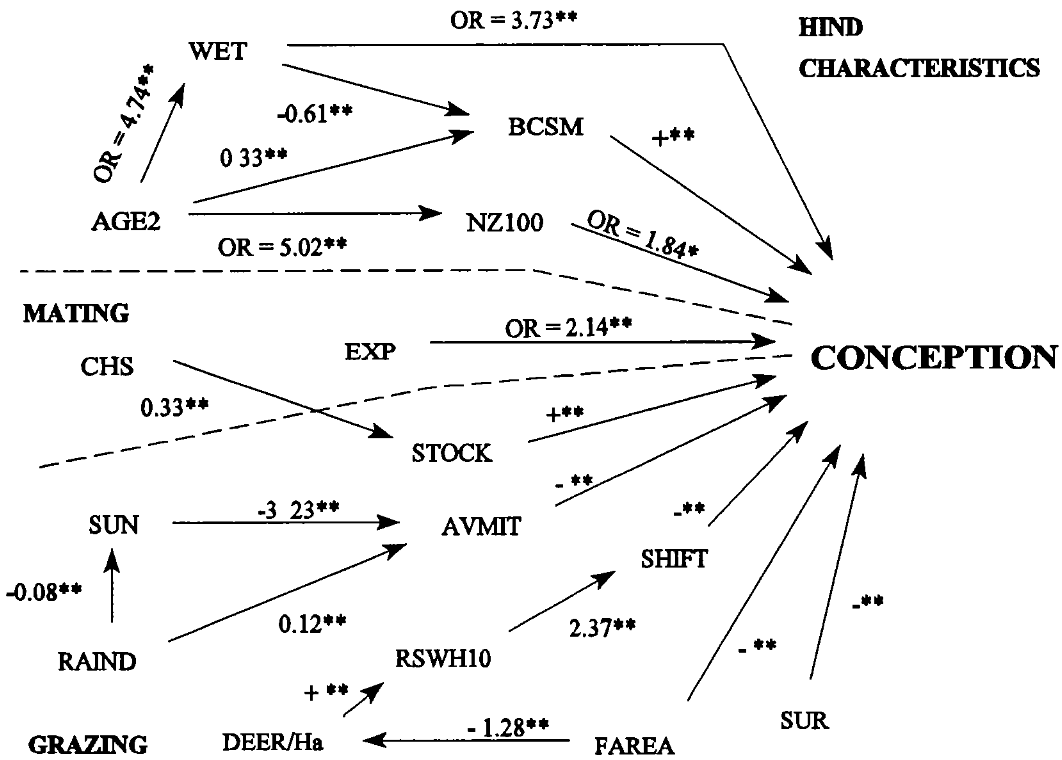


Figure 6 Overall final path diagrams of animal and grazing management risk factors for conception in adult hinds (see Table 1 for codes)



prolactin secretion associated with suckling (Loudon et al , 1983) Lactating hinds may also not synchronise as much as non-lactating hinds durng or just prior to the rut (Iason and Guinness, 1985), suggestng that early weaning may have a positive effect on oestrus synchrony and early conception Part of the effect of the weaning date may also be mediated through BCSM, since the later that hinds were weaned, the poorer their condition Further, the positive "stag effect" has been demonstrated with the use of melatonın implants to advance the reproductive season (Wilson et al , 1990) Early introduction of sire stags can significantly advance the onset of first oestrus in hinds by up to 6 days (Moore, 1985, Mc Comb, 1987), which may contribute to an increase in the number of hinds conceiving before May 1

If all other risk factors were maintained constant, hinds mated to experienced stags were 1 5 times more likely to conceive early and 2 3 times more likely to conceive at all than those mated to inexperienced stags The total positive effect of the experienced stag on early conception may, however, be greater on early conception as it was also mediated through early joining and a lower hind stag ratio, although these relationships are related to management decisons In this study, experienced stags were joined with hinds earlier than inexperienced stags, and had fewer hinds to mate, which may have partly contributed to the "stag effect" identified earlier The apparent beneficial direct effect of using hybrid wapiti sires on early conception was unexpected However, this relationship is not significant in the overall final diagram (see Figure 5) In this study, farmers who used wapiti sires did not have greater conception rates as they tended to increase the hind stag ratio The relationshıp between hind stag ratio and the likelihood of early conception may not be linear, and further analysis will be necessary to explore a possible threshold value Recommended hind stag ratio was about 30 (Kelly and Moore, 1977) with a maximum of 50 (Moore, 1985) The range used in this study was 8 to 82

The use of back-up stags was not significant in explaining the variability in early conception but appeared an important practice to increase overall conception By leaving primary sire stags after May 1, farmers may get a few more adult hinds pregnant, but it seems beneficial to replace the initial sire stag altogether This may ensure fertile mating of hinds coming into oestrus late if initial sires are sexually exhausted or infertıle The examination of both wapiti and red deer stags revealed at least 10% may have poor qualıty semen during the breeding season, which may result in reduced fertılıty (Haigh and Hudson, 1993) The non significance of the use of a back-up stag on the analysis of early conception may be because late conceiving adult hinds did not come into oestrus between the time of introduction of back-up stags (mostly after April 20) and May 1 However, the time of removal of sire stag (REMD) was not significant in the final model possıbly because if back-up stags were used (CHS1) they were removed from hinds on average 13 days later than other sires, which effect, ıf any, may be confounded with that of CHS1 The apparent positive effect of changing the mob compositıon may also be counfounded with that of using back-up stags as shown in figure 5

The analyses of grazing management and environmental factors are more difficult to interpret because there is no pre-existıng evıdence of association or certain biological explaination for many factors Some factors in this block were chosen based on logical thought without back-up from the literature, so this discussion is only suggestive of plausible explainations For instance, changing mob compositions (STOCK) may be significant because some farmers often mixed mating mobs together at the end of mating, which may be beneficial The beneficial effect of using back up stags in the overall final diagram is medıated through STOCK has changing mobs occured during the introduction of back-up sires The negative effects on conception of shifting hinds between paddocks and grazıng hinds on paddocks close to human presence may be associated with disturbance of mating mobs which may occur during oestrus, thus interfering with mating. The negative effect of the contact with other domestic livestock is intriguing and will need further exploration (Figure 2).

The significance of sward height variables in preliminary analyses suggests nutrition during mating may need to be further evaluated. Swards below 10 cm may have been of better quality because of limited amount of roughage and dead material. In this study, a seed head density score was recorded by some farmers (Audigé et al., 1993), but it was inconsistently assessed and was therefore rejected from analyses. However, hinds which did not grazed pasture below 10 cm were more often shifted (SHIFT) than the other hinds, which may be a confounding factor. When building null hypothesis path diagrams, it was hypothesized low residual pasture sward height would lead hinds to be shifted, but the sequence of event/decision may be the other way around. Residual pasture sward height may be over 10 cm because hinds were frequently shifted between paddocks. The significance of grazing below 5 cm will need to be further evaluated as its effect, if any, may depend on the pre-mating body condition of the hind. It is beleived that the lower the hind body condition, the higher nutrition level should be. Grazing below 5 cm in associated with reduced pasture intake, as observed with weaner deer (Ataja et al., 1989). The negative effect of high clover content in pasture is unexplained. It is known some type of clover can impair reproductive performance of ewes due to oestrogenic effect (Shackell and Kelly, 1984), but, in this study, there was predominantly white clover in pastures, a non-oestrogenic clover. In fact, warm and sunny weather, which was associated with high clover scores seemed to negatively influence conception, thus possibly being a confounding factor.

When considering the economic significance of early conception, the reader should refer to the investigation of risk factors for weaner bodyweight elsewhere in this proceedings. Early calving hinds produced weaner stags and hinds which were to 5.5kg and 2.5kg heavier on April 1 (as post-weaning weight), respectively.

It must be stressed the associations found in this study are not proof of causation and further research is required to validate cause and effect. This study has identified areas which deserve priority in research and development design to improve reproductive management techniques. However, the findings of this study do suggest that farmers:

- wean early and allow thin hinds to recover before the onset of the rut,
- cull dry hinds and hinds in low condition (a threshold body condition score is to be investigated further),
- join hinds early with at least one experienced sire (inexperienced sires could be trained with culled hinds),
- limit the hind to stag ratio (a threshold value is to be investigated further),
- use at least one back-up sire,
- keep mating mobs from disturbance.

Providing theses conditions are met and they have causal relationships, all adult hinds can be mated before May 1 with an overall 98 to 99% conception rate as has been observed on some farms in this study.

ACKNOWLEDGMENTS

We thank farmers, veterinarians, and technicians involved Funding was provided by N Z Game Industry Board, Ministry of Foreign Affairs of France, Deer Branch NZVA, Massey University, Pitman Moore, Rhône Mérieux, Cyanamid, Ag-Research, CIRAD-EMVT, Allflex and Te Pari Products

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