Suttie Consulting Ltd

Report to Deer Industry New Zealand: Estimation of Deer Population and Productivity Data 1990-2012

Report# SCL 12/2

June 2012

DEER INDUSTRY
NEW ZEALAND

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June 2012

Executive Summary

Conclusions

Table 1 Deer industry key performance indicators 1990-2012

Subject matter	Conclusion
Slaughter times and weights	Yearling Red deer stags are killed at a carcass weight of 55kg on November 1, which is one month earlier than in the current Inventory Model.
	Elk/Wapiti are killed in September which is 2 months earlier than Red deer are killed and at a 5-10kg higher carcass weight.
	Mixed age stags are killed in June and July at a carcass weight of 99kg and in November – February at a carcass weight of 110-132 kg.
	The proportion of hinds killed from March to June has increased from 2004-2011, compared with 1997- 2003. I estimate that this is due to a movement in hind slaughter from 22 to 18 months of age. I estimate this change to be an increase of 30% in 2004-2011 compared with 1997-2003.
	Female Red deer killed in April- May have an average carcass weight of 53kg and those killed in September – October, 51kg.
Liveweights	Stag and hind liveweight has increased from 1990 to 2011. As deer, and in particular stag, liveweight varies considerably with season, this fact must be factored into the Inventory Model.
National herd composition by stock class	The proportion of breeding hinds has remained about the same in the period 1990 – 2011, but the number of mature stags is less than half in 2011 compared with 1990. The changes in population structure warrant use of a flexible population model for deer.
	More intact adult stags are retained on deer farms where neither breeding nor meat is their primary function. This is unusual among farmed species.
Reproduction and calving	Hinds calved around 19-20 November in 2008, and around 30 November in 1992. These timings are earlier than the MPI model.
	Mixed age and rising 2 year old hind reproductive rates are stable from 1990 – 2011 at 85% and 70% respectively.
Mortality	It is reasonable to assume that mortality is 2% for stock older than one year and 5% for stock in the first year of life. Older stags die predominantly in March - July (65%) and older hinds from June - November (90%) and the deer in the first year of life from 3-7 months of age.
Feed quality	90% of deer are now estimated to be farmed on low class land in 2011, whereas in 1990 about half deer were farmed on high class land. This means that ME available to deer is much lower than Inventory Model calculates.
	Deer have a seasonal pattern of ME requirement and they voluntarily reduce energy requirement in winter. No other farmed species in NZ has this physiological mechanism. This should be accounted for in the

Subject matter	Conclusion
	Inventory Model
Milk production	Hinds lactate for 120 days and produce, on average 1.7L/ day of milk. Lactation is shorter and produces less milk that assumed in the Inventory Model.
Velvet production	Velvet weight has increased from 2kg to 4kg in the period 1990-2011. The principal relevance of velvet production to the Inventory Model is that it means more intact adult stags are retained on farms where neither breeding nor meat is their primary function. This is unusual among farmed species.

Changes that it is recommended that be made to the Inventory Model are specified in Table 2.

Table 2 Recommendations as to changes to be captured in revised Inventory Model

Applicable stock classes	New value or assumption	Existing assumption/amount	Brief explanation for change	Applicable years	Explanation if new value does not apply back to 1990
Red stags 0-1y	Slaughter is 1 November at a liveweight of 100kg .	Slaughter is one month later	Analysis shows an earlier peak	All	Data available from 1992 onwards
Elk/Wapiti stags 0-1y	Slaughter is on 1 October at a liveweight of 109-118kg	n/a: new category proposed			
Red stags 1-2y	Slaughter is on 1 Mar at a liveweight of 100kg				
All 2-3 y stags	Slaughter of 12% of animals are killed on 1 July at a liveweight of 140kg and 82% are killed on 1 December at a liveweight of 160kg	n/a: new split category proposed			
All mixed age stags	Slaughter of 12% of animals are killed on 1 July at a liveweight of 180kg and 82% are killed on 1 December at a liveweight of 209kg	n/a: new split category proposed			
Red hinds 1-2y	Slaughter is on 1 Oct at 93kg liveweight			1999-2003	Insufficient data for years prior to 1999
Red hinds 1-2 y	Slaughter is on 1 April (30%) at a liveweight of 93kg and 1 October (70%) at a liveweight of 96.5kg). I	Model indicates hinds killed in late summer	Analysis shows two peaks: one in autumn and one in winter. In 2012 there are 30%	2004-2011	

Applicable stock classes	New value or assumption	Existing assumption/amount	Brief explanation for change	Applicable years	Explanation if new value does not apply back to 1990
			more hinds killed in March-April than September-October compared with the 1997-2001 period. Hind carcasses were on average 4kg heavier throughout the year from 1996- 2011, compared with 1992-1996		
Elk/Wapiti 1-2y hinds	Slaughter is on 1 Dec at 100kg			1990-2011	
Red hinds Mixed age	Slaughter is on 1 Apr at a liveweight of 93kg		Data show these are the correct weights to use	1992-2012	Data available from 1992 onwards
Elk/Wapiti hinds mixed age	Slaughter is on 1 Apr at a liveweight of 100kg				
All except 0-1y.o. classes	Stag and hind liveweights to be taken from tables in Chapter 4. As deer, and in particular stag liveweight, varies considerably with season, this knowledge must be factored into Inventory Model	Calculated from a formula	Liveweight was calculated from a formula that neither reflects genetic gain nor the seasonal nature of stag (particularly) live weight	All	N/a
0-1 year old hinds	Mortality is 5% for stock in the first year of life; 65% of this mortality	2% mortality spread evenly throughout the	0-1 year mortality higher than model	All	N/a

Applicable stock classes	New value or assumption	Existing assumption/amount	Brief explanation for change	Applicable years	Explanation if new value does not apply back to 1990
and stags	occurs from March - July	year			
All classes save 0-1y.o. hinds and stags	Hinds older than one year have a 2% annual mortality with 60% from June to October and 30% in November, with the rest spread evenly from December to May. Stags older than one year have a 2% annual mortality with 80% from March to July, with the rest spread evenly from August to February.	2% mortality spread evenly throughout the year	Same as model	All	N/a
Hinds	Hinds lactate for 120 days and produce- ▪ 1.7L/day milk (hinds 2 years or older); or ▪ 1.4l/day(yearling hinds)	Inventory provides that all hinds produce 242L milk over 121 days (Dec-Mar)	Review of NZ data	1990-2011	The data are from Ward *et al* 2008, but as hinds have not been selected for milk output, there is no reason to consider that lactation performance is any greater now than in 1990
Hinds	Calving date was- ▪ 30 November in 1992 and advanced linearly thereafter to reach 19-20 November in 2008 (Hinds 2 years or older); or	Calving occurs at 1 Dec	Review of actual data	Selection for earlier calving has taken place since 1995	Data available from 1992 onwards

Applicable stock classes	New value or assumption	Existing assumption/amount	Brief explanation for change	Applicable years	Explanation if new value does not apply back to 1990
	▪ 2 weeks later than the dates for hinds 2 years or older ((yearling hinds) (which averaged 13 December by 2012).				
All	In 1990, 50% of all deer were on high class land and the remainder were on low class land. From 1990 – 2011, the proportion of deer on high class land has dropped to an estimated 10%, with 90% on low class land. ME available to deer is equivalent to that of a sheep/beef farm (2MJ ME kg/DM lower than currently assumed).	Deer are run on dairying-quality land	The analysis based on deer population changes within regions and assumptions as to reasons for farming practice change show a different distribution of deer to the assumed land classes.	The date of the trend varies across regions of NZ. In high class farming areas, for example Waikato, the trend started in 1994. In Southland and Canterbury, the trend started in 2004, coinciding with the start of the dairy conversion boom	N/a: new assumption involves shift in values from 1990 to present
All	Deer have a seasonal pattern of ME requirement and they voluntarily reduce energy requirement in winter. his should be accounted for in the Inventory Model	N/A: new consideration proposed	Issue overlooked in Inventory Model	All	N/a
Stags: 2-3y and MA	Velvet produced 2kg in 1990 and 4kg in 2011, with a linear increase over time	Average velvet weight is 3kg	Velvet production has increased due to genetic gain and rigorous culling of	All since 1990	N/a: new assumption involves shift in values from 1990

Applicable stock classes	New value or assumption	Existing assumption/amount	Brief explanation for change	Applicable years	Explanation if new value does not apply back to 1990
			poorer performing animals.		to present. Model sensitive to most appropriate weight rather than the average
All	Stock class proportions reflect industry changes over time as shown in Table 30	Fixed percentages	There have been key population changes since 1990 (e.g. the number of mature stags is less than half in 2011 compared with 1990, which mean that it is not possible to use fixed percentages for stock classes over the period	All	N/a: new assumption involves shift in values from 1990 to present

Keynote recommendation

Due to the fact that deer have such strongly seasonal patterns of growth, energy requirements, and reproductive features, which features are sufficiently different from traditional livestock species, deer merit a specific model. This recommendation is supported by the fact that the deer population composition has also changed over the 22 year period.

Chapter 1. Introduction

1.1. Objective of project

1.1.1. Suttie Consulting Ltd (Jimmy Suttie) was contracted by Deer Industry New Zealand (DINZ) to conduct the tasks specified in Table 3. Deliverables are as specified in the second column.

Table 3 Project tasks and deliverables

	Task	Where/how delivered
i.	Establishment of baseline industry-wide deer farming population and productivity data as at 30 June 1990	Through the provision of productivity tables in the spreadsheets
ii.	Assess the typical land classes that deer are farmed on to determine whether feed quality default values used by the Ministry for Primary Industries ('MPI') in the Greenhouse Gas inventory are realistic	Tasks i and ii are largely written together and present the bulk of this report.
iii.	Assessment of typical land classes that deer are farmed on to determine whether feed quality default values used by the Ministry for Primary Industries ('MPI') in the Greenhouse Gas inventory are realistic.	
iv.	Consideration as to extent to which data generated by project differ in magnitude from data used by MPI in the Inventory Model, and why, and consideration as to whether the differences are significant in the context of the calculation of deer industry greenhouse gas emissions.	Effected by my making of recommendations

1.2. Approach to the brief

1.2.1. I have interpreted the brief as the development of data documenting, in as much detail as necessary, population and productivity changes since 1990 to the present. The use of existing (albeit incomplete) data in combination with expert opinion to develop complete estimated data has resulted in the review and report component of this project being more comprehensive than I initially envisaged.

1.2.2. I have attempted to weigh up data from different sources in an attempt to provide a reasoned consensus. As the purpose of the review was not to exhaustively research each aspect in detail, I have instead brought together key references and data (either from my own knowledge or from advice from experts) to assemble the consensus; this approach should be sufficiently precise for the purpose of calculating deer emissions.

1.3. Information

1.3.1. Information requirements

The key types of information required to fulfil the project brief are set out in Table 4 and Table 5.

Table 4 Qualitative information requirements

Subject matter	Specific information required
Industry wide changes in management practice, with time, from 1990 - 2012	• Demography • New farming methods • Threats and farmer response to these • Movement among land classes • Stags leaving farmed herd for trophy production
Deer reproduction	• Incursion of Elk/Wapiti genes into hind herd • Effects of management practice changes
Lactation and milk production	• Red x Elk/Wapiti hybridisation • Weaning practices
Kill out percentage	• Effects of management practice changes • Data used to calculate kill out percentage (e.g. kill out percentage based on hot carcass weight is different from cold carcass)

Table 5 Quantitative information requirements

Subject matter	Specific information required
Stock numbers	• Stock numbers and age classes used in MPI greenhouse gas Inventory model • All stock number and age class data held by DINZ or Statistics NZ • Any refinements such as numbers of Elk/Wapiti and fallow deer
Slaughter data	• Monthly kill data, categorised into age and sex classes • Liveweight at slaughter (by sex if possible) • Kill out percentage by age, genotype and sex class
Annual average liveweight	• Average liveweight for all age, sex and genotype stock classes • An estimate of typical growth curves to model annual liveweight change
Reproductive rate	• By age and genotype
Mortality	• Estimated monthly mortality by age, sex and genotype stock classes • Effect on productivity of sub-clinical disease (to determine whether sub clinical disease was reducing productivity)
ME available and consumed per month	• Land class • ME of pasture and supplements
Milk yield	• Milk yield data by age class • Estimation of timing of calf mortality • Effect of weaning practice
Velvet yield	• Qualitative data on velvet industry changes • Average velvet weight/stag/year

1.3.2. Sources of key information

Over the last 22 years, the deer industry has changed rapidly in terms of structure, size, the way it has been managed and the way that it has been supported. One consequence of these changes is that there is little linear and comprehensive data covering all of this period which has been collected consistently to document deer productivity. Any attempt, such as this, to tabulate and interpret deer productivity data necessitates drawing data from a wide variety of sources each of which will carry its own issues of accuracy and robustness. Throughout this report, care has been taken to ensure that each data source is internally consistent.

I have taken several complementary approaches to assemble data for this review. I have undertaken literature searches, with heavy use of the DEEResearch publication database, to obtain documents published in refereed and unrefereed journals. A complete list of literature references is contained in Chapter 1APPENDIX A I have also read past issues of Deer Industry News magazines.

I have obtained unpublished deer industry data from DINZ, government departments, Crown-owned entities and Crown Research Institutes.

A component of this project entailed discussing with Industry experts the history of major management changes from 1990 – 2012, as this would provide qualitative data to augment the quantitative data, particularly where there gaps. Accordingly I interviewed leading people in the deer industry including farmers, journalists, processors and veterinarians/scientists. I used a structured interview format and each participant was asked the same series of questions, with specific questions on their areas of acknowledged speciality. The interview template is shown in Chapter 1APPENDIX B I am indebted to each of them for help and assistance with the project.

I am grateful to all providers of data.

I also used my personal knowledge of the deer industry.

A list of my information sources grouped by type are contained in Chapter 1APPENDIX C

Information as to the major sources used for each chapter is specified in Chapter 1APPENDIX D

1.4. **Structure of report**

1.4.1. Numerical information on stock numbers and slaughter data are presented in separate spreadsheets. Qualitative information on deer reproduction, lactation and kill out percentage are presented in this report together with the quantitative information. The chapters of this report are thus reviews of the deer productivity data relevant to the following key topics:

- Changes to deer farming management practices

- Slaughter
- Liveweight
- Reproduction and calving
- Mortality
- Feed quality
- Milk yield
- Velvet

1.5. Methodology

1.5.1. I was provided with methodology agreed between DINZ and MPI which is included in Chapter 1APPENDIX E

1.5.2. From time to time I deviated from the agreed methodology as data sources were insufficiently reliable to follow the methodology or I was able to locate additional data which superseded the agreed methodology. An explanation of and for any deviation, where relevant from MPI/DINZ methodology, is provided in Chapter 1APPENDIX A

Chapter 2. Changes to deer farming management practices

2.1. Deer industry generally

2.1.1. In 1990, deer in NZ were only recently domesticated and still exhibited wild tendencies that resulted in behavioural problems and meat quality issues. Indeed helicopter recovery of feral deer had only recently stopped; so many animals on farm were actually wild captured. The industry was still expanding in terms of numbers and had yet to establish a major meat industry. Most farmers' cash flow came from sale of velvet and live sales. Relatively low numbers of females were killed. In 1990, there were huge numbers of small (lifestyle-type) farmers running small herds on high value land on the outskirts of towns and cities whose performance often lagged behind industry averages; in 2012, they are no longer there.

2.1.2. About 3000 stags (approximately 1% of stags slaughtered) currently are used each year for the trophy hunting business.

2.1.3. After 2004, the hind kill was high and this meant that there were fewer replacements and the industry shrank. This trend has only been reversed in recent years.

2.1.4. In 2012, today's stable herd has resulted in the market for live animals being very subdued with farmers leaving the industry and selling their herds receiving no compensation for the genetic improvement they have bred into the animals. Deer farming now offers a lower capital cost option than it ever has in the past and currently on average land is showing good returns compared with other options. Deer farming is less labour intensive than dairy or sheep but more than beef.

2.1.5. Deer farming is now profitable but as other land use options, e.g. sheep farming, are also highly profitable, the high returns from venison tend to be overlooked. It will be interesting to see how deer farming fares should other industries experience a downturn in the future. This will be a real test for the robustness of the deer industry.

2.1.6. There are fewer specialist deer farms now, and most farms have deer with a range of other farming options. Farms with fewer than 200 hinds are now infrequent, as they have exited deer farming and there are many more farms with greater than 200 hinds.

2.1.7. The gap between top deer producers and the bottom is now very large. But the larger scale deer farms are showing an overall lift in performance with scale.

2.1.8. The costs of fencing and building deer sheds are high, which presents a barrier to entry for new farmers.

2.1.9. The deer industry as a whole is at risk from few new farmers coming in and reduction in deer farming expertise as people retire and exit the industry.

2.1.10. Deer are susceptible to the toxic effects of high endophyte pasture, and have benefitted from grasses with AR1, low endophyte grass and forage legumes.

2.2. Breed composition in the national herd

2.2.1. Eastern European Red deer were extensively introduced into NZ from the 1990s. It is widely held that they have contributed to a drift up in average hind live weight since then.

2.2.2. The deer herd is predominantly Red deer. Elk/Wapiti is 5% of the velvet industry and has not grown since 1996-1997. Elk/Wapiti are found on specialist units, and hybrid stags are used to cross-breed with Red deer hinds as terminal sires. Industry experts do not consider that there has been extensive introgression of Elk/Wapiti genes into the base Red deer hind herd. It would have been useful for the purposes of this report to critically analyse the impact of introgression, but this has proved impossible.

Chapter 3. Slaughter

3.1. Introduction

3.1.1. This chapter is directed towards identifying the main periods in which deer of various ages are slaughtered for venison and their liveweights at that time. Liveweight at slaughter is important since the Inventory Model is directed towards determining the emissions that have been expended in producing the body mass reached by an animal at its time of slaughter.

3.2. Structure of chapter

3.2.1. This chapter deals with the following things:

- dressing out percentage;
- timing of slaughter: introductory matters;
- timing of slaughter of stags;
- stag liveweights;
- timing of slaughter of hinds;
- hind liveweights; and
- recommendations relating to the foregoing matters.

3.3. Dressing Percentages

3.3.1. Dressing percentages in deer are typically higher than sheep or cattle. Dressing percentages are influenced by diet, concentrate fed animals having higher dressing percentages, presumably, as gut contents are lighter. Fallow deer in Australia had dressing percentages of up to 67% (Wiklund et al 2005). Dressing percentages are very hard to assess, as any time off feed prior to the final live weight will raise the dressing percentage and any extra carcass trim (kidneys, diaphragm) will lower the dressing percentage. In the data presented in Table 6, I have assumed that animals were weighed full immediately off feed and no additional carcass trimming took place. By contrast, assessing dressing percentage using ratios (as suggested in the MPI-DINZ methodology) is likely to embody errors in terms of what constitutes a carcass.

3.3.2. Body condition might also be expected to influence dressing percentage, and animals in poorer condition might be expected to have a lower dressing percentage, assuming the proportion of 'live weight' occupied by gut contents was similar. However animals in poor condition, if inadequately nourished may have a lower gut fill, thereby confounding the expected relationship. Additionally rapidly growing animals may have higher gut fill as they are eating more: (see lower panel of Table 6). This means that dressing percentage is lower in a well-conditioned animal. Taken together body condition is not a reliable indicator of dressing percentage.

Table 6 Recorded venison dressing percentages

Year, Location and reference	Data			Notes
1983 Otago (Drew, 1985)	**Age (months)**	**Carcass weight (kg)**	**Dressing %**	Over a range of carcass weights, although confounded by age, dressing percentage was similar.
	6	24.4	54.8	
	12	40.8	55.1	
	18	51.9	55.8	
	27	56.9	56.9	
2003 Otago (Wiklund et al 2003)	**Feed type**	**Carcass weight (kg)**	**Dressing %**	
	Pasture	54.1	53.5	
	Pellet	53.6	56.5	
2008 Otago (Wiklund et al, 2008)	**Rate of growth**	**Carcass weight (kg)**	**Dressing %**	
	Fast	49.6	52	
	Slow	52.3	53.4	

3.3.3. I have been unsuccessful at locating data for Red deer hind dressing out percentage. As reindeer males and females have similar dressing out percentages, (Eva Wiklund, *pers.comm*), in the absence of specific data, I feel that the stag data are acceptable, and the same percentage can be used for hinds and stags.

3.4. Conclusion

3.4.1. Taking the data above as a whole, dressings out percentages appear to range from 52 – 57%. A dressing out percentage of 55% is a reasonable number to use in the Inventory Model.

3.5. Timing of slaughter: introductory matters

3.5.1. Timing of slaughter for each stock class is an important parameter for greenhouse gas emissions calculations as it sets the time for that cohort leaving the productive population and thus ceasing to emit greenhouse gases.

3.6. Key background qualitative information

3.6.1. Information learnt from interviews with producers and veterinarians regarding slaughter and venison production can be summarised as follows:

- Deer may be being trucked further to slaughter in 2012 than in 1990.
- Deer slaughter capacity in the North Island is reduced reflecting the lower number of deer there now.
- The multi-species slaughter plants make savings and efficiencies in plant utilisation and shipping on account of killing several species.
- In 2012 more deer are killed in prime age groups, rather than spread over a longer slaughter season.
- Deer are bigger in 2012 than in 1990. Deer are killed earlier and capture higher schedule prices which peak September through November each year. Average carcass weights have room to rise still higher, to 65kg.
- Recently selection for weight gain by Deer Improvement Limited (DIL) and other stud breeders has started to make a difference. Previously most genetic progress was on antler size, not necessarily to the benefit of meat production.
- DEERSelect (a genetic evaluation system which ranks breeding stags on productive parameters, using Breeding Values, BVs) has made a big impact on deer meat production. Deer are now meatier with better conformation. A third of stags sold have Breeding Values (BVs) calculated.
- In 2012, deer are presented for slaughter in more consistent weight lines and more are exported in the target ranges of the marketers.
- There are fewer dark cutter carcasses now (high pH), as deer are handled more and are less stress-susceptible.

3.7. **Methodology: quantitative analysis**

3.7.1. To calculate productivity, it is important to take into account slaughter weights as well as age and size at slaughter.

3.7.2. In terms of quantitative data, I have used the DINZ levy data, which have been calculated from monthly levies received in respect of each carcass since 1992. The data comprises numbers killed each month, weight of venison for male and female Red, fallow and other (Elk/Wapiti) deer in each of the North and South Island. In this analysis I have combined North and South Island data, and the analysis of fallow deer data is limited and presented in the spreadsheet tables only.

3.7.3. To seek slaughter trends by month, for each year (for which there is data) I have calculated the percentage of the annual kill taking place each month using the number of animals killed each month and the total deer slaughtered that year. In turn these calculations have been used to estimate the number and timing of the kill of both yearling deer and adult deer for each gender. This approach has been repeated substituting carcass numbers with carcass weights to evaluate monthly venison production during each year.

3.7.4. I have also used these data to calculate average liveweights at slaughter of species, gender and age.

3.8. **Relevance of Elk/Wapiti and other breed data**

3.8.1. Although the Elk/Wapiti proportion of the national deer herd is less than 10%, these represent intrinsically large animals. In addition Elk/Wapiti are extensively used as terminal sires over Red deer hinds to produce larger, faster growing calves for venison production.

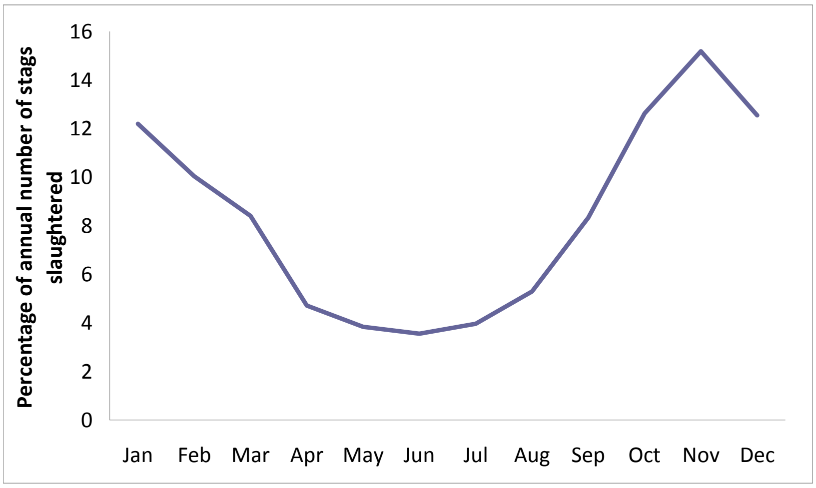
3.8.2. When male and female hybrid progeny are slaughtered, they are likely to be recorded at the slaughterhouse as Red Deer or Elk/Wapiti on the basis of their phenotype, which is a notoriously unreliable predictor of genotype. At this time (2012), due to this genetic ambiguity, it is not practicable to be definitive about the precise slaughter time of hybrid animals.

3.8.3. In the future, should mandatory use of electronic identification for the purpose of tracking animal movements under the NAIT scheme encourage more voluntary electronic recording of other useful parentage and performance data, I recommend that a separate category for hybrid venison production be added to the model.

3.9. **Timing of slaughter of stags**

3.9.1. Figure 1 shows the percentage of Red deer males, in each calendar year, slaughtered each month from 1994 to 2011. The data are for all males and there is no separation between young and mixed age animals.

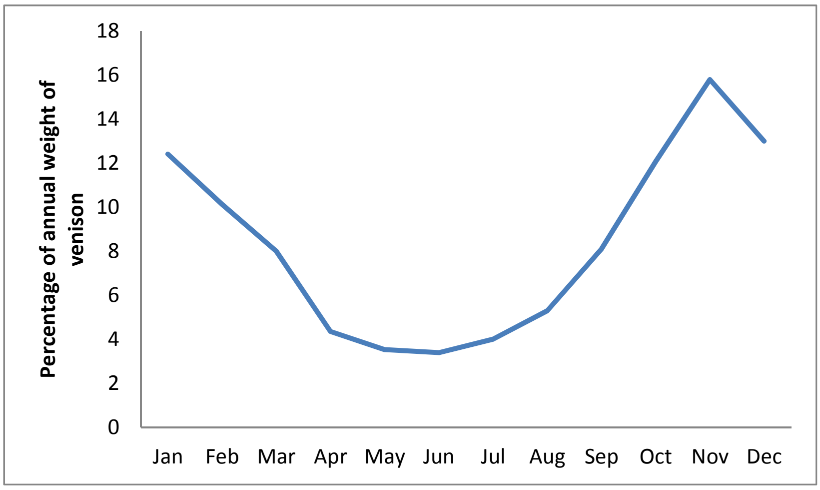
Figure 1 Slaughter pattern in Red deer stags



3.9.2. There is a strong seasonal pattern with most deer being slaughtered in the October to January period. In 3 years in the 1990s, a large proportion of deer were slaughtered in the winter months – presumably older stags (data not shown). The peak slaughter month in each year was consistently November. There is no evidence of the peak of slaughter occurring earlier (September and October) in the most recent years (data in the spreadsheets).

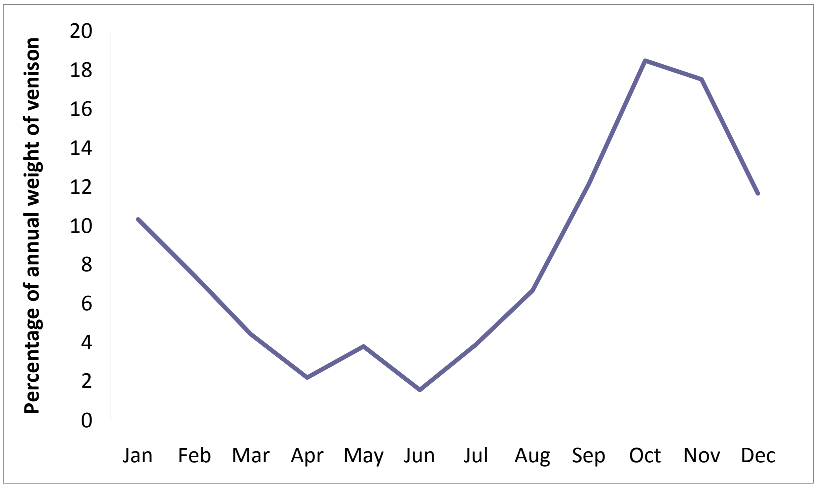
3.9.3. Figure 2 shows the proportion of the annual venison yield from male Red deer killed, by month. This was calculated to attempt to validate qualitative information that the peak slaughter of stags is earlier in 2011 compared with 1990. However the trend shown by the data largely mirrors the trend for numbers killed. I had postulated that were larger Red deer being slaughtered earlier, the proportion of annual yield by month would peak earlier, but this is not the case.

Figure 2 Pattern of venison yield each month from 1992- 2011 – Red deer stags



3.9.4. By contrast, the pattern for other male deer (Elk/Wapiti) (Figure 3) is strongly suggestive that larger Elk/Wapiti type animals are being slaughtered at higher weights (Figure 5) and earlier in their first year (in September-October) now compared to previous years. Very few Elk/Wapiti are slaughtered as terminal venison animals in their second year of life. They are next slaughtered from two years of age and over as cull velvet or replacement stags.

Figure 3 Pattern of venison yield - Elk/Wapiti stags



3.9.5. The carcass weight data, calculated from whole industry slaughter data, (and plotted in Figure 4) are partly confounded (compared to data from experimental studies) by the inclusion of mixed age stag data with data from yearling animals. To deal appropriately with this confounding factor, I exploited the fact that mixed age stags are never slaughtered during the breeding season in April and May. This means that all animals killed in these months are one year old stags (prime). The mean carcass weight in for each month from 1992-2011 is presented in Table 7. From this table, we can derive a mean carcass weight in April and May of 54.4kg. Since we know the mean carcass weight in all other months, the ratio of these monthly weights over 54.4 gives an estimate of the proportion of stags older than 2 years of age killed each month. The data are shown in Table 8.

Table 7 Mean monthly Red deer stag carcass weights

Month	Average carcass weight of Red deer males, 1992-2011 (kg)
Jan	60.5
Feb	60.0
Mar	56.5
Apr	54.6
May	54.2
Jun	56.6
Jul	59.4
Aug	59.1
Sep	57.6
Oct	56.7
Nov	61.9
Dec	61.4

Figure 4 Pattern of Red stag carcass weights

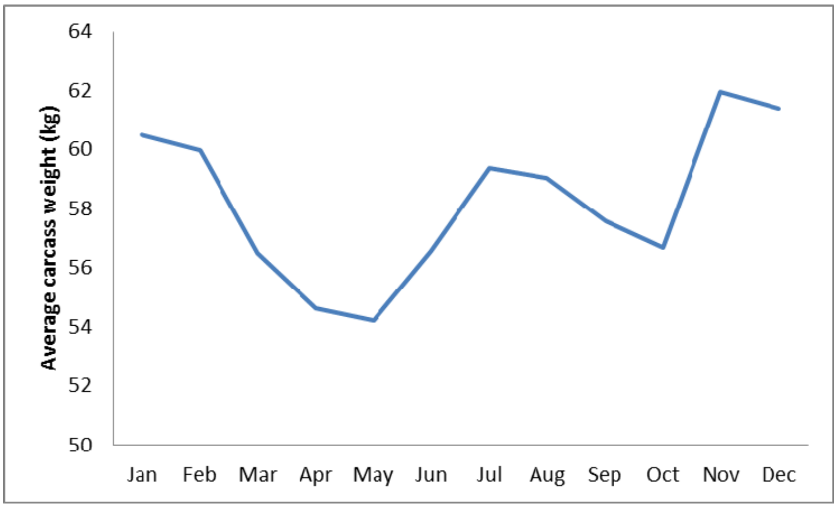


Table 8 Proportion of young (<2 year) and older (> 2year) stags in monthly stag kill

Month	Stags 0-2 years slaughtered as proportion of total kill	Stags aged more than 2 years slaughtered as proportion of total kill
Jan	0.90	0.10
Feb	0.93	0.07
Mar	0.98	0.02
Apr	1.00	0.00
May	0.98	0.02
Jun	0.94	0.06
Jul	0.92	0.08
Aug	0.93	0.07
Sep	0.95	0.05
Oct	0.92	0.08
Nov	0.88	0.12
Dec	0.91	0.09
Mean	0.93	0.07

3.9.6. The results of this analysis are consistent with the typical deer farming management practice of slaughtering the majority of mixed-age stags in summer after velvet antler removal and in winter after the breeding season.

3.9.7. To arrive at the proportions of stags in the 2-3 years and mixed aged classes split between average slaughter dates of 1 July and 1 December, I used the following methodology, based on DINZ slaughter levy data. (Not shown in the report, but available in accompanying summary data tables):

- multiplied the proportion of stags >2 years killed every month by the monthly proportion of total stags killed to get the proportion of stags killed that are mixed age each month;
- summed the months of the relevant periods (March to July inclusive for slaughter of breeding stags post rut) and August to February inclusive for slaughter of velvet stags; and
- divided the product by the total proportion of >2 years stags in the total kill.

3.9.8. From this I determined that the proportion of Red stags assumed to be killed on 1 July is 12% and the proportion of Red stags assumed to be killed on 1 December is 88%.

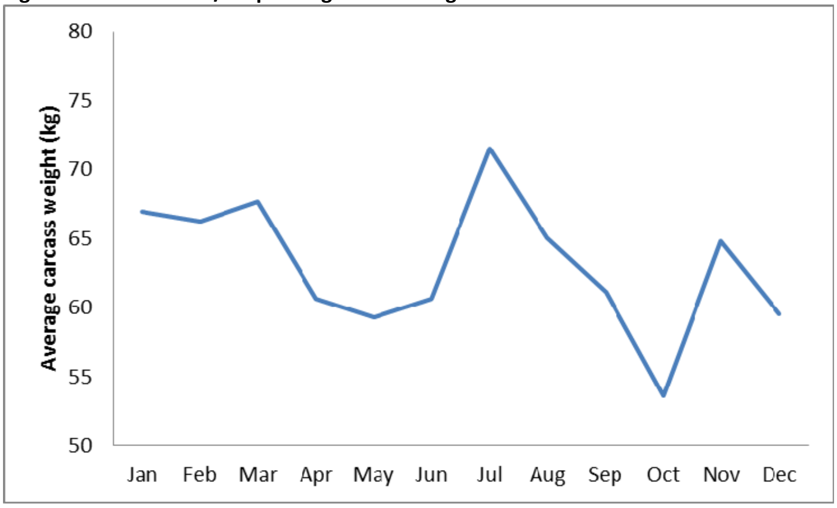
3.9.9. These assumptions need to be treated with care as they would be sensitive to selection of a different month of slaughter to accommodate the observed range of slaughter months and more accurate data on the age of kill at slaughter.

3.10. Stag liveweights at slaughter

3.10.1. *Red 0-1 years*: On 1 November, the average carcass weight is 55kg, which, which, using a dressing out percentage of 55%, gives a liveweight at slaughter of 100kg.

3.10.2. *Elk/Wapiti 0-1 years*: Figure 5 shows the carcass weight data for Elk/Wapiti stags. Most animals are slaughtered at a carcass weight of 60kg-65kg. This is consistent with the notion that Elk/Wapiti type animals are being killed earlier than Red deer, and at a higher liveweight at slaughter. Using the dressing out percentage of 55%, this translates to a liveweight at slaughter of 109-118kg.

Figure 5 Pattern of Elk/Wapiti stag carcass weights



3.10.3. *Red 1-2 years*: On 1 March, the average carcass weight is 55kg, which, using a dressing out percentage of 55%, gives a liveweight at slaughter of 100kg.

3.10.4. *All stag sub-species 2-3 years*: On 1 July, the average carcass weight is assessed to be 77kg, which, using a dressing out percentage of 55%, gives a liveweight at slaughter of 140kg. On 1 December, the average carcass weight is 88kg, which, using a dressing out percentage of 55%, gives a liveweight at slaughter of 160kg.

3.10.5. *All stag sub-species mixed age*: On 1 July, the average carcass weight is 99kg, which, using a dressing out percentage of 55%, gives a liveweight at slaughter of 180kg. Between November – February, carcass weights are assessed to be at an average of 115kg, which, using a dressing-out percentage of 55 gives liveweights at slaughter of 209kg.

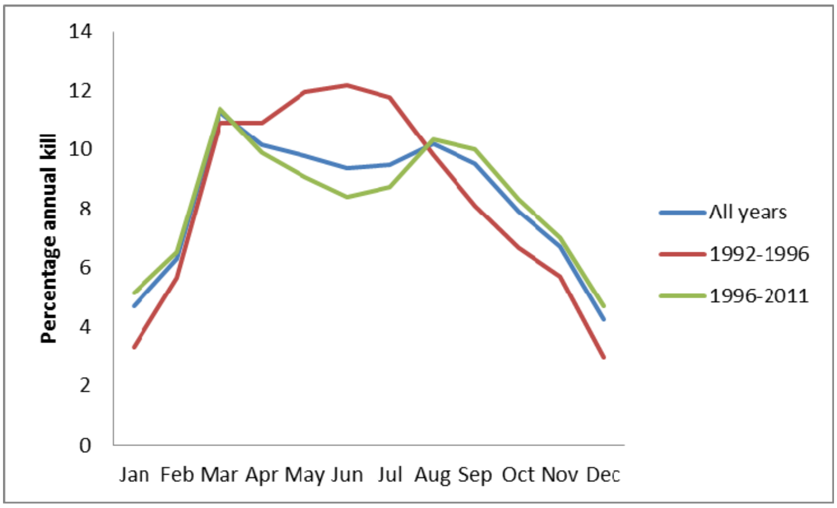
3.11. Conclusion

3.11.1. The data support the notion that most Red deer stags are killed on or about their first birthday in November, at a carcass weight of 55kg (based mainly on experimental slaughter data). By contrast Elk/Wapiti type animals are killed at 10-11 months of age but at a 5-10kg higher slaughter weight.

3.12. Timing of slaughter of hinds

3.12.1. Figure 6 shows the annual monthly slaughter pattern for Red deer hinds, in terms of proportion of the annual kill each month. The pattern, while less clear than for stags, shows most females being slaughtered from March to September. I have separated the data from 1992-1996, as it was evident that the data from those years varied from subsequent years.

Figure 6 Slaughter pattern in Red deer hinds



3.12.2. From 1992-1996, there was a single peak of Red Deer hind slaughter from March to September. From 1996 onwards, there are two slaughter peaks, one in March – April, (autumn) and another in September to October, (spring).

3.12.3. The ratio of hinds killed in autumn to hinds killed in spring fluctuates from 1994 to 1997. From 1998 to 2001, approximately equal numbers are killed in each season (see Table 9). Based on expert comment I conclude that the number of mixed age hinds killed from March to April was approximately equal to the number of rising 2 year old hinds killed in September to October, during that period.

3.12.4. From 2002 to 2003, more hinds were killed in spring than autumn, the conclusion being that more rising 2 year old hinds were killed in spring at about 20-22 months of age than mixed age hinds in autumn,.

3.12.5. From 2003 to 2011, more hinds were killed in autumn than spring, the conclusion being that more hinds are being killed earlier at 18 months of age before their second winter. This assumes that mixed age hinds are mainly killed in autumn and early winter

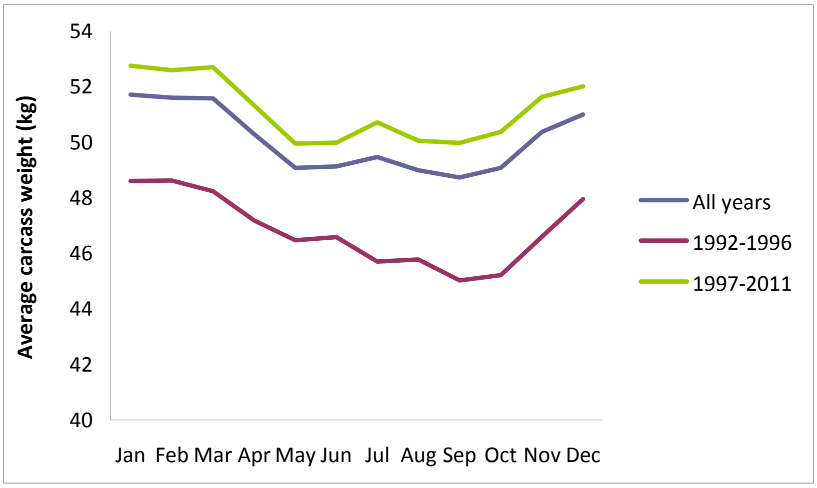
3.12.6. If one assumes that the ratio of mixed age hinds killed in March to April to rising 2 year old hinds killed in September to October was 1.0 in 1998 - 2001, and that the proportion of mixed age hinds killed remained the same, then about 25% ((1-0.6)+(1-0.90))/2) more younger hinds were killed in spring from 2002- 2003, than in the period 1998 - 2001. By contrast, from 2004 - 2011, about 30% more younger hinds were killed in autumn, [(0.2 +0.2+ 0+0.1+0.8+0.4)/5].

Table 9 Proportion of hinds killed by principal slaughter periods

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
% hinds killed from March to June	40.2	49.9	43.3	33.1	41.5	35.6	33.5	38.8	28.4	36.9	44.1	43.9	38.7	39.1	46.7	40.4	37.4	43.5
% hinds killed from July to October	43.9	31.1	34.3	48.0	37.9	38.0	39.4	39.7	46.8	43.1	37.1	37.5	40.6	37.1	25.3	29.1	30.5	31.3
ratio	0.9	1.6	1.3	0.7	1.1	0.9	0.8	1.0	0.6	0.9	1.2	1.2	1.0	1.1	1.8	1.4	1.2	1.4

3.13. Hind liveweights at slaughter

Figure 7 Pattern of Red hind carcass weights



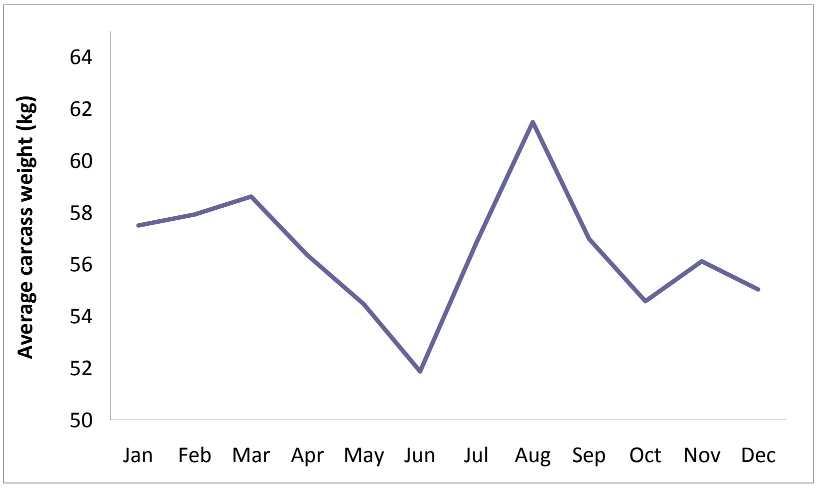
3.13.1. The carcass weight data from female Red deer (Figure 7) have been separated into two time periods as it is clear that hinds were smaller from 1992-1996 compared with later years, although the monthly pattern of carcass weights are similar.

3.13.2. Red deer hinds killed in March- April (whatever their age) have an average carcass weight of 53kg and those killed in spring 51kg, from 1996-2011. This translates into liveweights at slaughter of 96.5kg and 93kg respectively, using dressing out at 55%.

3.13.3. Female Elk/Wapiti are slaughtered at about 54-60kg (

Figure 8). There are insufficient data to make robust conclusions about pattern, but clearly the slaughter weights are only slightly greater than Red deer. I would estimate that Elk/Wapiti hinds in the 1-2years and mixed age class have carcass weights in the range 52-58kg, translating to liveweights at slaughter of 98-105kg. This means that predominantly yearling Elk/Wapiti females are slaughtered, rather than older animals.

Figure 8 Pattern of Elk/Wapiti hind carcass weights



3.14. **Recommendation**

That the Inventory Model takes account of the following findings:

- **Dressing out is 55%**
- **timing of (including proportions split by month where slaughter cannot be put onto one annual date) and liveweights at slaughter are as presented in Table 10.**

Table 10 Recommendations as to slaughter dates and liveweights at slaughter

		Hind				Stags				
	Age (years)	**1-2**		**MA**		**0-1**		**1-2**	**2-3**	**MA**
	Sub-species	Red	Elk/Wap	Red	Elk/Wap	Red	Elk/Wap	Red	All	All
Period										
1999-2003		1 Oct (93kg)								
2004-2011		1 Apr (30%) (93kg) 1 Oct (70%) (96.5kg)								
1990-2011			1 Dec (100kg)	1 Apr (93kg)	1 Apr (100kg)	1 Nov (100kg)	1 Oct (109-118kg)	1 Mar (100kg) -	1 Jul (12%) (140kg) 1 Dec (87%) (160kg)	1 Jul (12%) (180kg) 1 Dec (88%) (209kg)

Chapter 4. Liveweight

4.1. Introduction

4.1.1. Liveweight is strongly linked to energy requirements, particularly for maintenance. This is turn is related to feed intake and hence greenhouse gas emissions as by-products of the metabolism of feed. This chapter is directed towards estimating the liveweights of animals kept for breeding or velvetting purposes, for the purpose of determining their weights at death or eventual slaughter.

4.1.2. Deer liveweight fluctuates markedly in both sexes in an annual pattern.

4.1.3. Stags show a very clear seasonal pattern of liveweight change. Stags reach peak weight in March, and irrespective of whether they have access to hinds, lose weight during the autumn breeding season (the 'rut') due to inappetance. Inappetence continues during winter (even where feed supply is plentiful), hence stags gain little or no weight during winter. Stags start to grow rapidly in spring and continue this growth during summer. In stags older than 5 years, much of the summer weight gain is in the form of fat.

4.1.4. Hinds also seasonal fluctuations in liveweight albeit of lower amplitude, but such changes as are observed are mainly due to nutritional demands placed by pregnancy and lactation rather than inappetance.

4.2. Qualitative information

4.2.1. Deer show a pronounced pattern of feed requirements, which differs markedly from sheep and cattle.

4.2.2. The consensus view is that there is less of a weight range in 2011 in deer weaner weights now than in the past, and there are fewer small animals.

4.3. Quantitative information

4.3.1. Locating reliable data for deer liveweight has proved exceptionally difficult. There are few published studies of hind and stag liveweight since 1988. AgResearch Invermay provided excellent hind data, but stag liveweight is no longer recorded. Barry Martin, the AgResearch, Invermay deer farm manager, estimates the average maximum weight of a stag as 240kg, falling to 180kg in the winter.

4.3.2. Table 11 presents published and unpublished data for liveweight of stags and hinds both from before 1990 through to 2012.

Table 11 Summary of recorded liveweights

Location Period of study, and reference	Liveweights (kg)					Comments
Otago, 1974 – 1982 (*Moore et al, 1988)*	**Stags: Pre-rut (February)**					
		Year of birth				
	Age (years)	*1975*	*1978*		*1979*	
	1.2	89	95		106	
	2.2	120	134		143	
	3.2	152	161		184	
	4.2	180	183		212	
	5.2	192	212			
	Hinds: Pre-rut (March)					
		Year of birth				
	Age (years)	*1975*	*1977*		*1978*	
	1.3	74	83		76	
	2.3	83	95		87	
	3.3	90	98		96	
	4.3	93	106		98	
	5.3	99	106		98	
	6.3	101	109			
	7.3	105				
Lower North Island, 1992-1994 (*Audigé et al,* 1995)	**Adult Stags**					
		March	**June**	**Sept**	**Oct/Nov**	
	1992	146	136	134	150.7	
	1993	209	138	137	155	
DINZ-supplied deer slaughter plant data (only one plant's data held)	**Year of Measurement**	**Young Hind**	**Old Hind**	**Young Stag**	**Old Stag**	All data are calculated from carcass weights, assuming a 55% dressing percentage.
	2008	89	103	103	176	
	2009	92	107	104	187	
	2010	93	109	106	159	
	2011	95	111	105	174	
Otago, 1998 – 2011 (*AgResearch*, Unpublished data)	**Year of measurement**	**Weight**		**Hind stock classes**		▪ 350 – 550 hinds were weighed at AgResearch
	1998	109		Includes first calvers		
	1999	104				
	2000	117				
	2002	118				
	2003	115				
	2004	114				
	2005	116		Mixed-age hinds		

Location Period of study, and reference	Liveweights (kg)			Comments
	2011	127	only	Invermay each year from January to March. In some years, only mixed age hinds were weighed. ▪ Note the big increase from 2011 may be because mainly Eastern European origin hinds were weighed

4.3.3. Further, Challies (1978) reported liveweight data for feral Red deer in Westland from 1968 – 1974. Calculated by [carcass weight x 55%], mean stag weight was 129kg (95% confidence limits 62-197kg) and mean hind weight was 82kg (95% confidence limits 49-115kg). It is likely that the deer found on New Zealand farms up the 1990s were similar in size to feral deer, the population from which they had been captured for farming.

4.4. Hind liveweights

4.4.1. The liveweight of a mixed age hind was around 100kg in 1990, and this had risen to 110kg in 1998. The average size of a hind then rose to about 115kg, at least until 2005. There is some evidence, (based on introgression of Eastern European bloodlines) that some deer herds (e.g. those at AgResearch Invermay) may have larger hinds now than 5 years ago. However, expert comment from industry points to the fact that hinds on Class 6 and 7 land are not as large, and may be closer to the 115kg weight today. Hinds reach mature weight at 4-5 years of age.

4.4.2. In 2012, there has been an impact of Eastern European bloodlines on hind weights, as shown by the Invermay data. However, data back-calculated from carcass weights of slaughter hinds shows that the maximum liveweight of these hinds was 112 kg. In addition, expert comment, based on the fact that many hinds are now farmed on the Class 6 and 7 land, and may be smaller framed than the European deer supports a conclusion that the typical live weight of a red deer hind in 2012 is closer to 115kg. This value has been adopted in the summary tables, as the 127kg from the Invermay data is not representative of the population as a whole.

4.5. Stag liveweights

4.5.1. Stag liveweights are much harder to estimate due to serious limitations in data. Stag liveweight changes enormously throughout the year: stags reach peak annual weights in March, and some animals may lose 25 - 30% of body weight by June. In 1990, peak live weight of stags aged 5 years (which is probably not their mature weight) was 200kg, or about twice the size of the hinds. The winter weight of these animals was probably about 150kg. In the absence of any stag liveweight data since the early 1990s, I estimate stag weight by doubling the weight of the hinds. This provides an estimate of peak annual weight of 218-226kg for a stag, falling to about 145-150kg during the winter.

4.6. Conclusion

4.6.1. Stag and hind liveweight has increased from 1990 to 2011.

4.7. Recommendations

That the Inventory Model takes account of the following findings:

- **Hind liveweight and stag liveweight data as shown in** Table 12
- **In particular, June minima and March maxima in terms of stag live weights**
- **Weight loss in stags is linear from March to June**
- **No stags gain weight from June to September and liveweight gain in stags is linear from September to March**

Table 12 Pattern of annual changes in Red deer liveweight

	Red deer liveweight (kg)				
	Hinds		Stags		
	June	Mar	Jun	Sep	Mar
1990	100	100	133	133	200
1992	104	104	138	138	209
1998	109	109	145	145	218
1999	104	104	139	139	208
2000	110	110	147	147	220
2002	111	111	148	148	222
2003	109	109	145	145	218
2004	109	109	145	145	218
2005	113	113	150	150	226
2011	113	113	150	150	226

Chapter 5. Reproduction and calving

5.1. Introduction

5.1.1. All temperate and arctic deer species of the sub-family Cervinae of Cervidae are typically seasonal breeders which have a single calf in late spring and have a brief intense breeding season in the autumn. In New Zealand, peak calving is in November and the breeding season (when conceptions occur) is in April.

5.2. Reproductive rate

5.2.1. Reproductive rate is relevant to the Inventory Model in that it sets the datum point for the number of animals entering the population.

5.2.2. The strictest definition of reproductive rate, which I have used, is [(calves weaned/hinds mated) x 100], (also known as 'weaning rate'). This definition does not distinguish a hind's failure to conceive from early natal mortality and misadventure.

5.3. Qualitative findings regarding reproduction

5.3.1. The following statements regarding deer reproduction come from the interviews with farmers and industry experts:

- Eastern European introgression has raised live weight with little effect on reproduction, by contrast to hybridisation with Elk/Wapiti which lowered reproductive performance.
- Eastern European bloodlines have a higher weight threshold for puberty than Western European origin hinds.
- Timing of puberty in deer, which influences reproductive rate of first calving hinds is poorly understood. It is likely that target weights that industry uses are too low.
- Farmers feel that reproductive rates are better now than in the past, but little better than 80% survival to sale.
- Reproductive rates can be higher on hill land as the hinds are able to find greater space to calve and there is less mis-mothering.
- Reproductive wastage (embryos and foetuses) lost during gestation is regarded as a growing issue. This is as high as 11-12% in some mobs.
- Artificial insemination has made a limited impact as the industry resembles beef more closely than dairy in that many farmers wish to handle hinds less frequently than they would dairy cows.

Table 13 Studies into reproductive rates of deer

Location, Year and Reference	Hind cohort	Reproductive rate
Lower North Island, 1992-1993 (*Wilson and Audigé*, 1998)	Yearling NZ Red	70%
	Mixed age NZ Red	83.6%
Canterbury/North Otago, 2001, Deermaster Manual	Yearling NZ Red	72%
	Mixed age NZ Red	85%
Hawkes Bay Richmond Deer production programme2000	Yearling NZ Red	71%
	Mixed age NZ Red	87%
Otago, 2002 (*Asher and Pearse*, 2002)	Yearling NZ Red	70%
	>2 year old NZ Red	85%
Otago, 2012 (*GW Asher, pers.comm.,* 2012)	>2 year old NZ Red	85%

5.3.2. Deer reproductive rates have been remarkably consistent over the last 20 years. In a personal communication, Dr Geoff Asher of AgResearch Invermay informed me that he believes weaning rates to have improved by 3-4% in hinds farmed in the high country, due to more space and a better calving environment. While there is significant inter-farm variability, and undoubtedly some farms achieve 95%, it is safer to estimate 85% reproductive rates for mixed age NZ Red deer and 70% for first calvers. This assumes that all (100%) of mixed age and 70% of rising 2 year old hinds are mated.

5.3.3. Elk/Wapiti and European genetic influences have chiefly affected reproduction by raising the weight threshold required for puberty in hinds. The weight at which 50% of hinds would be expected to be pregnant was 65kg for NZ Red deer, 75kg for NZ/Eastern European hybrids, 85kg for Eastern European, 108kg for 30% Elk/Wapiti and 150kg for Elk/Wapiti (Asher and Wilson, 2011). Thus reproductive rates in first calving hinds are strongly linked to bodyweight which is influenced by genotype.

5.3.4. Statistics NZ data for reproductive rate give a lower estimate of 76%, based on numbers of hind alive and number of calves alive. This value is substantially lower than the research data given in this report, most likely due to the Statistics NZ data not accounting for unmated hinds and movements. The data I am relying on are for known numbers of hinds mated on farms where stock movements were controlled.

5.4. Conclusion regarding reproductive rate

5.4.1. Mixed age and rising 2 year old hind reproductive rates were stable from 1990 – 2011 at 85% and 70% respectively.

5.4.2. While some expert comment indicates that hind reproductive rates may be higher in 2011, compared with the earlier period, hard data indicated that 85% weaning is likely to be the industry norm.

5.5. Calving date

5.5.1. Calving date is relevant to the Inventory model for two reasons. First, it sets the date when animals enter the population and hence defines the start of the period during which deer commence emitting greenhouse gases as a by-product of feed metabolism. Second, the calving date indicates the start of lactation.

5.6. Qualitative finding regarding calving dates

- Calving patterns are tighter now than previously.
- The peak calving date is a few days earlier in 2011 compared with 1990, but is still in November.

- Farmers indicate that while calving percentages (calves weaned/hinds mated) may have increased somewhat from 1990, mixed age reproductive success over the last 20 years has been 85% and yearling hind reproductive success 70%.
- Estimates for reproductive success fall between 76 – 95% for mixed age hinds.
- Introgression of Elk/Wapiti and the known influence of European Red Deer genes into the base population of UK-derived Red Deer have been, overall, to reduce breeding success.

5.7. Quantitative findings regarding calving dates

5.7.1. Calving data are rare owing to the difficulty of making accurate observations. Several studies have recorded calving date. Table 14 summarises their findings.

5.7.2. In data not shown, Griffiths *et al* (2008) showed that a wide variety of nutritional treatments to hinds and endocrine treatments failed to markedly affect calving date. In contrast Eastern European blood lines may calve slightly earlier. There is a note of caution in interpreting conception and calving dates in Red deer as Griffiths et al (2008) showed that gestation length in Red deer is highly variable, from approximately 220 – 250 days.

Table 14 Studies into calving dates

<table>
<tr><th>Location , Year and Reference</th><th colspan="4">Data</th></tr>
<tr><td rowspan="4">1992 -1993 Lower North Island (Wilson and Audigé, 1998)</td><td rowspan="2">Hind class</td><td colspan="3">Calving date</td></tr>
<tr><td>Start</td><td>Median</td><td>End</td></tr>
<tr><td>Yearling NZ Red</td><td>21 November</td><td>13 December</td><td>25 January</td></tr>
<tr><td>Mixed age NZ Red</td><td>4 November</td><td>30 November</td><td>22 January</td></tr>
<tr><td>Otago, about 2004 (Scott et al 2006)</td><td colspan="4">Eastern European hinds conceived a mean of 13 days earlier than Western European hinds</td></tr>
<tr><td rowspan="3">Canterbury and Otago, 2005 - 2006 (Griffiths et al, 2008)</td><td colspan="2">Hind class</td><td colspan="2">Mean calving date</td></tr>
<tr><td colspan="2">Mixed age NZ Red (2005)</td><td colspan="2">19 November ± 0.6days</td></tr>
<tr><td colspan="2">Mixed age NZ Red (2006)</td><td colspan="2">20 November ± 0.6days</td></tr>
</table>

5.8. Conclusion regarding calving

5.8.1. It can be concluded that the average date of calving is 19-20 November and that calving date may have advanced by 10 days since 1990.

5.9. Recommendation

That the Inventory Model takes account of the following findings:

- **First calving hinds have a 70% weaning rate and older hinds have an 85% weaning rate**
- **The data used in the model should be 30 November in 1990 and 19-20 November in 2008, with a linear change between these dates**

Chapter 6. Mortality

6.1. Introduction

6.1.1. Mortality, in terms of the predicted dates of deaths of deer, is relevant for the Inventory Model as it enables account to be made of greenhouse gas emissions ceasing through reasons other than slaughter of deer.

6.1.2. Most deer mortality is caused by disease, accidents and at calving in hinds. Principal diseases are Malignant Catarrhal Fever (MCF), Johne's disease and Yersinia (the latter of which mainly affects calves).

6.2. Qualitative findings

6.2.1. The following sections are from comments made in farmer expert interview:

- Tuberculosis is almost solved.
- Yersinia can be managed.
- Since the mid-1990s, MCF is considered to be less prevalent, but Johne's has risen in importance, particularly in the last 12 years.
- Johne's disease is insidious and worse than Tb. Johne's was only a big problem from the late 1990s onwards.
- Parasites remain an issue.
- Stag mortality, weight loss and damage have been reduced by stocking stag mobs at 0.25ha/stag during the roar.

6.3. Quantitative Findings

6.3.1. The quantitative mortality data collated in Table 15 is derived from published sources as well as unpublished MAF/MPI monitoring farm data.

Table 15 Summary of studies on incidence of deer mortality

<table>
<tr><th>Year, Location and Reference</th><th colspan="3">Data</th></tr>
<tr><td>1988 Otago (Moore et al, 1988)</td><td colspan="3">• Adult hinds: 1.3% annual mortality
▪ Adult stags: 1.9% (<1.0% for 2 year old stags and 4% for older stags) annual mortality</td></tr>
<tr><td>1992-1994 Lower North Island (Audigé et al 1995)</td><td colspan="3">• Weaner hinds and stags (3-15months): 5.87% annual mortality
• Yearling and adult stags: 2.56% annual mortality
• Yearling and adult hinds: 1.77% annual mortality</td></tr>
<tr><td rowspan="13">North Island and South Island (MPI Unpublished data)</td><td colspan="3">Median Annual Mortality Deer >1 year old (%)</td></tr>
<tr><td>Year</td><td>North Island</td><td>South Island</td></tr>
<tr><td>2000</td><td>2.4</td><td>-</td></tr>
<tr><td>2002</td><td>1.0</td><td>-</td></tr>
<tr><td>2003</td><td>2.3</td><td>-</td></tr>
<tr><td>2004</td><td>2.2</td><td>2.1</td></tr>
<tr><td>2005</td><td>3.0</td><td>2.1</td></tr>
<tr><td>2006</td><td>2.7</td><td>2.0</td></tr>
<tr><td>2007</td><td>2.1</td><td>3.0</td></tr>
<tr><td>2008</td><td>3.0</td><td>2.0</td></tr>
<tr><td>2009</td><td>2.5</td><td>3.0</td></tr>
<tr><td>2010</td><td>2.0</td><td>2.2</td></tr>
<tr><td>2011</td><td>2.3</td><td>2.6</td></tr>
</table>

6.3.2. Johne's disease has the potential to cause mortalities of up to 25% in weaner deer, but on farms where Johne's disease occurs typical mortality rates may be around 1-3%. (*JRG*, 2006).

6.3.3. Adult deer mortality is similar in both and has generally remained between 2% and 3% in the period 1990 – 2011.

6.3.4. There appear to be no structured studies of causes of deer mortality or variations in deer mortality throughout the year. Conventional wisdom indicates that-

- calves are most susceptible in autumn- early winter, post weaning;
- stags are susceptible post roar; and
- hinds may be most vulnerable in late winter and over calving.

6.3.5. This can be tabulated on an annual basis as shown in Table 15, with the assumption that overall mortality is 5% for yearling and 2% for older than yearling deer. Estimates ignore mortality of calves before weaning, as this is considered reproductive failure and is considered in that section.

Table 16 Deer mortality patterns split by age and sex

	% Mortality			
	0-1 year old		> 1 year olds	
	hinds	stags	hinds	stags
Jan	No data	No data	0	0
Feb	No data	No data	0	0
Mar	15	15	0	5
Apr	20	20	0	20
May	15	15	0	20
Jun	10	10	5	20
Jul	10	10	10	20
Aug	5	5	20	10
Sep	5	5	20	5
Oct	5	5	10	0
Nov	5	5	30	0
Dec	5	5	5	0

6.4. Recommendation

That the Inventory Model takes account of the following findings:

- **Mortality of deer of both sexes less than one year old is 5% annually and for animals of both sexes older than one year is 2% annually.**
- **Monthly mortality rates are as specified in Table 15.**

Chapter 7. Feed quality

7.1. Introduction

7.1.1. Metabolisable energy ('ME') available to deer is a crucial issue for calculation of greenhouse gas emissions. Deer, as for all livestock, consume forage of varying ME content and use that energy to maintain and grow body mass. Greenhouse gases are emitted as a by-product of the metabolism of feed to produce energy in a form useful to the animal and of utilisation of that energy. Deer are farmed on land that varies in terms of ME availability, from high producing Land Classes 3 and 4 to poorer Land Classes 6 and 7. In addition, the balance in terms of numbers of deer on each land class has varied from 1990 -2012. As ME availability will be different on each land class, in this chapter I have scrutinised carefully deer farming land class trends from 1990 – 2012.

7.1.2. ME availability is influenced by many factors including land type, fertiliser application, previous grazing history, season and forage borne by the land or cultivated thereon. Consequently, making generalisations about ME availability is fraught with issues.

7.1.3. Deer have occupied most land types typical of New Zealand pastoral farming systems since deer farming started in the mid-1970s. Since 1990, there has been a strong swing to farming deer in the high country, particularly in the South Island. As ME available differs between each land class by approximately 2MJME/kgDM, it is important to assess the impact of deer farming trends on available ME for deer.

7.1.4. Perhaps the most important parameters to take account of when determining ME availability is stocking rate in conjunction with land class. However, since stocking rates are matters of judgment by management and are strongly influenced by-

- the availability of supplementary feeds, and
- the tendency to remove young stock for finishing on improved pasture in the lowlands,

these factors add to the complexity of determining what at first blush, appears to be a straightforward metric. In addition the MPI model treats New Zealand as 'one farm', so stocking rate can be eliminated from these deliberations.

7.2. Methodology

7.2.1. Expert opinion

I consulted experts on the changes to land types on which deer are run.

7.2.2. Literature search

I undertook a literature search to seek ME from pasture available to deer, which I have included with a table of seasonal ME requirements for deer and which I strongly advise be considered in any analysis of deer greenhouse gas emissions.

7.2.3. Quantitative analysis

In order to quantify the numbers of deer on the different standard land classes from 1990 – 2010 for the purpose of determining ME availability, I examined the change in total deer numbers and regional deer numbers over the period (source: Statistics NZ) and data specifying the different land classes (as defined in Chapter 1APPENDIX H present in each region (source: Land Use Capability Survey Handbook, Lynn et al, 2009).

The methodology used to assess deer population and the classes of land they are farmed on is based on the broad assumption that in 1990 deer were farmed on a mix of land classes, from 3-4, 5 and 6-7, yet by 2010 they were farmed on poorer land classes within each region. Deer numbers in each region were analysed and the patterns of change were discussed in relation to known land use changes in each region. Assumptions were made about the reasons for changes in numbers – principally due to changes in land use where deer were farmed on poorer land over time. Ratios of deer on land classes 2-4 and 6-7 were estimated and applied to deer numbers in each region in each year. This yielded estimates of deer numbers likely to have been farmed on higher or lower land classes in each region. Full methodology for each region is given in Table 26. The estimates for the number of deer likely to have been farmed on high and low class land is given in Table 27.

These percentages were used to estimate ME available to deer by multiplying the high class percentages by high ME values (from original Inventory Model) and lower class percentages by ME values applicable to sheep and beef farms, as quoted by Litherland et al (2002).

7.3. Qualitative findings

7.3.1. Metabolisable Energy

- Deer farming experts were unanimous in agreeing that the huge increase in dairy farming since about 2000 has dramatically shifted deer from low-lying irrigated pastures to the high country of both islands, particularly the South Island.

- The range of ME availability from pasture on New Zealand deer farms is 9.5MJ/ME kg DM - 11.5MJ/ME kg DM.
- A significant issue is the timing of feed demand by deer. As the feed demand rises rapidly in late winter to early spring, on many farms there is insufficient forage to meet nutritional needs in late August/early September.

7.3.2. Land classes used for deer farming

- Deer have largely gone from irrigated land, since centre pivot irrigation is incompatible with deer fencing.
- Most experts consulted remarked on the trend for deer farming moving to lower class hill land, as compared to flatter more fertile land, particularly since 2000 – 2002. The limitation now is access to better land for deer finishing, although there is a move to finish deer on poorer land, often on crops on valley bottoms.
- Deer are a good land use option for land that does not suit dairy, beef or sheep.
- There is a trend in the Canterbury high country to increase the number of hinds, keep sheep numbers steady and reduce the number of beef cattle. Deer are a lower input system, and only needed to be mustered once or twice a year. They can live most of their lives on large hill blocks.
- Deer are better on snow-prone land than sheep.

7.4. Quantitative findings

7.4.1. Land types on which deer are run

Changes in deer numbers from 1990 to 2010 and analysis of the reasons for the changes is presented in Chapter 1APPENDIX I .

Interpretation of the data relating to regional deer numbers is somewhat subjective, but in the context of New Zealand agricultural trends over the last 20 years, the data support the following conclusions as to the trend in land class type for deer farming:

- In the North Island deer farming began on better agricultural land (e.g. Waikato) and initially it was economic, but competition with other land uses (dairy, cropping) prevented a rapid increase in deer farming as these land uses were more profitable and the majority of deer farms in that region may now be studs or on land unfit for dairy.
- In the Hawke's Bay, the trend is similar although growth in dairy is unlikely to be the principal competitive land use preventing the rapid growth spurt seen in the South Island at the turn of the century. It is likely that competition with other uses is now resulting in the steady decline in deer numbers. It is likely that remaining deer are being farmed on lower land classes.
- In both Southland and Canterbury, the large increase in deer numbers in the 1999-2004 periods is speculatively considered to be on better land classes, a trend rapidly reversed in the next 4-5 years.

- The estimates indicate that in 1990, deer may have been farmed on high and low class land about equally. Since the mid-1990s, the trend has been for more deer to be farmed on lower rather than high-class land. The zero for deer farmed now on high-class land is a factor of the assumption. The percentages intuitively agree with the assumptions of the deer experts originally consulted.

Table 17 Total Estimated division of national deer herd (by numbers and as a percentage) between High land classes (Classes 1-4) and Low land classes (Classes 6-7)

	1990	1992	1994	1996	2002	2004	2006	2008	2010
Total Deer	976199	1135223	1230823	1142261	1647912	1756850	1579527	965860*	1004476*
Total Deer: Low Class land	453387	511022	518679	446825	617145	641234	465111	241447*	111609*
Total Deer: High Class land	522812	624201	712144	695435	1030767	1115616	1114416	1109517*	1116085*
% Low Class land	54	55	58	61	63	64	71	80*	90*
% High Class land	46	45	42	39	37	36	29	20*	10*

Note that Rounding errors have caused some variation in absolute deer numbers, but the percentages are the important guide.

*These numbers have been modified from the estimates shown in Table 28 in Chapter 1APPENDIX I in order to adjust for unrealistically low outcomes of the synergies of various assumptions used in the methodology.

7.4.2. ME availability

In New Zealand, ME available to stock changes greatly with location, land class and season. Table 18 presents a range of data on ME available on sheep and beef farms, hill country deer and dairy farms.

Table 18 Metabolisable energy (ME) available by season in different farms

Year and Location and Reference	Data						Comments
2002, (*Litherland et al*, 2002)	**MJ ME/kg DM available**						Sheep and Beef Farm data
		Summer	*Autumn*	*Winter*	*Spring*	*Annual Mean*	
	Waikato	8.5	8.1	9.8	10.3	9.2	
	Tararua	10.0	9.2	10.6	11.6	10.3	
	Canterbury	9.0	7.6	9.5	10.8	9.2	
	Southland	10.0	10.0	11.3	11.4	10.7	
2009, Whiterock Station, Canterbury (*DINZ Focus Farm notes*, 2009)	**MJ ME/kg DM available**						
	Dec	*Winter*	*Sept*	*Oct*	*Nov*		
	9.5 –11	9 –11.5	10.6 –12	10.5 – 11.8	9.5-10.5		• Deer farm • Farmer comment was that late summer ME could fall to 8. • Stocking rate was 2.9 - 4.6 Deer/ha
	Pasture growth rate kg/DM/ha/day						
	10 - 50	0	5 - 40	5 - 40	5 - 30		Lower numbers are unimproved pasture and the higher numbers are following

Year and Location and Reference	Data		Comments
			various fertiliser applications
1992 Arid South Island high Country (*Allan and Lowther*, 1992)	**Pasture yield kgDM/ha/year**	**Equivalent MJ ME/kg DM available**	
	2000	20000	Mid Tussock Grassland
	5000	50000	
2004 (John Caradus, *pers.comm.*)	**Pasture yield** 11500 – 13500kgDM/ha/year		Top quality dairy land

The percentages of land use (Class 2-4 and Class 6-7) estimated in Table 29 and summarised in Table 17 have been applied to MPI and Litherland et al (2002) data that represent respectively Classes 2-4 and 6-7 land, to give an estimate for each year of ME available to deer. This was done by multiplying the Class 2-4 ME value (MPI) by the percentage of deer farmed on that land class and adding that to the percentage of deer farmed on the Class 6-7 land multiplied by the ME value (Litherland). The data are presented in Table 19. The Litherland data were used since, following a literature search and interviews with relevant experts, they represent the most complete dataset of regional and seasonal ME availability on sheep and beef farms.

7.5. Conclusion

7.5.1. The Inventory Model assumes that deer were kept on high ME available pasture, when in fact since about 2000-2004, the data in Table 29 show that they have been predominantly farmed on pastures more typical of sheep and beef farms.

7.5.2. 90% of deer are now estimated to be farmed on low class land in 2011, whereas in 1990 about half deer were farmed on high class land. This means that ME availability in the case of deer is much lower than that assumed by MPI when determining greenhouse gas emissions from deer using data outputs of the Inventory Model.

Table 19 Monthly ME of feed (MJME/kgDM) adjusted for land class

Monthly ME of Feed (MJ-Kg) adjusted for land class.												
Year	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1990	11.4	10.9	11.4	11.5	11.3	10.1	10.2	10.0	9.7	10.0	10.2	11.0
1991	11.4	10.9	11.4	11.5	11.3	10.1	10.2	10.0	9.7	10.0	10.2	11.0
1992	11.4	10.9	11.4	11.5	11.3	10.1	10.2	10.0	9.7	9.9	10.2	11.0
1993	11.4	10.9	11.4	11.5	11.3	10.1	10.2	10.0	9.7	9.9	10.2	11.0
1994	11.3	10.9	11.3	11.5	11.3	10.1	10.2	10.0	9.6	9.9	10.1	10.9
1995	11.3	10.9	11.3	11.5	11.3	10.1	10.2	10.0	9.6	9.9	10.1	10.9
1996	11.3	10.8	11.3	11.5	11.3	10.0	10.1	9.9	9.5	9.8	10.0	10.9
1997	11.3	10.8	11.3	11.5	11.3	10.0	10.1	9.9	9.5	9.8	10.0	10.9
1998	11.3	10.8	11.3	11.5	11.3	10.0	10.1	9.9	9.5	9.8	10.0	10.9
1999	11.3	10.8	11.3	11.5	11.3	10.0	10.1	9.9	9.5	9.8	10.0	10.9
2000	11.3	10.8	11.3	11.5	11.3	10.0	10.1	9.9	9.5	9.8	10.0	10.9
2001	11.3	10.8	11.3	11.5	11.3	10.0	10.1	9.9	9.5	9.8	10.0	10.9
2002	11.2	10.8	11.3	11.4	11.3	10.0	10.1	9.9	9.5	9.7	10.0	10.9
2003	11.2	10.8	11.3	11.4	11.3	10.0	10.1	9.9	9.5	9.7	10.0	10.9
2004	11.2	10.8	11.3	11.4	11.3	10.0	10.1	9.9	9.5	9.7	9.9	10.9
2005	11.2	10.8	11.3	11.4	11.3	10.0	10.1	9.9	9.5	9.7	9.9	10.9
2006	11.0	10.7	11.3	11.4	11.3	9.9	10.0	9.8	9.3	9.5	9.7	10.8
2007	11.0	10.7	11.3	11.4	11.3	9.9	10.0	9.8	9.3	9.5	9.7	10.8
2008	10.8	10.6	11.2	11.3	11.2	9.8	9.8	9.7	9.2	9.3	9.4	10.7
2009	10.8	10.6	11.2	11.3	11.2	9.8	9.8	9.7	9.2	9.3	9.4	10.7
2010	10.6	10.5	11.2	11.2	11.2	9.6	9.7	9.6	9.0	9.1	9.1	10.5
2011	10.6	10.5	11.2	11.2	11.2	9.6	9.7	9.6	9.0	9.1	9.1	10.5
2012	10.6	10.5	11.2	11.2	11.2	9.6	9.7	9.6	9.0	9.1	9.1	10.5

7.5.3. Seasonality of feed intake

By contrast to many other domestic species, deer have a pronounced seasonal pattern of energy requirements, which are set out in Table 20. What this means is that the energy consumption (and hence probably greenhouse gas output) of deer is not linearly related to body size, but is also affected by season. In winter, from June to August, yearling deer only grow at a maximum of 150g/day, irrespective of the amount of feed on offer. Adult stags (older than 3 years) do not grow in winter irrespective of the amount of feed on offer. Simply put, they reduce their voluntary food intake to an amount sufficient to maintain body weight only. By contrast from September to February, all male deer increase voluntary food intake and grow rapidly. This abrupt physiological change is known to be under control of day length. This seasonal pattern is also shown by yearling hinds, but at lower amplitude than stags. Recent data indicates that pregnant and non pregnant hinds reduce food intake in autumn, about equally, (Scott et al, 2011)

Table 20 Red deer Seasonal Feed Requirements (Drew 1996)

		Feed requirement (MJ ME/day)				
		Autumn	**Winter**	**Spring**	**Summer**	**Average Stock Units**
Stags	Rising yearling	16	21	27	56	1.5
	Rising 2 year old	24	28	31	30	1.8
	Rising 3 year old	24	33	38	36	2.1
Hinds	Rising yearling	15	17	22	21	1.2
	Rising 2 year old	20	23	23	45	1.8
	> 2 year old	23	22	24	47	1.9

7.6. Recommendation

That the Inventory Model takes account of the following findings:

- **The distribution of deer between land of high and low class from 1990 – 2011 is as specified in Table 17.**
- **Monthly ME available to deer from 1990 – 2011 is as specified in Table 19.**
- **ME requirements of deer are seasonal and are in accordance with Table 20.**

Chapter 8. Milk Yield

8.1. Introduction

8.1.1. Red deer hinds commence lactation at calving time in November, and reach peak lactation in December. Milk output decreases linearly from December to weaning, either early (in March) or late (May). For the purposes of this analysis I have assumed that most calves are weaned in March.

8.2. Qualitative findings

8.2.1. These findings are taken from discussions with scientists familiar with deer lactation.

8.2.2. Lactation performance of hinds is determined by calf genotype. A Red deer hind has surplus lactation capacity.

8.2.3. Hinds will put their own body reserves into feeding the calf if nutrition is challenging.

8.3. Quantitative Data

8.3.1. Red deer hinds grazing ryegrass pasture produced up to 3.2L/day milk from birth to January, then lactation output decreased linearly until July when it was zero (Ward *et al*, 2008). Barrell *et al* (2012) reported 1.3 L/day at week 5 of lactation, falling to 0.8L/day at week 17 of lactation. (I have used the data for milk water and added 22% to account for milk solids). Lactation yield in deer is very strongly driven by calf demand (Barrell *et al* 2012). Red deer hinds feeding F1 Elk/Wapiti calves can produce 25% more milk than a Red hind feeding a Red deer calf (Ward *et al* 2008).

8.3.2. As the lactation output is so strongly driven by calf demand, it is likely that unless severely undernourished on very poor hill country, lactation output of deer is unlikely to be affected greatly by ME supply from the feed (David Stevens, AgResearch Invermay, *pers. comm.*, 2012).

8.3.3. To calculate an average milk yield throughout lactation, I used the data from Ward *et al* (2008), which were the most complete. He showed a linear decrease from 3L/day over lactation. At the midpoint of lactation, in January, milk yield was 1.7L/day. It seems that 1.7L/day is a reasonable average estimate for deer milk production over the period of lactation for hinds older than 2 years.

8.3.4. I have been unable to locate milk yield data for yearling hinds. As yearling hinds are approximately 80% of the liveweight of hinds older than 2 years, I have estimated that milk yield will be 80% that of the older hinds. This is 1.4l/day at the midpoint of lactation.

8.4. Recommendation

That the Inventory Model takes account of the following findings:

- **Hinds lactate for 120 days**
- **Hinds older than 2 years produce 1.7L of milk daily**
- **Hinds younger than 2 years produce 1.4L of milk daily**

Chapter 9. Velvet yield

9.1. Introduction

9.1.1. The husbandry of stags for velvet rather than meat or for breeding represents a major departure for deer compared to other domesticated species. The antler itself when removed weighs, on average, 4kg.

9.2. Qualitative findings

9.2.1. From 1990 to 1997 a typical deer farm had the following deer stock groups:

- stags for velvet production;
- venison stags;
- venison hinds;
- replacement hinds; and
- breeding stags.

9.2.2. After the Asian financial crash in 1997, velvet demand dwindled and many smaller velvet operations (20-30stags) ceased. This trend has continued from 1997 to the present day and in 2012 there are very few small velvet producers. A few big players with greater than 1400 stags on each farm dominate the velvet industry. 30 farms produce most of NZ velvet.

9.2.3. A market to sell former velvet stags for trophy hunters peaked about 5 years ago.

9.2.4. From 1990-1997, velvet was a major cash crop on farms.

9.2.5. Red deer have shown a higher rate of increase in velvet weight through genetic gains.

9.2.6. In 1990 all velvet was processed in New Zealand, whereas by 2011 75% is exported green to Asia for processing there.

9.3. Quantitative findings

9.3.1. From 1990-1997 annual velvet yield per adult stag was around 2-3kg, as shown in Table 21, based on data provided by MPI. In the 2010-2012 period, with fewer stags, average annual velvet production per stag is close to 4kg. . When one considers that a stag will gain 70kg of body weight in a year, the 4kg of velvet represents only about 6% of that weight gain. Production of velvet itself requires a relatively modest amount of energy, when placed in this context. When a large animal is kept for a year during which it consumes ME and emits greenhouse gases, its energetic requirements for body growth are likely to have higher impact on the greenhouse gas emissions than the energetic requirements of growing velvet, per se.

Table 21 Velvet yield per stag

Year	Average Annual Velvet Weight per stag (kg)
1990	1.94
1991	1.60
1992	1.63
1993	1.94
1994	2.31
1995	2.61
1996	2.85
1997	3.07
1998	2.99
1999	3.37
2000	2.87
2001	3.46
2002	3.22
2003	3.35
2004	2.95
2005	3.80
2006	2.29
2007	3.62
2008	3.16
2009	3.21
2010	3.22
2011	4.00

9.4. Conclusion

9.4.1. Velvet weight has increased, linearly, from 2kg to 4kg from 1990-2011.

9.5. Recommendation

That the Inventory Model takes account of the following findings:

- **The annual velvet yield per velvetting stag is in accordance with Table 21**.

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APPENDIX B QUESTIONNAIRE FOR INDUSTRY EXPERTS

Deer Industry Greenhouse Gas (GHG) Inventory Project

Questionnaire on Significant Deer Industry Events

Jimmy Suttie

Suttie Consulting Ltd, April 2012

Background

The Deer Industry, in common with all agricultural industries in New Zealand, will require to pay GHG levies to the Government. At this time, MAF have calculated GHG emissions from deer, based on a set of data and a series of assumptions. The Deer Industry has the opportunity to come up with an alternative data set, which can add the necessary detail to MAF data.

Part of the data used to calculate emissions by MAF is a historic assessment of deer farming practice.

I have been contracted by Deer Industry New Zealand to assemble data sets of deer numbers, productivity and land class occupation since 1990 to enable new data to ne entered into MAF models to provide more accurate data and hence more realistic calculations of deer GHG emissions.

The purpose of this questionnaire is to request leading deer industry figures to provide data and reflection on historic changes to deer productivity, their impact on farming/processing practice and their impact on financial returns.

I would be obliged if you could answer the following questions and either email these back to me or arrange to call me for a chat in the evening.

1. What significant changes to deer productivity have taken place since 1990 and when did they happen?
2. What were the downstream consequences of these changes?
3. What were the financial implications of these changes?

Many thanks,

Jimmy Suttie

jimmy@suttieconsulting.co.nz

0292 332 556

03 489 5958 (evenings or leave a message)

APPENDIX C INFORMATION SOURCES BY TYPE

Table 22 Summary of data sources

Type of source	Description of particular source, if relevant
Refereed publications	NZ Animal Production Society Proceedings
Unrefereed publications	Proceedings of the New Zealand Veterinary Association Deer Branch
Industry publications	The Deer Farmer
	Deer Master Manual
	Deer Industry News
Unpublished reports	
Unpublished scientific data	AgResearch
Unpublished industry data	Deer Industry New Zealand Focus Farm Field day notes
	Ministry for Primary Industries
	Landcorp Farming Limited
Government Departments	Ministry for Primary Industries
	Statistics New Zealand
Discussions with deer farmers and industry leaders	Colin MacNicol, John Spiers, Trevor Walton, Andy MacFarlane, James Guild, Bill Taylor, Clive Jermy and Keith Hood, Colin Stevenson, John Signal
Discussions with scientists	Geoff Asher, Ken Drew, Colin Mackintosh, Andrew MacPherson, David Stevens, Graham Barrell, Peter Wilson, Eva Wiklund, Barry Martin, Liz Wedderburn, John Caradus, Gavin Sheath,
Discussions with veterinarians	Noel Beatson

APPENDIX D MAJOR DATA SOURCES FOR EACH CHAPTER

Table 23

Chapter	Major Source	Metric	Where used in model
Chapter 3 (Slaughter) and referenced tables in spreadsheets	DINZ levy data	Slaughter number by species and gender Weight of deer meat by species and gender	Extensively used to attempt to estimate out age, slaughter date and weight at slaughter relationships
	Eva Wiklund	Carcass Weight	Dressing out percentage
	Ken Drew	Carcass Weight	Dressing out percentage Tables in text
Chapter 4 (Liveweight)	Laurent Audigé	Liveweight data	Tables in spread sheets
	Chris Challies	Liveweight	Text
	Ken Drew	Liveweight	Dressing out percentage Tables in text
	Geoff Moore	Liveweight	Text and Excel tables
Chapter 5 (Reproduction and calving)	Geoff Asher	Weaning rate	To determine number of births included in tables X, Y, Z
	Deermaster	Reproductive rate	Text and tables
	Wendy Griffiths	Calf birth dates	Text
Chapter 6 (Mortality)	Laurent Audigé	Mortality data	Tables in text

Chapter	Major Source	Metric	Where used in model
	Johne's Research Group	Johne's disease incidence	Text
	Geoff Moore	Mortality	Text and Excel tables
	MPI Focus farm data	Mortality data	Tables in spreadsheets
Chapter 7 (Feed quality)	Animal Production Survey (Statistics New Zealand) (Note: Data are reanalysed in spreadsheets)	▪ Stock numbers ▪ Deer populations by region	Population changes with time Regional analysis Estimation of proportion of each stock class
	Bruce Allan and Bill Lowther	Hill country ME	Text
	Annette Litherland	ME available on typical sheep and beef farms	Text and tables in text
	I Lynn	Hill country ME	Text
	Ross Stevens		Text
Chapter 8 (Milk yield)	Graeme Barrell	Milk yield	Data in text
	Ian Scott	Lactation	Text
	Jamie Ward	Lactation	Text

APPENDIX E MPI-DINZ AGREED METHODOLOGY

AIM

Determine assumptions regarding the deer population, productivity and herbage dry matter intake to be used as inputs in the MAF Greenhouse Gas Inventory Model for deer.

METHDOLOGY

POPULATION STATISTICS

Estimate monthly deer numbers for last day of each month, from January 1990 to the present, as follows:

1. Determine total number of deer by from July 1990 to present by summing total deer on last day of each month in each stock class.
2. For the purpose of step 1, the monthly number on the last day of each month for each stock class is determined according to the following roll-forward equations:

   Hinds/Stags <1year old
   [closing # last day previous month(**A**) +
   #births during current month(**B**) +
   –
   [#transferred out to another class (**D**)+
   #slaughtered current month (**E**) +
   #Deaths current month (**F**)]

   All other stock classes
   [closing # last day previous month(**A**) +
   #transferred in from another class (**C**)]
   –
   [#transferred out to another class (**D**)+
   #slaughtered current month (**E**) +
   #Deaths previous month (**F**)]

   B determined on basis of assumptions made by science expert (using literature research) as to rates of reproduction i.e. numbers of fawns produced per hind annually and typical date ranges when fawning occurs

   C and **D** based on following assumptions:
   - Stock classes to be those currently adopted in the deer GHG inventory model i.e.
     - Hinds: <1year, 1-2 year, breeding; and
     - Stags: <1year, 1-2 year, 2-3 year, breeding
   - Wholesale changes between stock class occur on 1 July every year as per the following table:

Hinds		**Stags**	
Class 30 June calendar year X	*Class 31 June calendar year X*	*Class 30 June calendar year X*	*Class 31 June calendar year X*
<1year	1-2 year	<1year	1-2 year
1-2 year	breeding	1-2 year	2-3 year
breeding	breeding	2-3 year	breeding
		breeding	breeding

- Births always enter the <1 year class during the month in question
- The stock classes to which deaths apply (could be all, but not necessarily) and the months when they occur are to be determined using scientific expertise (e.g. examining literature on deer longevity, fawn survival rates, and ages at which stock most vulnerable to various diseases such as Johne's disease and parasite challenge).

Hinds		**Stags**	
Class 1 June calendar year χ	*Class 1 Jul calendar year χ*	*Class 1 June calendar year χ*	*Class 1 Jul calendar year χ*
< 1 year	1-2 year	< 1 year	1-2 year
1-2 year	breeding	1-2 year	2-3 year
breeding	breeding	2-3 year	breeding
		breeding	breeding

E to be determined based on the following data:

Type of data	**Source of data**
Actual monthly slaughter numbers, classified by sex and age (in terms of 'old' or 'young'	DINZ, via Johne's Management Ltd
Actual monthly slaughter numbers by sex from 1992	DINZ, via processors
Ages at which different stock classes slaughtered under standard management practices including consideration of changes over time in the breed composition of the national herd (deer with Elk/Wapiti genetics have faster growth rates and therefore reach slaughter weights earlier)	Expert industry opinion

3. In respect of the first month of the series (July 1990) **A is** determined by-
    a. estimating total deer on 1 July 1990;
    b. estimating the ratio by which the stock were divided between the seven relevant stock classes; and
    c. applying that ratio to the estimated total deer on 1 Jul 1990

4. For the purpose of 3(a) above, take Statistics *NZ Agriculture Census data* and extrapolate by comparison to annual farm survey and DINZ farmer survey deer numbers (which reveal population trends).
5. For (b), combine-
   - industry expert advice as to management systems applying to the national herd in 1990
   - Extrapolations to 1990 of deer numbers by the 7 classes numbers from the 5 yearly *Statistics NZ censuses*, as modified by any differences between the stock management policies applied by the MAF monitor farms used in the censuses and the management systems applying to the national herd.

F to be determined based on the following:
- Overall annual death rates from *MAF farm monitoring reports*;
- expert opinion; and
- Scientific literature as to relative stock class vulnerabilities and any periods during which stock more vulnerable

PRODUCTIVITY DATA

1. Estimated average liveweight at (a specified) slaughter (date/s) for each stock class to be determined as **Y/Z**, where
   Y = carcass weight; and
   Z = dressing out percentage, expressed as a decimal.
2. Y to be determined as follows:
   a. Estimate average ratio between stock classes of slaughtered animals for each month, using estimated monthly values of **E** for each stock class (see previous section)
   b. Use scientific expertise (e.g. by reference to typical growth curves assuming plentiful feed) to estimate ratio of carcass weights for each month commencing in July, between the different hind classes and also the different stag classes (e.g. for July, the ratio of carcass weights expected a 1 month old, hind, and the ratio of carcass weights expected of a 1 month old, 13month old, 25 month old and 37 month old stag)
   c. Apply the monthly hind ratios to the actual monthly total hind carcass weights (supplied by DINZ) and apply the monthly stag ratios to the actual monthly total stag carcass weights (supplied by DINZ) to arrive at a monthly estimated carcass weight for each stock class.
3. **Z** to be determined by literature review on deer carcass composition, including any known data on the nexus between age and dressing out percentage, and current processor production models.

HERBAGE DRY MATTER INTAKE AND OTHER ENERGETICS-RELATED INPUTS INTO MODEL

1. Methodology for determining land class assessments to be submitted at a later date. May involve closer examination of Statistics NZ surveys and land use classifications.
2. Milk output to be taken from research into hind lactation and industry opinion.

APPENDIX F ACTUAL METHODOLOGY

Table 24 Table setting out variances in project methodology from provided methodology

Chapter	Methodology	Deviation, if any, from DINZ/MPI Methodology
2 (Industry Wide Changes in Management)	A list of leading farmers, experts and industry specialists was agreed by contractor and DINZ. This group was approached and interviewed using a structured process to cover the main headings of this report with specific questions that were relevant to the interviewee specialist knowledge.	Not covered in methodology
3 (Timing of Slaughter)	• Monthly slaughter number and weight of meat was calculated for each gender of each species. • Carcass weight and slaughter weight were calculated. • The proportion of each species and gender of the annual kill slaughtered each month was calculated and plotted and tabulated to demonstrate the strong seasonal patterns • Dressing out weight was determined by literature review and by calculation	Dressing out percentage was determined from research papers and large scale farm data e.g.DeerMaster, (A deer farmer recording initiative in the South Island from 1997 – 2000) owing to the difficulties with assumptions using industry data.
3 (Liveweight at slaughter)	I have used DINZ levy data to obtain additional information to calculate this for each- • deer species; • year; and • month.	
7 (Population Statistics)	Total number of deer from Statistics NZ data are tabulated	1) and 2) A,C, D not calculated. All data required to calculate these are given in Tables.E not calculated but all necessary data are presented to make this calculation 3) a) done b) tabulated. Based on DINZ data with assumptions that calving is an even split of sexes, and stags live to 8 years of age. c) in table to MPI

Chapter	Methodology	Deviation, if any, from DINZ/MPI Methodology
		4) Stats NZ data used 5) used F – data presented
4 (Liveweight)	I have inserted the best data available to me (published data and a large set of unpublished hind data from Invermay). Ideally, this should be calculated monthly to reflect the huge seasonal variations seen in deer, especially stags as reliable data are scant and not up-to-date, particularly for stags.	MPI had no data
5 (Mortality)	Published data and expert opinion	No deviation
6 (Reproduction and calving	)Published data and expert opinion	I used research data to present information that is more precise although this estimate is constant over the years.
7 (Feed quality)	Deer numbers in each region were analysed and the patterns of change were discussed in relation to known land use changes in each region. Assumptions were made about the reasons for changes in numbers – principally due to changes in land use where deer were farmed on poorer land over time. Ratios of deer on land classes 2-4 and 6-7 were estimated and applied to deer numbers in each region in each year. This yielded estimates of deer likely to have been farmed on higher or lower land classes in each region. These percentages were used to estimate ME available to deer by multiplying the high class prcentages by high ME farms and lower class percenatges by ME values found on sheep and beef farms. These estimates are found in the Excel tables.	Not covered in methodology
8 (Milk yield)	Published data and expert opinion	No deviation
9 (Velvet yield)	MPI data (Ettema, *pers comm*)	Not covered in methodology

APPENDIX G SLAUGHTER DATA

1. Figure 9 shows the slaughter pattern for other (Elk/Wapiti) male deer. Reliable data from 1999 only are available. There is a strikingly different pattern from Red deer stags, in that the seasonal peak of slaughter is September – October. There is also evidence that in more recent years more deer have been slaughtered in September. I conclude that the conventional wisdom that slaughter dates of male deer have been getting earlier is due to larger Elk/Wapiti being slaughtered earlier.

Figure 9 Percentage of annual kill of Elk/Wapiti stags by month

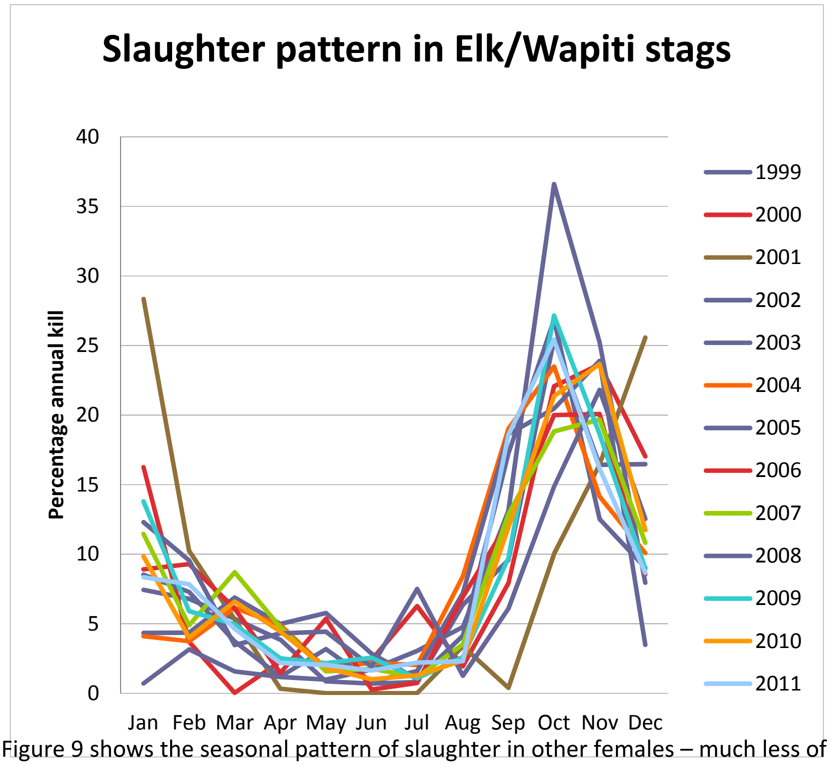
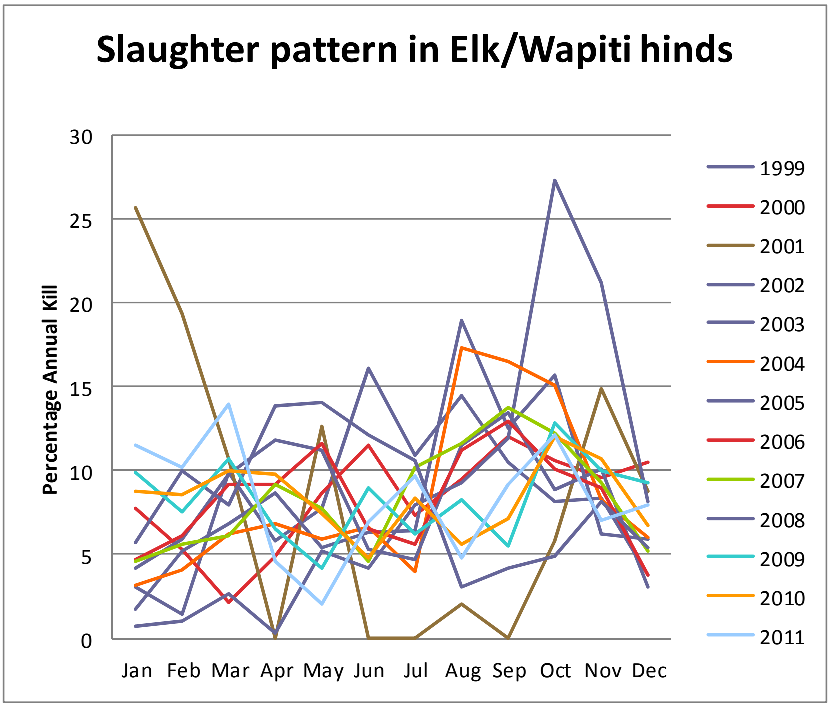


Figure 9 shows the seasonal pattern of slaughter in other females – much less of a clear pattern emerges.

Figure 10 Percentage of annual kill of Elk/Wapiti hinds by month



APPENDIX H LAND CLASS DEFINITIONS

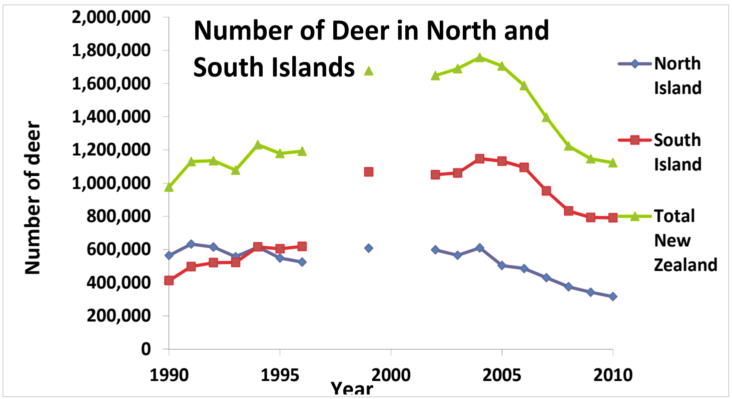
Figure 11 Definitions of Land Classes under Land Use Capability Survey Handbook, (Lynn *et al*, 2009)

Class	Definition
1	Versatile, multi-use land with minimal physical limitations for arable use. It is flat or undulating and has deep resilient soils that are easily worked and there is minimal risk of erosion.
2	Very good land with slight physical limitations to arable use. There is slight susceptibility to erosion under cultivation, moderate soil depth, slight wetness after drainage. May have unfavourable soils structure which presents difficulties in working. It may be undulating.
3	Land with moderate physical limitations to arable use. Moderate susceptibility to erosion under cultivation, rolling slopes, shallow or stony soils, wetness after drainage, low soil fertility and moderate structural impediments to cultivation.
4	Severe physical limitations to arable use. Moderate to high susceptibility to erosion, strongly rolling slopes, shallow or stony soils, and wet after drainage and sever structural impediments to cultivation.
5	High producing land which is unsuitable for cropping, due to slope, erosion risk, rocky outcrops or flooding. There is little land of this class in NZ.
6	Land unsuited to arable, and has slight limitations to pastoral use. Moderate erosion even under permanent pasture, steep slopes, shallow or stony soils, excessive wetness with low moisture holding ability
7	Land unsuitable for arable and has severe physical limitations for perennial pasture. Severe erosion risk, very steep slopes, low moisture holding very shallow soils and low natural fertility.
8	Land unsuitable for arable, pastoral or commercial forestry use.

APPENDIX I CHANGES TO SIZE AND DISTRIBUTION OF NATIONAL HERD

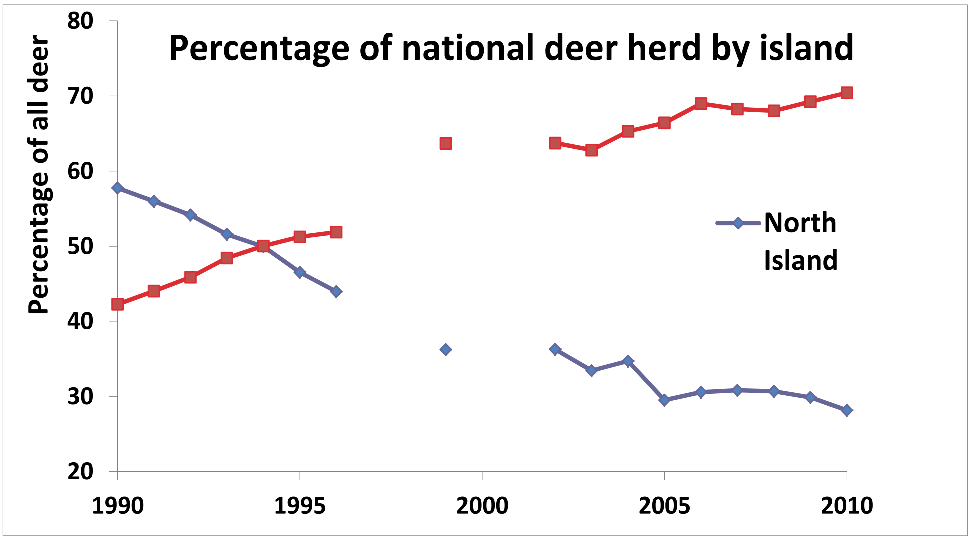
1. Overall deer numbers
   1.1. The green line in Figure 12 shows that deer numbers broadly grew until about 2005, with slight fluctuations in 1992-93 and 2000, before reducing throughout both Islands since 2005.
2. Inter-island deer numbers
   2.1. Figure 12 also shows the number of deer in the North and South Islands over the period 1990 to 2010. In the early 1990s, there were actually more deer farmed in the North Island compared with the South. Deer numbers in the North Island were already falling prior to the spectacular rise in numbers in the South Island between 1996 and 2004. Indeed the rise in the NZ deer herd at that time was entirely due to increases in deer numbers in the South Island. Since 2004, deer numbers have continued to fall in the North Island, somewhat consistently, but have dropped greatly in the South Island. Since 2008, there is some indication of stability in numbers overall in NZ

Figure 12 Inter-island and national deer population



   2.2. Figure 13 presents the percentage of deer in each island from 1990 – 2010. Taking into account the missing data, the percentage of deer in the North Island has decreased more or less linearly since 1990, whereas the South Island proportion has increased, linearly. These trends are unaffected by the huge changes in absolute deer numbers and no doubt are a strong reflection of the well understood trend to deer farming in more marginal hill country rather than better quality agricultural land.

Figure 13 Percentage of national deer herd by island



3. Regional deer numbers
    3.1. Figure 14 shows the distribution of deer by region from 1990 – 2010. Canterbury and Southland have been deer farming strongholds from 1990, no doubt due to the proximity of wild captured foundation stock. The data from Statistics NZ is hampered by two large gaps, but the overall pattern can clearly be observed. Growth in deer numbers was particularly spectacular in Canterbury and Southland from 1996 – 2004. This rapid growth was not observed elsewhere, particularly in the North Island regions.

Figure 14 Deer distribution by region

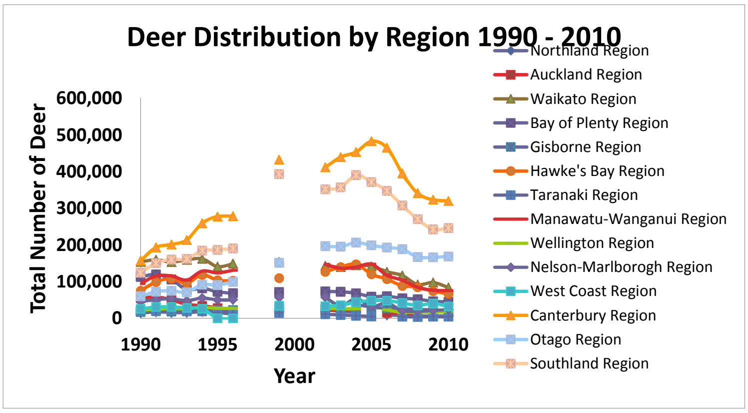
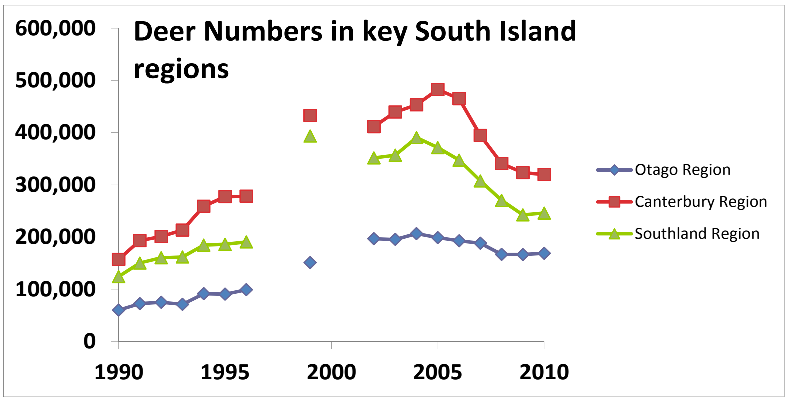


Figure 15 Changes in deer numbers in selected regions



3.2. Figure 15 comprises data from three key South Island regions, Canterbury and Southland, as before, but this time including Otago. Otago differs from the other two regions, as it had neither the spectacular increase in numbers in 1999-2004, nor the equally spectacular fall, from 2004-2010: indeed, since 2002, deer numbers have been remarkably constant. Otago differs from the other South Island regions in that there never was a large-scale invasion of high-class land by deer, and dairy growth in Otago has displaced fewer deer farms than the other regions. I suggest that the majority of the Otago herd is now and has been largely for 10 years on lower land classes. In contrast, the Southland and Canterbury deer ratios between 2004-5 and 2009-10, may provide a discriminator to estimate deer numbers on lower and higher classes of land. In turn, this may give an insight into ME availability.

3.3. The number of deer in each region from 1990 – 2010 - even year data only showing – are specified in Table 25.

3.4. Assumptions relating to land use and deer farming in each region are set out in Table 26.

3.5. Table 27 presents estimates for deer numbers on High and Low Land Classes. For simplicity, I have collectively classified Classes 1 - 4 as High and Classes 6-7 as Low.

3.6. Table 28 provides a summary of the estimated number of deer in each land class for each year, with the percentage of deer estimated to be on that class of land.

Table 25 Deer numbers by region from 1990-2010 (showing even years only for simplicity)

	Region	1990	1992	1994	1996	2002	2004	2006	2008	2010
North Island	*Northland*	14,266	15,497	18,141	11,304	23,412	16,746	8,703	6,564	6,663
	Auckland	54,011	49,851	33,916		20,259	23,483	15,271	12,240	
	Waikato	153,686	153,022	161,997	148,822	143,098	144,468	126,585	91,865	83,952
	Bay of Plenty	112,645	105,701	81,873	68,180	73,027	68,044	60,163	51,995	44,893
	Gisborne	17,127	18,306	22,955	22,174	25,752	37,878	27,507	23,261	15,093
	Hawke's Bay	75,101	107,683	118,301	102,393	126,718	147,378	106,761	84,426	66,573
	Taranaki	20,209	22,799	19,024	13,012	10,762	6,687		3,524	4,468
	Manawatu-Wanganui	94,628	115,398	128,676	130,909	147,128	139,242	117,242	84,417	75,437
	Wellington	22,089	26,388	30,232	27,086	27,423	25,802	22,722	16,871	18,819
South Island	*Nelson-Marlborough*	45,786	53,286	54,917	50,620	57,255	53,190	41,148	19,307	23,784
	West Coast	25,636	30,926	25,998		33,262	43,777	48,043	34,955	32,325
	Canterbury	157,095	201,162	258,980	278,082	411,581	453,336	465,055	340,882	319,907
	Otago	59,802	75,068	91,414	99,026	196,703	206,434	192,790	166,856	168,696
	Southland	124,209	160,155	184,512	190,630	351,558	390,423	347,537	270,072	245,975
New Zealand		**976,290**	**1,135,242**	**1,231,109**	**1,192,138**	**1,647,938**	**1,756,888**	**1,586,918**	**1,223,324**	**1,122,695**

Table 26 Method of determining land class distribution of deer by region

Region	Predominant LUC Land Class (Lynn *et al*, Land Use Capability Survey Handbook, 2009)	Deer population changes from 1990 - 2010	Assumptions about Deer Farming	Calculation to allocate deer to Land Classes
Northland	Northland is predominantly Class 6, with areas of Class 3 and 4.	Deer numbers rose from 1990 – 2002 then have fallen since then.	In 2010, deer are all on Class 6 only, and that prior to 2004 they were on a mix of each Class. Between 2004 and 2010, deer populations reduced on Class 3 and 4 only.	Subtract 2010 population from 2002 (maximum numbers) and calculate ratio of deer on Land Class 6/Land Classes 3 and 4. Apply this ratio to years1990-1996. From 2004, subtract deer population in 2010 from the population in that year to give the numbers estimated on each land class.
Auckland	Auckland has a lot of Class 2 and 3 land with extensive areas of Class 6 in the hills	Deer numbers have fallen consistently from 1990 to 2010	In 1990 deer were farmed on small blocks of Class 2 and 3 land and since then have consistently moved to Class 6 hill	Subtract 2008 population (all Class 6) from 1990 population (mixed land class).
Waikato	Predominantly Class 2, with areas of Class 6 and 7	Deer numbers were very high in 1990, peaked in 1994, and have fallen since then.	In 1990 deer occupied land now used mainly for dairy, and the fall since 1994 has been largely on better land classes	Subtract 2010 population from 1994 (maximum numbers) and calculate ratio of deer on Land Class 6/Land Classes 3. Apply this ratio to years1990-1992. From 1996, subtract deer population in 2010 from the population in that year, to give the numbers estimated on each land class
Bay of Plenty	Predominantly Class 2, in the coastal strip with areas of Class 6 and 7	Deer numbers have fallen consistently from 1990 to 2010	Assume consistent replacement of deer on better land with horticulture (kiwi fruit). Deer displaced to Class 6 and 7 land.	Subtract 2010 population (all Class 6) from 1990 population (mixed land class). Calculate the ratio and apply to all other years.
Gisborne	Some Class 3 with large areas of Class 6 and 7	Deer numbers never high, peaked in 2004, and then fell.	Assume most deer were always on poorer land, but all losses since 2004 have been from Class 3 Land	Subtract 2010 population from 2004 (maximum numbers) and calculate ratio of deer on Land Class 6 and 7/Land Class 3. Apply this ratio to years1990-2002. From 2006, subtract deer population in 2010 from

Region	Predominant LUC Land Class (Lynn *et al*, Land Use Capability Survey Handbook, 2009)	Deer population changes from 1990 - 2010	Assumptions about Deer Farming	Calculation to allocate deer to Land Classes
				the population in that year to give the numbers estimated on each land class.
Hawke's Bay	Class 3 land with extensive areas of Class 6	Deer numbers peaked in 2004, and have reduced since then	Prior to 2004, deer were farmed on a mix of land classes. Assume consistent replacement of deer on better land with other land uses since 2004. Deer displaced to Class 6 land.	Subtract 2010 population from 2004 (maximum numbers) and calculate ratio of deer on Land Class 6 /Land Class 3. Apply this ratio to years1990-2002. From 2006, subtract deer population in 2010 from the population in that year to give the numbers estimated on each land class.
Taranaki	Very fertile Land Classes 1, 2 and 3, with some Class 5, 6 and 7	Deer numbers always low. Peaked in 2002	Deer were farmed on some good land early in the period, but now mainly on Class 6.	Subtract 2010 population (all Class 6) from 1990 population (mixed land class). Calculate the ratio and apply to all other years.
Manawatu-Wanganui	Very varied, with extensive areas of Class 1, 2 and 3 land with areas of Class 6 and 7	Deer numbers peaked in 2004, and have fallen since then	In 2010, deer are all on Class 6 only, and that prior to 2004 they were on a mix of each Class. Between 2004 and 2010, deer populations reduced on Class 3 and 4 only.	Subtract 2010 population from 2004 (maximum numbers) and calculate ratio of deer on Land Class 6 and 7/Land Classes 1, 2 and 3. Apply this ratio to years1990-2002. From 2006, subtract deer population in 2010 from the population in that year to give the numbers estimated on each land class.
Wellington	Class 3 Land in the Hutt Valley and Wairarapa, otherwise Class 6 and 7	Deer numbers always low and peaked in 1994 and then fell steadily since then.	In 2010, deer are all on Class 6 and 7 Land only, and that prior to 1994 they were on a mix of each Class. Between 1996 and 2010, deer populations reduced mainly on Class 3 land	Subtract 2010 population from 1994 (maximum numbers) and calculate ratio of deer on Land Class 6/Land Classes 3. Apply this ratio to years1990-1992. From 1996, subtract deer population in 2010 from the population in that year, to give the numbers estimated on each land class
Nelson-Marlborough	Patches of Class 3 with extensive areas of Class 6	Deer numbers were never high and peaked	In 2010, deer are all on Class 6 and 7 Land only, and that prior to	Subtract 2010 population from 2002 (maximum numbers) and calculate ratio of

Region	Predominant LUC Land Class (Lynn *et al*, Land Use Capability Survey Handbook, 2009)	Deer population changes from 1990 - 2010	Assumptions about Deer Farming	Calculation to allocate deer to Land Classes
	and 7	in 2002.	2002 they were on a mix of each Class. Between 2004 and 2010, deer populations reduced mainly on Class 3 land	deer on Land Class 6/Land Classes 3. Apply this ratio to years1990-2000. From 2004, subtract deer population in 2010 from the population in that year, to give the numbers estimated on each land class
West Coast	Some Class 4 Land, and extensive areas of Class 6 and some 7	Deer populations peaked in 2006, then fell	In 2010, deer are all on Class 6 and 7 Land only, and that prior to 2006 they were on a mix of each Class. Between 2008 and 2010, deer populations reduced mainly on Class 4 land	Subtract 2010 population from 2006 (maximum numbers) and calculate ratio of deer on Land Class 6 and 7/Land Classes 4. Apply this ratio to years1990-2004. From 2006, subtract deer population in 2010 from the population in that year, to give the numbers estimated on each land class
Canterbury	Sharp demarcation between Class 2, 3 and 4 land on the Canterbury Plains and Class 6 and 7 land in the hills	Deer populations peaked in 2006, then fell	In 2010, deer are all on Class 6 and 7 Land only, and that prior to 2006 they were on a mix of each Class. Between 2008 and 2010, deer populations reduced mainly on Class 4 land	Subtract 2010 population from 2006 (maximum numbers) and calculate ratio of deer on Land Class 6 and 7/Land Classes 4. Apply this ratio to years1990-2004. From 2006, subtract deer population in 2010 from the population in that year, to give the numbers estimated on each land class
Otago	Some Class 3 and 4 land, with extensive Class 6 and 7 hills.	Deer populations peaked in 2004, and then fell. They did not fall as much as in Southland or Canterbury	In 2010, deer are all on Class 6 and 7 Land only, and that prior to 2004 they were on a mix of each Class. Between 2006 and 2010, deer populations reduced mainly on Class 4 land	Subtract 2010 population from 2004 (maximum numbers) and calculate ratio of deer on Land Class 6 and 7/Land Classes 3 and 4. Apply this ratio to years1990-2002. From 2006, subtract deer population in 2010 from the population in that year, to give the numbers estimated on each land class
Southland	Sharp demarcation between Class 2, 3 and 4	Deer populations peaked in 2004, and	In 2010, deer are all on Class 6 and 7 Land only, and that prior to	Subtract 2010 population from 2004 (maximum numbers) and calculate ratio of

Region	Predominant LUC Land Class (Lynn *et al*, Land Use Capability Survey Handbook, 2009)	Deer population changes from 1990 - 2010	Assumptions about Deer Farming	Calculation to allocate deer to Land Classes
	land on the plains and Class 6 and 7 land in the hills	then fell.	2004 they were on a mix of each Class. Between 2006 and 2010, deer populations reduced mainly on Class 4 land	deer on Land Class 6 and 7/Land Classes 3 and 4. Apply this ratio to years1990-2002. From 2006, subtract deer population in 2010 from the population in that year, to give the numbers estimated on each land class

Table 27 Estimated deer numbers on High Class land (classes 1-4) and Low Class land (classes 607) by region, showing even years only for simplicity

Region	Land Class	1990	1992	1994	1996	2002	2004	2006	2008	2010
Northland	High	10205	11157	13061	8139	16749	10083	2040	0	0
	Low	4060	4401	5152	3210	6663	6663	6663	6564	6663
Auckland	High	41771	37611	21676		8019	11243	3031	0	
	Low	12240	12240	12240		12240	12240	12240	12240	9500
Waikato	High	73923	73604	77921	64870	59146	60516	42633	7913	0
	Low	79609	79265	83914	83952	83952	83952	83952	83952	83952
Bay of Plenty	High	67752	60808	36980	23287	28134	23151	15270	7102	0
	Low	44893	44893	44893	44893	44893	44893	44893	44893	44893
Gisborne	High	6817	7286	9136	8825	10249	15075	12414	8168	0
	Low	10293	11002	13796	13327	15477	22765	15093	15093	15093
Hawke's Bay	High	41155	59010	64829	56111	69441	80763	40188	17853	0
	Low	33946	48673	53472	46282	57277	66615	66573	66573	66573
Taranaki	High	16248	18330	14556	8544	6294	2219		0	0
	Low	4042	4560	4468	4468	4468	4468		3524	4468
Manawatu-Wanganui	High	46084	56199	62665	63753	71651	63805	41805	8980	0
	Low	48544	59199	66011	67156	75477	75437	75437	75437	75437
Wellington	High	8350	9975	11428	8267	8604	6983	3903		0
	Low	13739	16413	18804	18819	18819	18819	18819	16871	18819
Nelson-Marlborough	High	26785	31172	32126	29613	33494	29406	17364	0	0
	Low	19001	22114	22791	21007	23761	23784	23784	19307	23784
West Coast	High	8383	10113	8501		10877	14315	15710	2630	0
	Low	17253	20813	17497		22385	29462	32333	32325	32325
Canterbury	High	49014	62763	80802	86762	128413	141441	145097	20975	0
	Low	108081	138399	178178	191320	283168	311895	319958	319907	319907
Otago	High	10944	13737	16729	18122	35997	37777	24094	0	0
	Low	48858	61331	74685	80904	160706	168657	168696	166856	168696
Southland	High	45957	59257	68269	70533	130076	144457	101562	24097	0
	Low	78252	100898	116243	120097	221482	245966	245975	245975	245975

Table 28 Division of national deer herd by numbers and as a percentag between High Class land (classes 1-4) and Low Class land (Classes 6-7)

	1990	1992	1994	1996	2002	2004	2006	2008	2010
Total Deer	976199	1135223	1230823	1142261	1647912	1756850	1579527	1207235	1116085
Total Deer: Low Class land	453387	511022	518679	446825	617145	641234	465111	97718	0
Total Deer: High Class land	522812	624201	712144	695435	1030767	1115616	1114416	1109517	1116085
% Low Class land	54	55	58	61	63	64	71	92	100
% High Class land	46	45	42	39	37	36	29	8	0

APPENDIX J DEER POPULATION DATA

Table 29 Deer population data split by stock class and reproductive status (Data source: MPI's Animal Production Survey, acknowledged by MPI to be incomplete in years prior to 2005)

Note: assumptions were made to complete the dataset (in particular years 1997-1998 and 2000-2010) to account for periods in which data were not gathered. There are discrepancies in the data that cannot be perfected.

	< 1 year old			1-2 y				>2 y				
	calves born on farm alive at four months	Hind calves	Stag calves	Hinds mated	Hinds NOT mated	Breeding stags	Non-breeding stags	Hinds mated	Hinds NOT mated	Non-breeding stags	Breeding stags	TOTAL
1990	343,482	118,934	157,639	72,744	12,729	3,843	48,732	427,769	4,278	112,938	16,684	976,290
1991	350,322	169,848	217,466	71,622	12,814	3,783	53,170	421,173	4,212	135,479	16,426	1,129,503
1992	391,071	152,741	179,480	73,768	13,564	3,897	74,711	433,788	4,338	182,036	16,919	1,135,242
1993	364,001	154,816	167,056	69,379	12,985	3,665	62,046	407,979	4,080	180,561	15,912	1,078,479
1994	370,496	188,611	170,037	78,933	15,028	4,170	77,169	464,162	4,642	203,794	18,103	1,231,109
1995	367,108	183,023	168,482	73,917	14,203	3,905	77,037	434,665	4,347	188,022	16,953	1,178,704
1996	381,668	146,985	175,164	78,725	14,149	4,159	70,531	462,940	4,629	216,801	18,056	1,192,138
1997	461,183	196,704	211,657	92,893	17,170	4,907	65,307	546,256	5,463	192,026	21,305	1,353,688
1998	540,698	246,422	248,150	107,061	20,191	5,656	60,083	629,572	6,296	167,252	24,554	1,515,238
1999	620,213	296,141	284,643	121,230	23,212	6,404	54,860	712,888	7,129	142,477	27,804	1,676,788
2000	631,712	278,142	289,921	124,000	23,237	6,550	49,026	729,182	7,292	131,381	28,439	1,667,171
2001	643,211	260,143	295,198	126,771	23,262	6,697	43,193	745,475	7,455	120,285	29,075	1,657,555
2002	654,710	242,144	300,476	129,542	23,287	6,843	37,359	761,769	7,618	109,190	29,710	1,647,938
2003	670,370	275,564	307,663	128,711	23,852	6,799	34,560	756,886	7,569	118,321	29,520	1,689,444
2004	699,719	334,670	321,132	126,141	24,694	6,663	33,659	741,772	7,418	131,808	28,930	1,756,888
2005	648,446	298,195	290,080	136,065	61,451	5,978	77,562	685,093	20,772	101,768	28,121	1,705,084
2006	595,782	295,055	278,118	104,333	47,472	7,824	71,987	633,770	22,335	95,337	30,688	1,586,918
2007	536,604	240,924	246,599	94,551	42,117	4,027	57,869	585,557	17,009	85,445	21,925	1,396,023
2008	494,163	217,062	221,599	73,423	31,782	4,057	45,017	521,375	10,483	79,879	18,648	1,223,324

2009	431,921	191,660	212,092	80,313	32,764	3,243	45,767	483,449	9,464	69,178	17,928	1,145,858
2010	428,470	197,991	196,273	81,339	27,734	4,391	48,462	471,516	9,033	67,695	18,262	1,122,695
2011	426,660	191,404	188,304	84,035	26,823	6,029	42,632	446,928	11,358	72,309	18,712	1,088,533

Note: assumptions were made to complete the dataset (in particular years 1997-1998 and 2000-2001) to account for periods in which data were not gathered.

We note that APS numbers of hind and stag calves sum to more than calves alive on farm at 4 months of age in many cases, which is inexplicable.

Table 30 Proportion of national herd by stock class

	Hind cohort			Stag cohort			
	0-1	1-2	MA	0-1	1-2	2-3*	MA
1990	0.12	0.09	0.44	0.16	0.05	0.02	0.11
1991	0.15	0.07	0.38	0.19	0.05	0.02	0.12
1992	0.13	0.08	0.39	0.16	0.07	0.02	0.16
1993	0.14	0.08	0.38	0.15	0.06	0.02	0.16
1994	0.15	0.08	0.38	0.14	0.07	0.02	0.16
1995	0.16	0.07	0.37	0.14	0.07	0.02	0.16
1996	0.12	0.08	0.39	0.15	0.06	0.03	0.17
1997	0.15	0.08	0.41	0.16	0.05	0.02	0.14
1998	0.16	0.08	0.42	0.16	0.04	0.02	0.11
1999	0.18	0.09	0.43	0.17	0.04	0.01	0.09
2000	0.17	0.09	0.44	0.17	0.03	0.01	0.09
2001	0.16	0.09	0.45	0.18	0.03	0.01	0.08
2002	0.15	0.09	0.47	0.18	0.03	0.01	0.07
2003	0.16	0.09	0.45	0.18	0.02	0.01	0.08
2004	0.19	0.09	0.43	0.18	0.02	0.01	0.08
2005	0.17	0.12	0.41	0.17	0.05	0.01	0.07
2006	0.19	0.10	0.41	0.18	0.05	0.01	0.07
2007	0.17	0.10	0.43	0.18	0.04	0.01	0.07
2008	0.18	0.09	0.43	0.18	0.04	0.01	0.07
2009	0.17	0.10	0.43	0.19	0.04	0.01	0.07
2010	0.18	0.10	0.43	0.17	0.05	0.01	0.07
2011	0.18	0.10	0.42	0.17	0.04	0.01	0.07

*The number of R3 stags is estimated by assuming that the productive life of a stag is 10 years.
If yearling and 2 year old stags are separately accounted for in the model, then all other stags must be 3-10 years of age. If one assumes no age specific mortality, then each age cohort will be one eighth of the total number. I have used this calculation to estimate the number of 3 year old stags in the table above.