DEER MORTALITY PROFILE

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

This paper presents the mortality profile of farmed red deer

MATERIALS AND METHODS

A 2-year observationnal study was conducted on 15 commercial red deer farms in the North Island of New Zealand About 2700 hinds, 2400 weaner deer and 1500 stags were individually monitored The composition of deer mobs was recorded Mortalities were identified as spontaneous deaths or deer euthanased by the farmer because of disease or injury The likely causes of mortality were investigated by post-mortem examinations and further laboratory investigations as appropriate Where possible, post-mortems were conducted by the researchers or the farmer's regular veterinary practitioners Where that was not possible, farmers were given personal and written instructions to undertake a post-mortem and collect specimens, either fixed or frozen for later gross or laboratory confirmation

Mortality rates were classified according the their likely causal factor as dystocia, malignant catarrhal fever (MCF), yersiniosis, osteochondrosis, misadventure (including injuries and broken bones), miscellaneous (rare mortalities with identified causal factor) and unconfirmed (mortalities with causal factor unknown or unconfirmed)

Total numbers of deer at risk were obtained from grazing records (Audigé *et al*, 1993) to compute seasonal and annual mortality rates

RESULTS

Annual and seasonal mortality numbers and rates are presented in tables 1 and 2, respectively The monthly distribution of weaner, stag and hind mortalities is presented in figure 1

Identified hind mortalities were mainly caused by dystocia , broken bones and MCF More than half of hind mortalities (54 2%) were from unconfirmed causes However 15 7% of those were associated with poor body condition (fading)

MCF was the most common confirmed cause of stag death (20 6%) killing 0 53 stag per 100 stag x year A large proportion of mortalities were associated with misadventure (31 3%) including injuries, either self-inflicted or caused by other stags (15 6%) 42 9% of stag mortalities remained unconfirmed with 7 9% associated with fading

Yersiniosis was confirmed in 18 6% of weaner deaths This disease killed 1 09 weaners per 100 weaner x year, mainly during the first 6 months after weaning Yersiniosis was suspected in a further 41% of mortalities, where post-mortem examinations were either not performed or

Table 1 : Mortalities of hinds, stags, weaners and calves, from April 1 1992 to April 1 1994.

HINDS

Diagnosis	Number	%	Mortality rates (/100 hinds x year)
Unconfirmed			
Fading	13	15 7	0 28
Ataxia	1	1 2	0 02
Pneumonia	1	1 2	0 02
Enteritis	2	2 4	0 04
Rumenitis	1	1 2	0 02
Dystocia ?	2	2 4	0 04
No diagnosis	25	30 1	0 53
Total Unconfirmed	45	54 2	0 96
Dystocia	8	9 6	0 17
MCF			
Acute	7	8 4	0 15
Chronic	1	1 2	0 02
Total MCF	8	9 6	0 17
Misadventure			
Drowned	7	8 4	0 15
Injury	1	1 2	0 02
Broken neck	5	6 0	0 11
Broken leg	3	3 6	0 06
Other	1	1 2	0 02
Total misadventure	17	20 5	0 36
Miscellaneous			
Enzootic ataxia	3	3 6	0 06
Liver cancer	1	1 2	0 02
Volvulus	1	1 2	0 02
Total miscellaneous	5	6 0	0 11
Total mortalities	83	100 0	
Mortality rates (/100 hinds x year)			1 77
Number of hinds x year at risk			4683

STAGS

Diagnosis	Number	%	Mortality rates (/100 stags x year
Unconfirmed			
Fading	5	7 9	0 20
Interstitial nephritis	1	1 6	0 04
Black-leg	1	1 6	0 04
Johnes disease	1	1 6	0 04
No diagnosis	19	30 2	0 77
Total Unconfirmed	27	42 9	1 10
MCF			
Acute	10	15 9	0 41
Chronic	3	4 8	0 12
Total MCF	13	20 6	0 53
Misadventure			
Handling stress	2	3 2	0 08
Broken neck	3	4 8	0 12
Broken leg	2	3 2	0 08
Stag fight	2	3 2	0 08
Injury	3	4 8	0 12
Other	8	12 7	0 33
Total misadventure	20	31 7	0 81
Miscellaneous			
Facial abcesses	2	3 2	0 08
Gun shot	1	1 6	0 04
Total miscellaneous	3	4 8	0 12
Total mortalities	63	100 0	
Mortality rates (/100 stags x year)			2 56
Number of stags x year at risk			2459

WEANERS

Diagnosis	Number	%	Mortality rates (/100 weaners x year)
Unconfirmed			
Yersiniosis ?	77	41 0	2 40
Lungworm	1	0 5	0 03
Lameness	3	1 6	0 09
Swollen joint	1	0 5	0 03
Fading	1	0 5	0 03
Septicaemia	1	0 5	0 03
Hepatitis	1	0 5	0 03
Enteritis	1	0 5	0 03
No diagnosis	26	13 8	0 81
Total unconfirmed	112	59 6	3 50
Yersiniosis	35	18 6	1 09
Misadventure			
Broken neck	15	8 0	0 47
Broken leg	7	3 7	0 22
Injury	1	0 5	0 03
Stress at weaning	1	0 5	0 03
Other	5	2 7	0 16
Total misadventure	29	15 4	0 91
Osteochondrosis	9	4 8	0 28
MCF*	1	0 5	0 03
Miscellaneous			
Malformation	1	0 5	0 03
Blind	1	0 5	0 03
Total miscellaneous	2	1 1	0 06
Total mortalities	188	100 0	
Mortality rate (/100 weaners x year)			5 87
Number of weaners x year at risk			3202

CALVES

Diagnosis	Number	%
Hind-calf relationship		
Dystocia	21	22 1
Stillbirth	9	9 5
Small weak fawn	2	2 1
Overmothered	1	1 1
Mismothering	6	6 3
Fawn victimised	6	6 3
Ruptured stomach	3	3 2
Total	48	50 5
Calf diseases		
Malformation (scoliosis)	1	1 1
Cryptosporidiosis	1	1 1
Liver abcess (navel infection)	1	1 1
Total	3	3 2
Direct management related		
Weather stress	2	2 1
Handling stress	1	1 1
Fawn lost	1	1 1
Lost through fence	8	8 4
Left behind	2	2 1
Misadventure	2	2 1
Broken neck	1	1 1
Broken leg	1	1 1
Broken back	1	1 1
Total	19	20 0
Unconfirmed	25	26 3
Total diagnoses	95	100 0

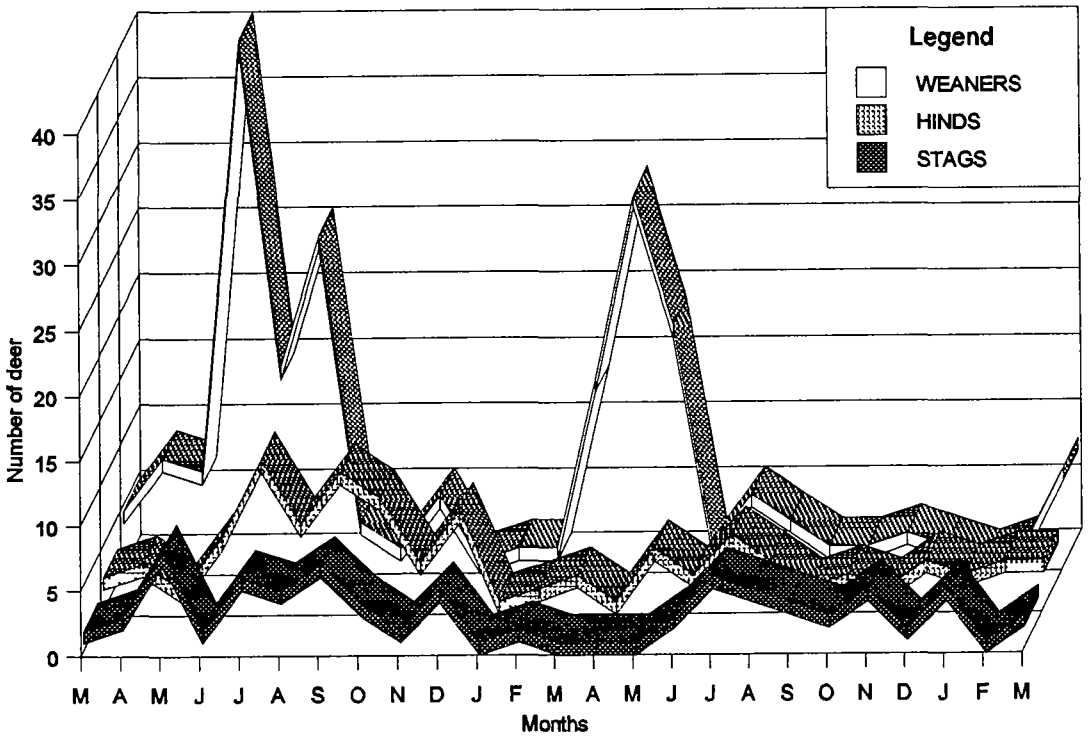
* This weaner died on August 28 1993 (8-9 5 months)
? Diagnosis based on circumstantial evidence

Table 2 : Seasonal hind, stag and weaner mortality rates (/100 deer-3 months). Data from April 1 1992 to April 1 1994.

	AUTUMN March 1 - June 1*		WINTER June 1 - September 1		SPRING September 1 - December 1		SUMMER December 1 - March 1	
	Number of occurence	Mortality rates	Number of occurence	Mortality rates	Number of occurence	Mortality rates	Number of occurence	Mortality rates
HINDS								
Unconfirmed	6	0 11	15	0 31	19	0 44	5	0 12
Dystocia					1	0 02	7	0 17
MCF			7	0 15	1	0 02		
Misadventure	4	0 07	10	0 21	1	0 02		
Miscellaneous	3	0 05			3	0 07	1	0 02
Total hinds	13	0 23	32	0 67	25	0 58	13	0 32
Total number of deer at risk		5590		4774		4297		4071
STAGS								
Unconfirmed	6	0 21	9	0 35	11	0 47	1	0 05
MCF	1	0 03	4	0 16	6	0 26	2	0 09
Misadventure	4	0 14	7	0 28	2	0 09	7	0 33
Miscellaneous			1	0 04			2	0 09
Total stags	11	0 38	21	0 83	19	0 82	12	0 57
Total number of deer at risk		2866		2541		2321		2108
WEANERS								
Unconfirmed	23	0 68	80	2 35	6	0 19	1	0 03
Yersiniosis	32	0 94	3	0 09				
Misadventure	18	0 53	5	0 15	5	0 16	3	0 10
Osteochondrosis	7	0 21			2	0 06		
MCF			1	0 03				
Miscellaneous	2	0 06						
Total weaners	82	2 41	89	2 62	13	0 42	4	0 14
Total number of deer at risk		3401		3402		3086		2919

* This period includes March 1993 and 1994, and May-June 1992 and 1993

Figure 1 : Monthly distribution mortalities of weaners (3-15 months), hinds (>15 months) and stags (>15 months) from March 1992 to March 1994.



unconclusive Misadventure accounted for 15 4% of weaner mortalities, killing 0 53 weaners per 100 weaner x year, mainly occuring in Autumn On one farm, 9 weaners were euthanised because of osteochondris lesions (4 8% of weaner mortalities) MCF was confirmed in one weaner stag in August 1993 (8-9 months of age) which is unusually young for that disease

Half of identified calf losses were related to the hind-calf relationship (50 5%) and were perinatal mortalities, mainly due to dystocia (22 1%) and stillbirth (9 5%) Most unconfirmed calf losses were suspected to be perinatal mortalities The remainder of losses (20%) were directly related to the management of calving mobs with 8 4% of dead calves lost outside the calving paddock boundary

A large proportion of unaccounted for calves (77 3%) could not be found From ultrasound pregnancy testing and other reproduction data both years combined, calculated foetus-calf loss rates were 17 0% and 9 1% in yearling and adult hinds, respectively, ranging from 0-38 8% in yearlings and from 0-18 6% in adult hinds between farms The overall apparent loss rate from time of pregnancy diagnosis to weaning was 10 4% of all hinds combined

Overall mortality rates (number of losses per 100 deer x year) were 1 77, 2 56 and 5 87 in hinds, stags and weaners, respectively, ranging from 0-4 33 in yearling and adult hinds, from 0-9 62 in yearling and adult stags and from 0 35-30 3 in weaner deer, between farms

DISCUSSION

Mortality results presented in this paper do not differ greatly from preliminary estimations presented previously (Audigé *et al.*, 1993) The monthly distribution of deer mortalities confirms a seasonal variation with the highest mortality rates for weaners being between the ages of 3- and 6-months whereas the highest mortality rates for yearling and adult deer were between June and October During the survey, about 20-30 deer were recorded as missing but it was not possible to know whether they died, escaped from the mob when being mustered to the yards, escaped outside the farm or simply lost their ear-tag These deer were not included in the mortality list

Mortalities of yearling and adult deer are not high on commercial deer farms Over two years, annual mortality rates of 1 77 and 2 60 per 100 hinds and stags, respectively, were lower than 4 6% reported for adult ewes (Quinlivan, 1971) Malignant catarrhal fever alone killed 0 53 stags and 0 17 hinds per 100 deer x year at risk, respectively, with an overall annual mortality rate due to this disease of 0 29 per 100 yearling and adult deer in this study This figure is lower than the 1 1% mortality rate due to MCF estimated by Beatson (1984) in Canterbury No chronic cases presented nasal or ocular discharges occasionally observed in this condition Most deaths occured after a prolonged period of fading, with or without scouring, that lasted up to 4 months It was difficult to ascertain whether MCF was the primary cause or a complication of the fading condition One chronic case had extensive thickening of blood vessels ("periarteritis nodosa-like") in many organs (liver, kidneys, pampiniform plexus,) typical of this condition in deer (Wilson et al , 1983, Johnstone, 1993)

Mortality rates of weaner deer on most farms were between 2 and 3 (/100 weaner x year) , but on some farms losses were considerably higher, raising the overall figure to 5 87 One farm lost 17 5 and 11 5 weaner per 100 weaner x year at risk during Autumn and Winter, respectively, through an outbreak of Yersiniosis Since most weaners on that farm were sold before the end of June, the annual mortality rate of 30 3, become 15 2 when calculated per 100 weaner x 6 months at risk, which is more meaningful A second farm experienced an outbreak of osteochondrosis

associated with copper deficiency (Audigé *et al*, 1993), which affected up to 12% of calves at weaning and resulted in 9 weaners being euthanased over the study period It is likely that total economic losses extended beyond mortalities through lack of growth in survivors and this is being investigated in other analyses

Serological investigations (unpublished data) showed almost all weaner mobs to have experienced subclinical infection by *Yersinia spp* by June Clinical yersiniosis occured on only two farms in 1993 where appropriate predisposing environmental conditions (shelter, sward allowance, weather conditions) appeared to prevail Thus specific risk factors may have triggered the clinical manifestation of the disease on these farms These will be analysed but it may be difficult to establish a relationship because of the limited number of cases To identify risk factors for a yersiniosis outbreak, other epidemiological investigations such as case-control studies may be required However, with the current knowledge of these health problems, it seems these mortalities may be preventable through planned disease control programmes This study was carried out before the vaccine "Yersiniavax" was widely used Farmers started vaccinating in 1993, mostly in the face of a clinical yersiniosis outbreak Since most farmers in this study used this vaccine in 1994 after this study concluded, it would be appropriate to further monitor this health problem and the overall success of vaccination strategies It was interesting to note that on one farm, 7 of 13 severely clinically affected weaners (including the ones that died) came from the same sire, thus supporting the observation of Mackintosh et al (1990) of apparent genetic predisposition of the disease recorded during a vaccination trial

The most frequent mortality factors overall were related to misadventure, which include injuries, broken bones and acute stress problems particularly in stags and weaners Most occured in Autumn and were related to yarding around weaning Weaning and handling procedures will be investigated as risk factors in further analyses

Foetal and calf mortalities are a significant cause of loss to the farmer with an overall 17% and 9 1% of yearling and adult hinds, respectively, losing their progeny between June (date of pregnancy diagnosis) and weaning On one farm, 38 6% of calves from yearlings were lost It was not possible to accurately estimate the rate of foetal loss in this study since individual hind pregnancy diagnoses before calving were not undertaken However, on many farms, bodyweight changes during late pregancy, udder palpation and physical appearance (ie signs indicative of advanced pregnancy) were used to identify hinds carrying their foetus to term All hinds identified not pregnant by this method were confirmed dry at weaning From the 8 farms that carried out these observations, foetal loss was calculated to be 0 66% and 0 85% in yearling and adult hinds, respectively From these estimates of foetal loss during pregnancy, it seems likely that the considerable majority of the 9 1-17% average losses between conception and weaning occured at or shortly after birth Of those losses, 77 3% could not be identified It is likely that on these commercial farms, dead calves were simply not found because of the extensive nature of the operation, or perhaps were removed by scavengers Despite these limitations, most identified losses occured through dystocia (22 1%), stillbirth (9 5%) and calves lost through fences (8 4%) which may be related to farm management Risk factors for calf mortality are under investigation

The range of mortality rates between farms suggest some mortalities might be preventable providing key risk factors can be identified and modified Although our data may not provide sufficient numbers of observations of any one disease to allow powerfull statistical analysis, an attempt is being made to identify management factors likely to minimise mortality rates of yearling and adult deer At the time of writing this analysis was not completed

Care must be taken before extrapolating these results to the whole of New Zealand as mortality patterns might differ between district However, these results are the best current estimates of mortality rates of farmed red deer in New Zealand

This health and production study has proven valuable in identifying the mortality profile of farmed red deer in the lower part of the North Island of New Zealand, highlighting the most important diseases Further research is needed to identify risk factors and to evaluate prevention strategies on farms These results showed reducing calf mortalities and preventing yersiniosis outbreaks in weaner deer may be the most relevant areas for research into improvement of farm productivity Although our large database will provide further information as analysis progresses, it will be appropriate to further monitor deer farms to validate these findings and to evaluate changes that may occur through the implementation of new control strategies

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