Venison deep-muscle bruising

Final report

Authors: Cameron Craigie[1], Harold Henderson[1], Noby Jacob[1], Jack Somerton[1], Sara Walden[1], Tracey Kitchen[2] and Jamie Ward[1]

Date: November 2019

[1] AgResearch Limited
[2] Venison Packers Feilding

CONFIDENTIAL REPORT FOR DEEResearch Limited

CLIENT REPORT NUMBER: FBP

Contents

1. Client Summary

- Deep-muscle bruising (DMB) in venison is a specific form of bruising that is of concern to venison processors and marketers as causes are currently unknown and damaged product can enter the marketplace undetected.
- A previous preliminary study was unable to associate any causative or risk factors with incidence of DMB at a New Zealand DSP.
- This more in-depth study was commissioned to collect further DMB incidence and associated metadata on a season of venison slaughter at Venison Packers Feilding (VPF) in order to investigate possible risk factors for increased incidence of DMB.
- Data were recorded on 250 mobs where at least 1 carcass with DMB from the mob from 93 Suppliers using seven Transporters with on the 98 days with bruising recorded.
- The peak bruising time was in the 6 weeks prior to Christmas.
- Total weight of DMB meat was 427 kg on 752 carcasses.
- The loss of product, while approximately 1% of carcass weight, was approximately 3.5% of high-value rear leg meat yield.
- Potential risk factors associated with DMB including pre-slaughter stress, stunning method, mob size, gender and carcass weight were not clearly associated with DMB.
- 7.5% of DMB samples had a pH ≥6.00 and 14.3% with pH ≥5.90 which was higher than expected. Elevated pH is associated with pre-slaughter stress; however, it is not clear whether the pre-slaughter stress is a result of the DMB or a causative factor of the DMB.
- There is evidence of some variation in the incidence rate of DMB among Suppliers.
- Given the widespread supplier base (n = 93) who had mobs with DMB incidences, it seems unlikely that there is a single cause of DMB, but it is possible that these suppliers have some commonality in their operations.
- 105 mobs from the other 65 Suppliers with only mobs without DMB.
- 269 mobs without DMB.
- Suppliers (n= 65) without DMB have now been identified from VPF records.
- It is recommended that focus group of transport operators is formed who have visited various properties to try and identify differences or similarities between the DMB and non-DMB suppliers.

2. Executive Summary

A preliminary investigation (FBP 78503, reported to DEEResearch in May 2018) into the potential causes of deep-muscle bruising in the hind legs of deer was undertaken in the 2017/2018 season. This study failed to identify risk factors, so a more comprehensive study was commissioned:

1. To investigate the following risk factors: Gender, Carcass weight, Supplier, Transporter and Mob size.
2. Search for patterns in deep-muscle bruising (DMB) occurrence throughout the season from September 2018 to June 2019 (covering the majority of the processing season).

A protocol was developed by Venison Packers Feilding (VPF) that involved bagging and tagging bruised trim with the carcass ID throughout the season. VPF them compiled metadata (risk factors) for each sample. AgResearch staff recorded the weight and pH of each bruised sample. This information allowed the presence and severity of incidence of DMB to be characterised, and the potential associations with risk factors to be investigated.

Results showed that DMB carcasses originated from 93 different suppliers across the season and that DMB affected 4.2% of animals. The loss of product, while approximately 1% of carcass weight, was approximately 3.5% of high-value rear leg meat yield.

This investigation found that risk factors such as stunning method, gender, mob size carcass weight and pH as an indicator of pre-slaughter stress were **not** associated with DMB incidence or severity (the amount of bruised venison).

DMB incidence was highest in the six weeks prior to Christmas 2018, suggesting there may be some seasonal effects at play. There is evidence of some variation in the incidence rate of DMB among Suppliers.

Given the somewhat inconclusive results as to the causes of DMB the following recommendations are made:

- Consult transporters and their drivers to try and identify common management, yard or other differences between suppliers with zero incidence of DMB and those with DMB (e.g., create a focus group).
- Further investigations of individual animal data from the kill summary (Gender, GR, Age, Grade, Carcass weight) on animals processed that had zero incidence of DMB. These risk factors could then be compared for animals with DMB compared to those without DMB.
- Further investigations could also be undertaken with a subset of suppliers who have DMB incidence and zero incidence on a case study basis to either corroborate transporter observations or investigate farm system differences if nothing is apparent by general supplier observation.
- Consult DeerPRO Manager to see if they have any supporting data.
- Socialise findings with interested parties (e.g., Venison Processors Technical Committee, Venison Marketers Group, DINZ Venison Marketing Manager, QA Manager, Producer Manager and DeerPRO Manager) to help determine what the next steps (if any) should be taken.

3. Background

Deep-muscle bruising (DMB) presents as a very specific form of haemorrhage in the rear leg cuts. It results in product downgrades and significant losses over time. If affected cuts are not detected and dissected in-plant affected product can enter the market and will only be identified at that later point by customers (i.e., butchers, chefs or other food service agents). The causative factors of deep-muscle bruising in venison are not well understood. In general, bruising in venison, like beef and lamb, is typically associated with stress and physical impact injury linked to handling, transportation, lairage and stunning prior to slaughter. Anecdotally, venison processors believe the cause of DMB to occur prior to arrival at the processing plant, but exactly where or what may be leading to the bruising was unknown.

A preliminary investigation, reported to DEEResearch (Craigie et al., 2018), into the potential causes of DMB in the hind legs of deer was undertaken in the 2017/2018 season. This study ran between 15 November 2017 and 17 March 2018 and a total of 395 DMB meat samples were saved along with carcass ID tags by VPF staff. AgResearch recorded the weight and ultimate pH of each sample.

A total of 154 kg of DMB venison was recovered and the weight of DMB meat per carcass where DMB was recorded varied from 20 g to 2.3 kg, with an average of 0.39 kg. Despite the effort in collecting DMB samples, the study failed to identify specific causative or risk factors of DMB. The sampling regime of the preliminary study did not allow for an in-depth analysis of risk factors (other than supplier) or seasonality.

In response, the present investigation was commissioned to investigate a range of potential risk factors and seasonality on DMB and address the following aims:

1. Investigate the following risk factors: Gender, Carcass weight, Supplier, Transporter, and Mob size.
2. Search for patterns in bruising occurrence throughout the processing season from September 2018 to June 2019 (i.e., covering most of the season).

4. Methods

Deep-muscle bruised (DMB) meat was trimmed from rear legs during fabrication. A protocol was previously developed that included the following steps:

1. DMB product was retained with carcass tag, placed in a vacuum bag and frozen at -18ºC.
2. Plant staff recorded metadata on an ongoing basis, including mob number, Transporter company name, mob arrival time, supplier company name, gender, total number slaughtered for that day, and slaughter type.
3. DMB product was thawed, and science staff collected the following 'observed' data: weight, pH, and a DNA sample recovered and stored.

4. Observed data (weight of DMB product, pH and DNA sample number) was matched to processing plant records.
5. Data were analysed using Excel, R and Genstat, where summary information was generated and used to identify trends and gain insights into risk factors for DMB.

5. Results and Discussion

5.1 General Overview

- This study encompassed 112 slaughter days from 5 Oct 2018 to 12 June 2019 covering the majority of one full season.
- During the trial period five days had no data recorded (other than total kill number).
- Venison from red deer and wapiti crossbreds (*Cervus elaphus spp.*) only is considered.
- There were 780 DMB carcasses from 250 mobs (where at least 1 carcass presented with DMB) with 12570 carcasses out of a total of 18655 carcasses (107 Days) from 519 mobs.
- There were 269 mobs without DMB with 6085 carcasses.
- Daily kill numbers for deer averaged 174 and ranged from 50 to 232.
- Data on pH and bruised weight were matched for 752 (of the 780 total) DMB carcasses (pH was not recorded on 2 of these 752 carcasses). Ultimate pH was not recorded on non-DMB carcasses in this study.
- Total weight of DMB meat was 427 kg on 752 carcasses.
- The loss of product, while approximately 1% of carcass weight, was approximately 3.5% of high-value rear leg meat yield.
- The pH values were within expected norms, similar to other industry datasets (e.g., Deer Progeny Test undertaken between 2012-2014 [DPT] on rising yearling carcass loin muscles (n=914) mean 5.63, range 5.46-6.55 (unpublished)).
- A summary of DMB weight and pH of DMB meat is shown in Table 1.

Table 1: Summary statistics for the recorded weight and pH of deep-muscle bruised (DMB) venison

	n	min	max	mean	sd
CC Weight (kg)	752	33.8	103.5	58.9	8.5
DMB meat weight (kg)	752	0.03	3.89	0.57	0.36
DMB meat pH	750	5.5	6.7	5.7	0.17

5.2 Seasonal effects

The following figures show the daily total number of Red deer processed (slaughtered) (Fig 1), the daily number presenting with DMB (Fig 2), and the proportion presenting with DMB in a day over the trial period (Fig 3).

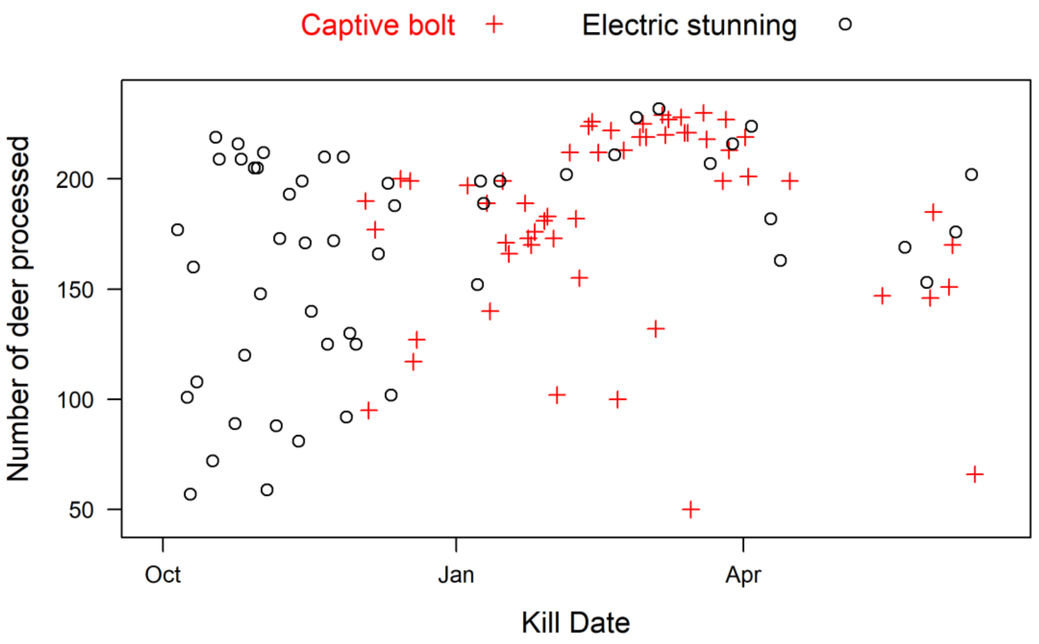


Figure 1: Daily total of Red deer processed across the season. Black denotes electric stunning and red denotes captive bolt stun.

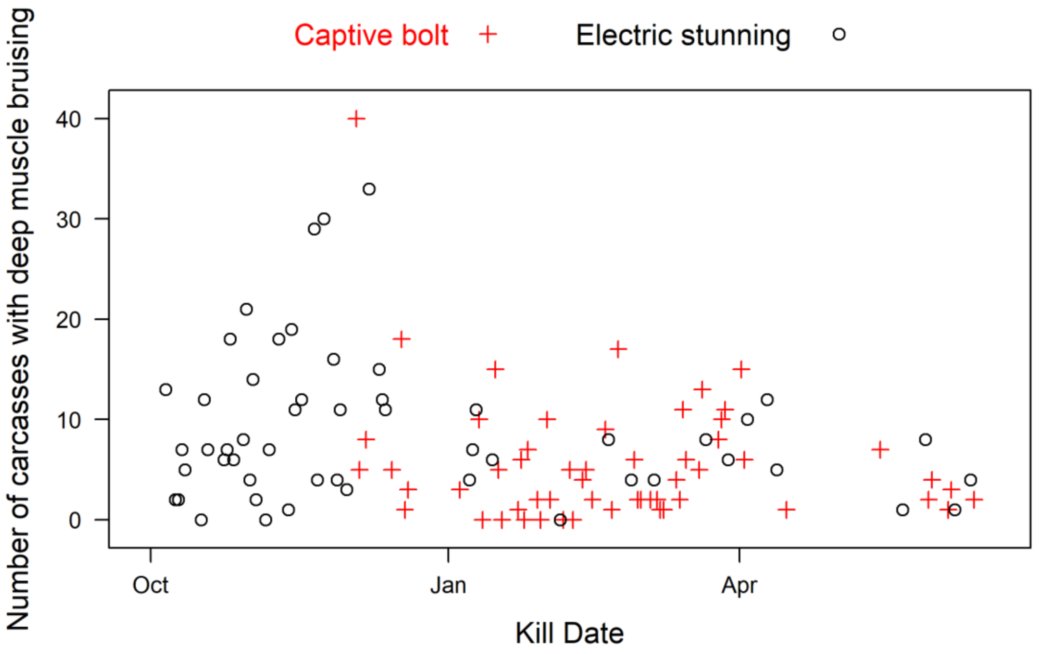


Figure 2: Daily total of carcasses with deep-muscle bruising in the hind legs across the season. Black denotes electric stunning and red denotes captive bolt stun.

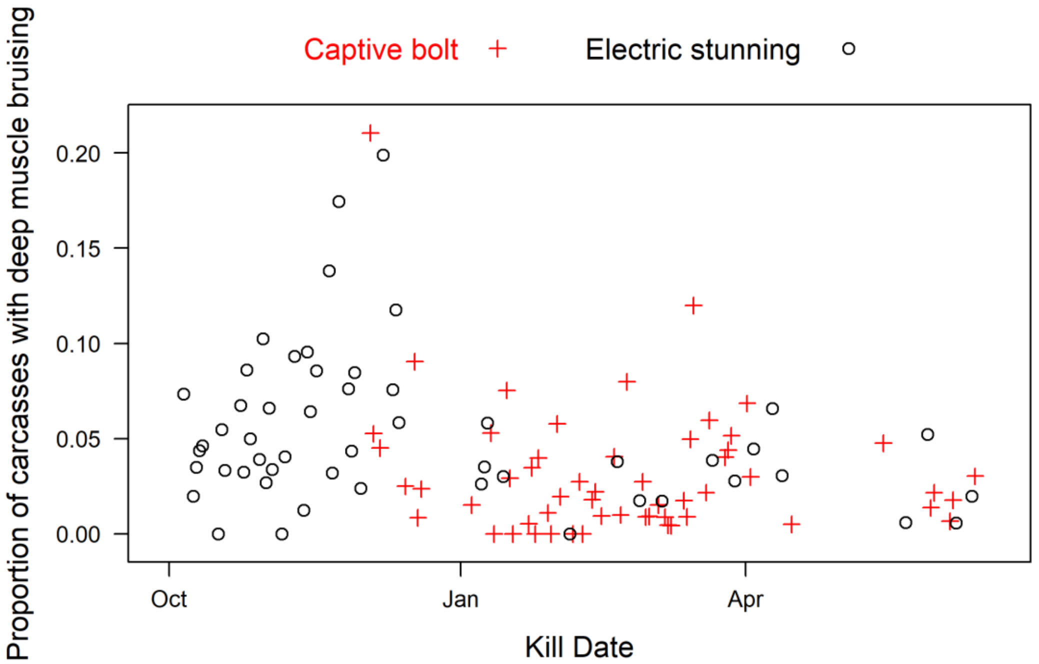


Figure 3: The proportion presenting with deep-muscle bruising each day across the season. Black denotes electric stunning and red denotes captive bolt stun.

The proportion of carcasses with DMB was highest between mid-November and late-December 2018. From October until Christmas there was frequently >5% of the carcasses on any given day presenting with DMB, whereas post-Christmas the incidence of DMB is generally <5%. This seasonality suggests that there might be different farm management practices that occur during these respective periods that influence the incidence of DMB. One possible cause might be increased yarding and handling associated with velvet (including spiker) antler removal prior to transport for slaughter during the earlier period. Another possibility is that animals in general are becoming tamer/more settled as they get older and more habituated to handling. However, to better understand this seasonal trend a complete dataset, including mobs presenting without DMB, have now been added. There were 269 mobs with 6085 carcasses without DMB. It is important to note that there could potentially be confounding effects of timing of slaughter with supplier or other factors.

There does not appear to be a clear trend with respect to stunning type (i.e., Electric vs captive bolt stunning), and, although this is confounded with the spring slaughters, it appears unlikely to be a risk factor.

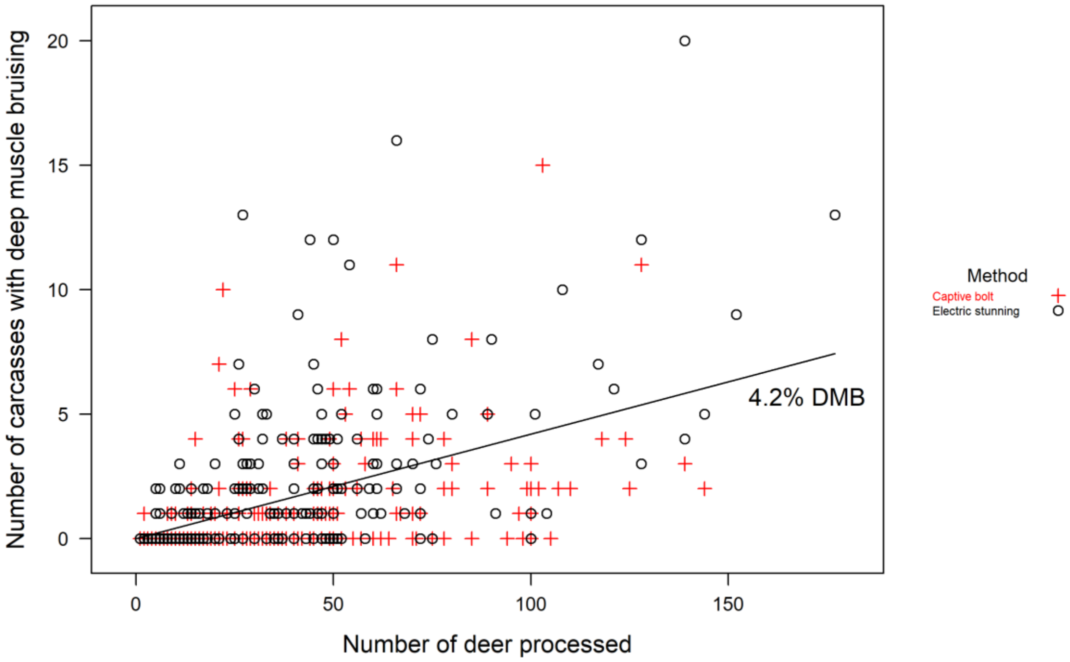


Figure 4: The number of carcasses with DMB plotted on the number of animals processed for each of the 519 mobs. The line is for the overall DMB rate of 4.2%.

Table 2: Table of numbers of Mobs and Carcasses in 3 Periods and incidence of deep-muscle bruising (DMB).

Number of Mobs

Period	Bruising in Mob No	Bruising in Mob Yes	Grand Total
5 Oct - 16 Nov 2018	36	63	99
20 Nov - 19 Dec 2018	45	55	100
4 Jan - 12 Jun 2019	188	132	320
Grand Total	269	250	519

Number of carcasses

Period	Bruising in Mob No	Bruising in Mob Yes	Grand Total	Number of carcasses with DMB	Percent with DMB
5 Oct - 16 Nov 2018	648	2963	3611	202	5.6%
20 Nov - 19 Dec 2018	614	2209	2823	248	8.8%
4 Jan - 12 Jun 2019	4823	7398	12221	330	2.7%
Grand Total	6085	12570	18655	780	4.2%

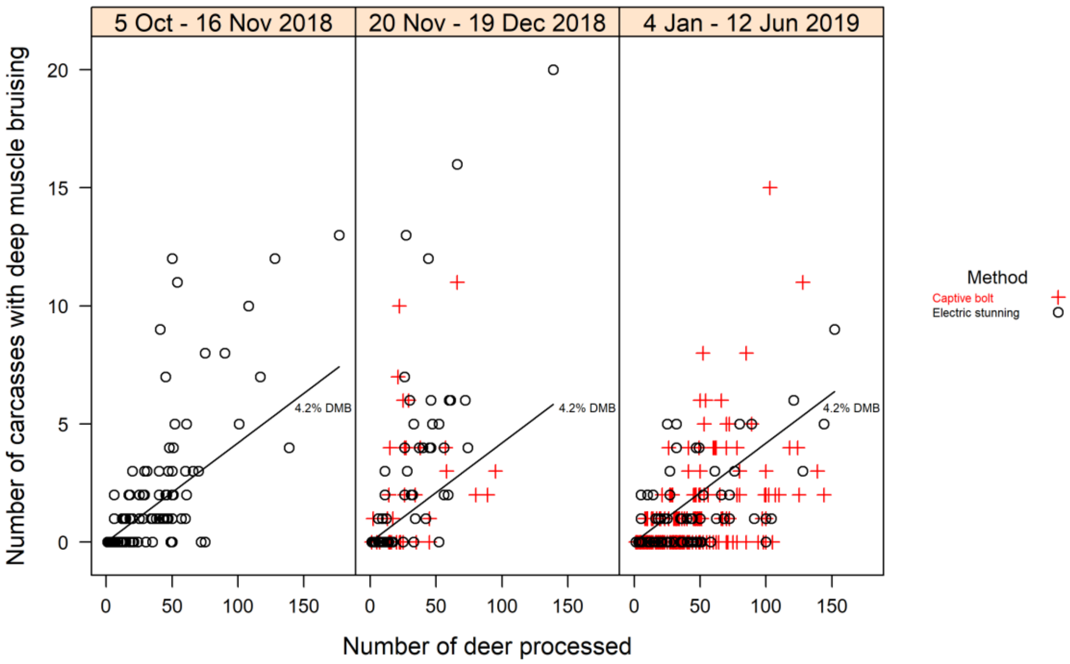


Figure 5: The number of carcasses with DMB plotted on the number of animals processed for each of the 519 mobs with panels by Period. The line is for the overall DMB rate of 4.2%.

When the individual DMB rate is 4.2%, a mob of size 16 has a 50% chance of at least 1 DMB incidence, a mob of size 70 has a 95% chance of at least 1 DMB incidence and a mob of size 108 has a 99% chance of at least 1 DMB incidence (Figure 6).

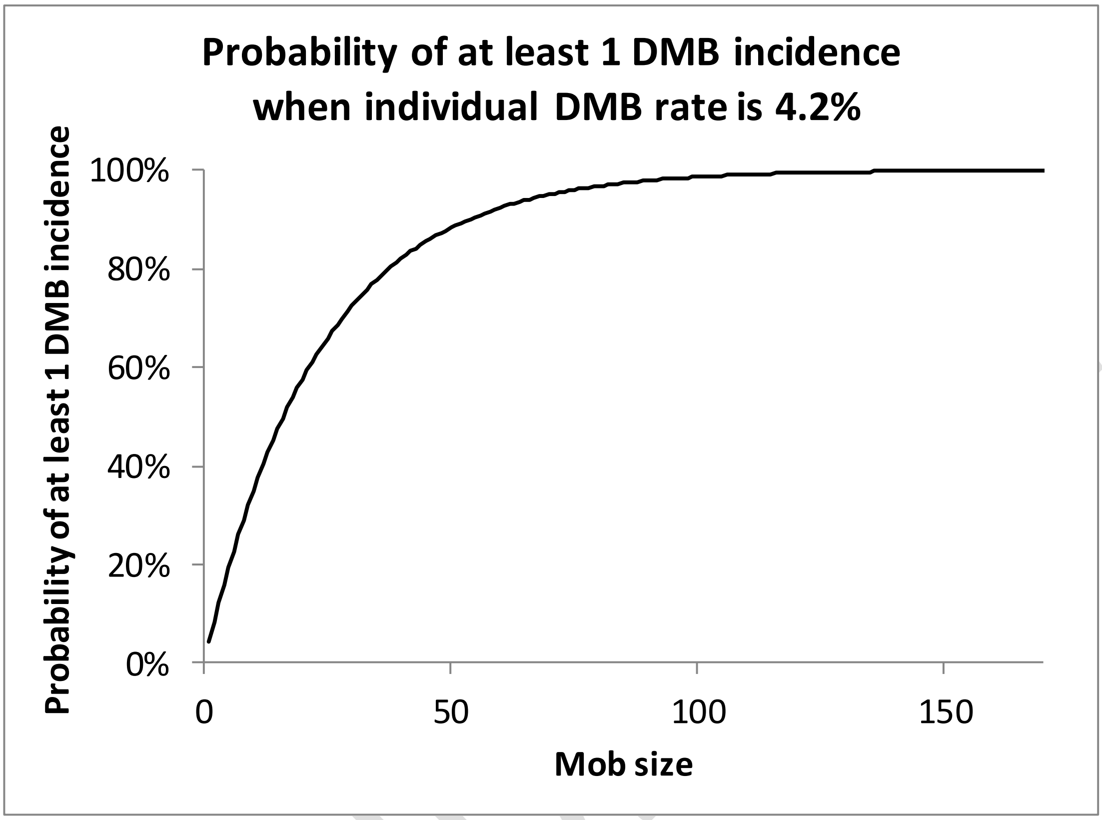


Figure 6: Probability of at least 1 DMB incidence in mob when individual DMB rate is 4.2% on Mob size.
The probability of at least 1 DMB in a mob if size n = 1 – (1-probability individual DMB)^n

5.3 Transport

- The vast majority of Suppliers are within in a 2-3-hour drive radius of the processing plant.
- 519 mobs from 158 Suppliers.
- Data was from 250 mobs from 93 Suppliers using seven Transporters with at least 1 carcass with DMB from the mob on the 98 days with bruising recorded.
- 105 mobs from the other 65 Suppliers with only mobs without DMB.
- Additional data (Supplier, Transporter and Mob size) from 269 mobs without DMB.
- 136 of the 158 Suppliers used only one Transporter and 21 used two different Transporters and 1 used three different Transporters.

Table 3: Summary of Transporters of deer mobs.

	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	Total
Mobs	248	4	2	17	1	1	1	41	24	180	519
Suppliers											158
Suppliers:Transporters	96	4	1	1	1	1	1	11	11	54	181

- There were 181 Supplier:Transporter combinations, as 21 used two different Transporters and 1 used three different Transporters, for example:
- T1 transported 248 mobs from 96 Suppliers.
- T10 transported 180 mobs from 54 Suppliers.
- 16 Suppliers used both these Transporters.
- T4 transported their own stock.

The Transporter data set is biased towards two operators who have transported most of the mobs of deer. And there is geographical confounding of Supplier and Transporter. However, there is a general degree of consistency of incidence of DMB across Transporters (Figure 9, Table 4). The variance component for Transporter, in the Generalised Linear Mixed Model analysis with Supplier and Transporter as random effects, was 0.04 ± 0.05. There is also similarity in the elevated rates of DMB within mob pre-Christmas in the three most frequently represented Transporters, all of which indicates that it is unlikely to be a transporter specific issue. Transporter is also confounded with Supplier, potentially localised area and even farm system type.

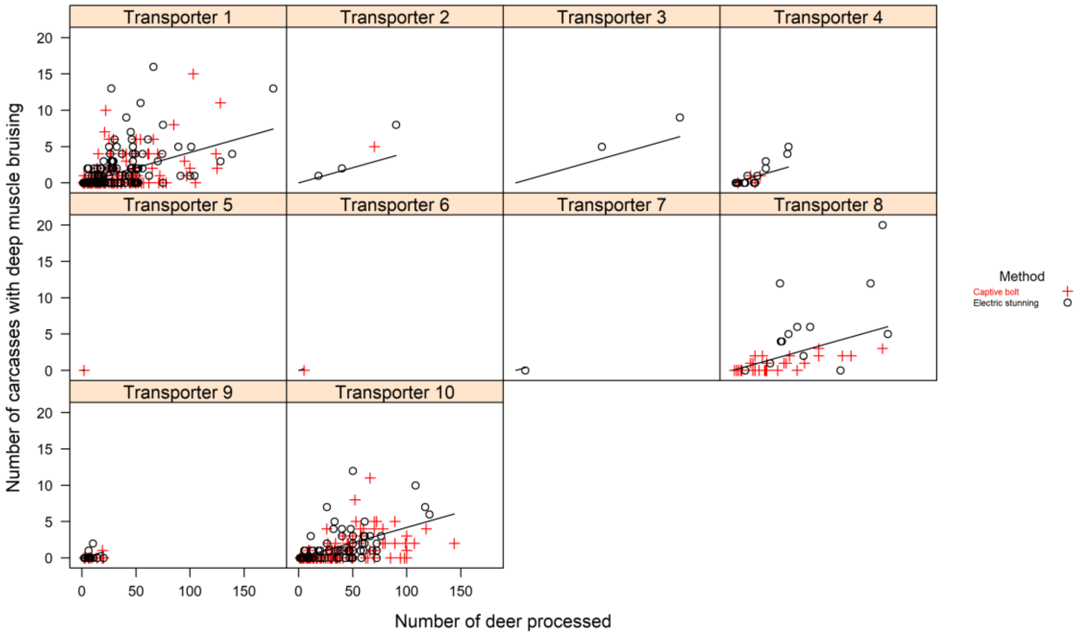


Figure 7: The number of carcasses with DMB plotted on the number of animals processed for each of the 519 mobs with panels by Transporter. The line is for the overall DMB rate of 4.2%.

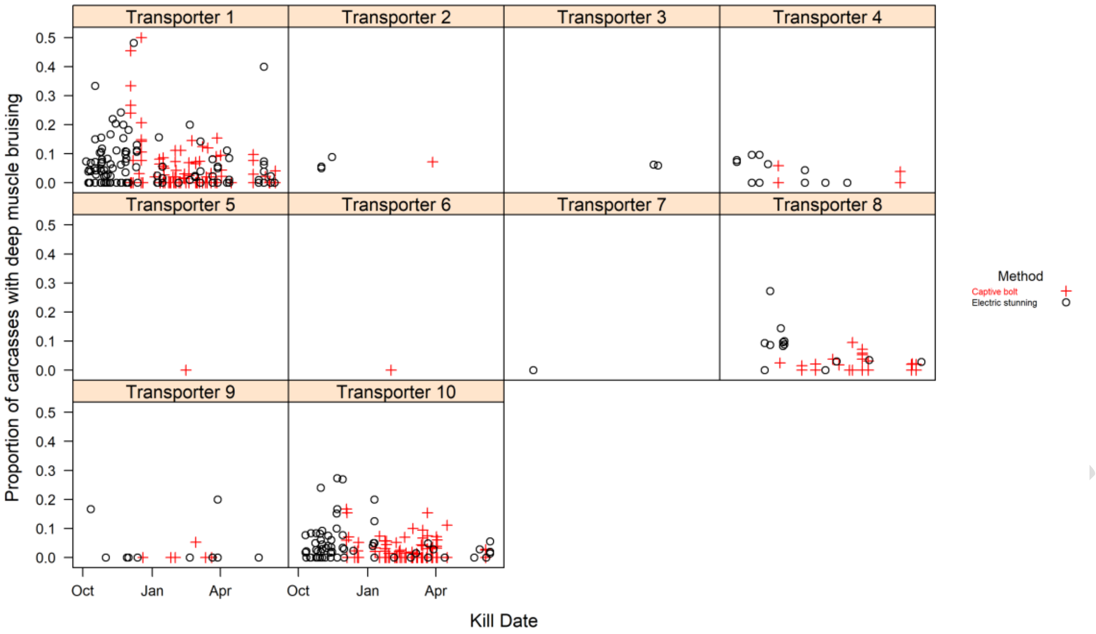


Figure 8: The proportion of mob presenting with deep-muscle bruising (DMB) by Transporter across the season.

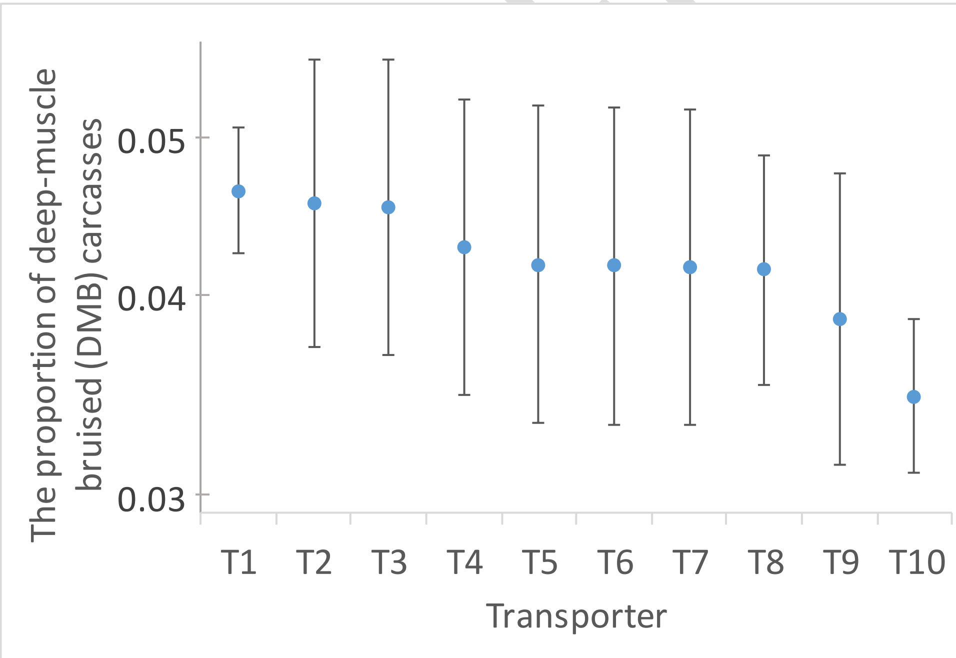


Figure 9: The predicted proportion of deep-muscle bruised (DMB) carcasses by Transporter. The error bars represent the standard error of the mean (sem).

Table 4: Ranking of Transporters by predicted proportion of mob presenting with deep-muscle bruising (DMB) from a Generalised Linear Mixed Model with Supplier and Transporter as random effects. These predicted proportions are not the raw proportions but are shrunk towards the mean.

Transporter	Proportion DMB
T1	0.046
T2	0.046
T3	0.045
T4	0.043
T5	0.042
T6	0.042
T7	0.042
T8	0.042
T9	0.039
T10	0.035

5.4 Supplier

There is evidence of some variation in the incidence rate of DMB among Suppliers. Carcasses with DMB came from 93 different Suppliers during the trial period. Deep-muscle bruising raw proportion by Supplier ranged from 0 to 0.34. This observation suggests:

a) that these 93 Suppliers have some common element(s) in their farming operations that are causing DMB, and/or
b) that there are multiple factors underpinning occurrence of DMB.

The other 65 Suppliers had only mobs (105 mobs) without DMB.

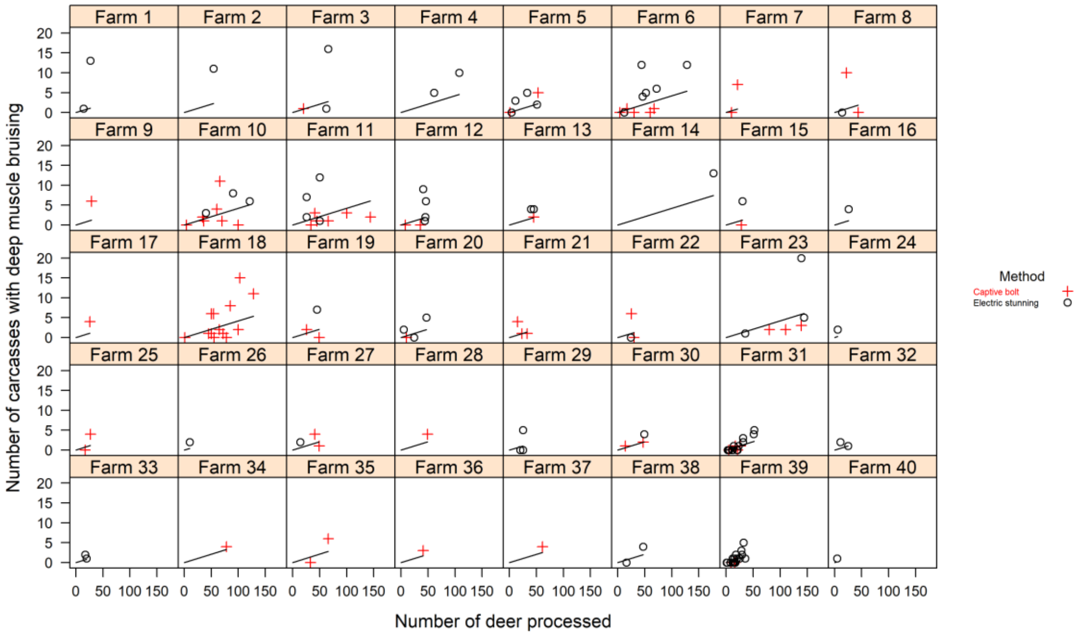
Figure 10 shows the number of carcasses with DMB on the number of animals processed for each of the 519 mobs with panels by Supplier. The line is for the overall DMB rate of 4.2%.

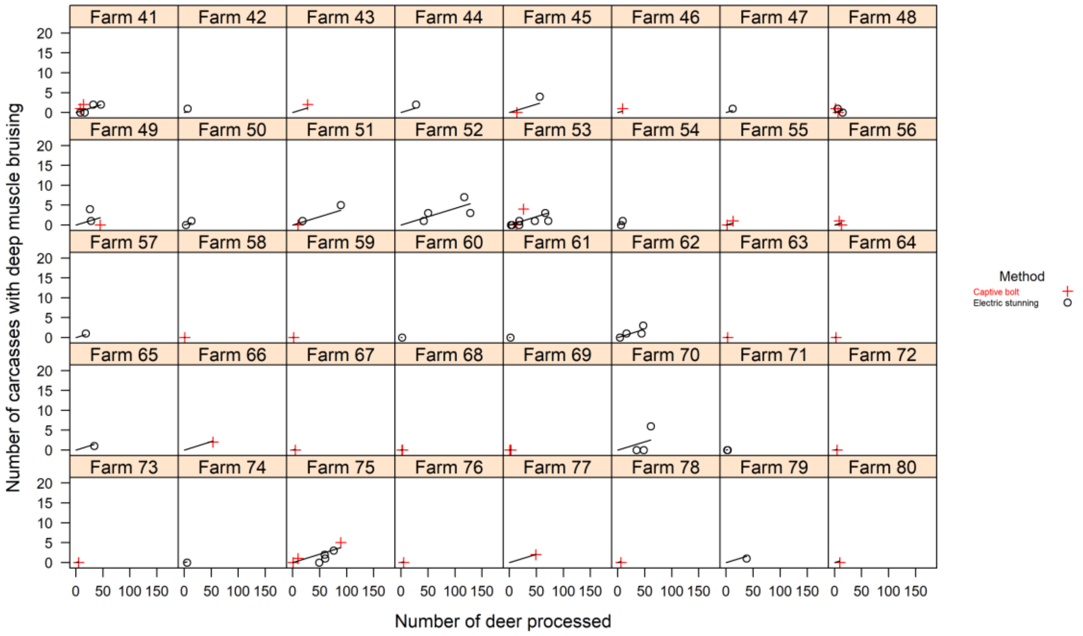
There were no particularly obvious trends within the individual Supplier data, much of that is due to the relatively small size of most individual Suppliers' datasets. The incidence of DMB among Suppliers over mobs had mean 0.041, standard deviation 0.058 and the range from 0 to 0.34. There is evidence of some variation in the incidence rate of DMB among Suppliers. The variance component for Supplier, in the Generalised Linear Mixed Model analysis with Supplier and Transporter as random effects, was 0.19 ± 0.08.

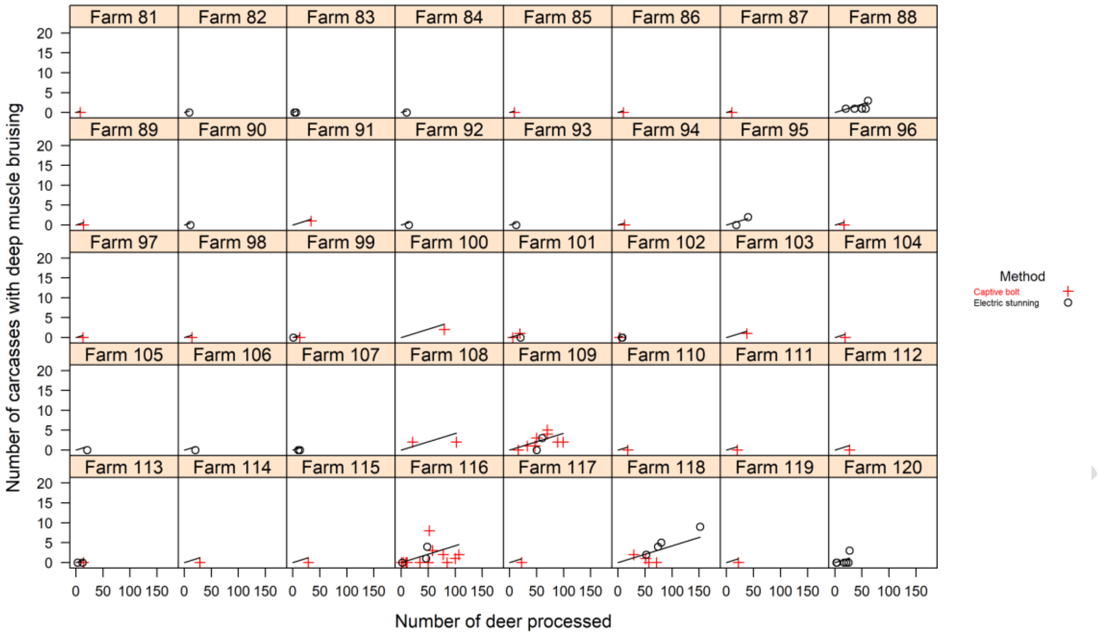
Table 5: Number of Suppliers and mobs with and without DMB

	Suppliers with only mobs without DMB	Suppliers with both mobs without DMB and with some DMB	Suppliers with only mobs with some DMB	Total
Suppliers	65	54	39	158
Mobs	105	348	66	519
Mobs/Supplier	1.6	6.4	1.7	3.3

Suppliers with fewer Mobs, of course, have more chance of having Mobs only with or only without DMB. (For example, the extreme is Suppliers with only 1 Mob.) Suppliers with smaller mobs also have a greater chance of having no DMB (Figure 6).


Farm 1
Farm 2
Farm 3
Farm 4
Farm 5
Farm 6
Farm 7
Farm 8
Farm 9
Farm 10
Farm 11
Farm 12
Farm 13
Farm 14
Farm 15
Farm 16
Farm 17
Farm 18
Farm 19
Farm 20
Farm 21
Farm 22
Farm 23
Farm 24
Farm 25
Farm 26
Farm 27
Farm 28
Farm 29
Farm 30
Farm 31
Farm 32
Farm 33
Farm 34
Farm 35
Farm 36
Farm 37
Farm 38
Farm 39
Farm 40
Number of carcasses with deep muscle bruising
Number of deer processed
Method
Captive bolt
Electric stunning


Farm 41
Farm 42
Farm 43
Farm 44
Farm 45
Farm 46
Farm 47
Farm 48
Farm 49
Farm 50
Farm 51
Farm 52
Farm 53
Farm 54
Farm 55
Farm 56
Farm 57
Farm 58
Farm 59
Farm 60
Farm 61
Farm 62
Farm 63
Farm 64
Farm 65
Farm 66
Farm 67
Farm 68
Farm 69
Farm 70
Farm 71
Farm 72
Farm 73
Farm 74
Farm 75
Farm 76
Farm 77
Farm 78
Farm 79
Farm 80
Number of carcasses with deep muscle bruising
Number of deer processed
Method
Captive bolt
Electric stunning



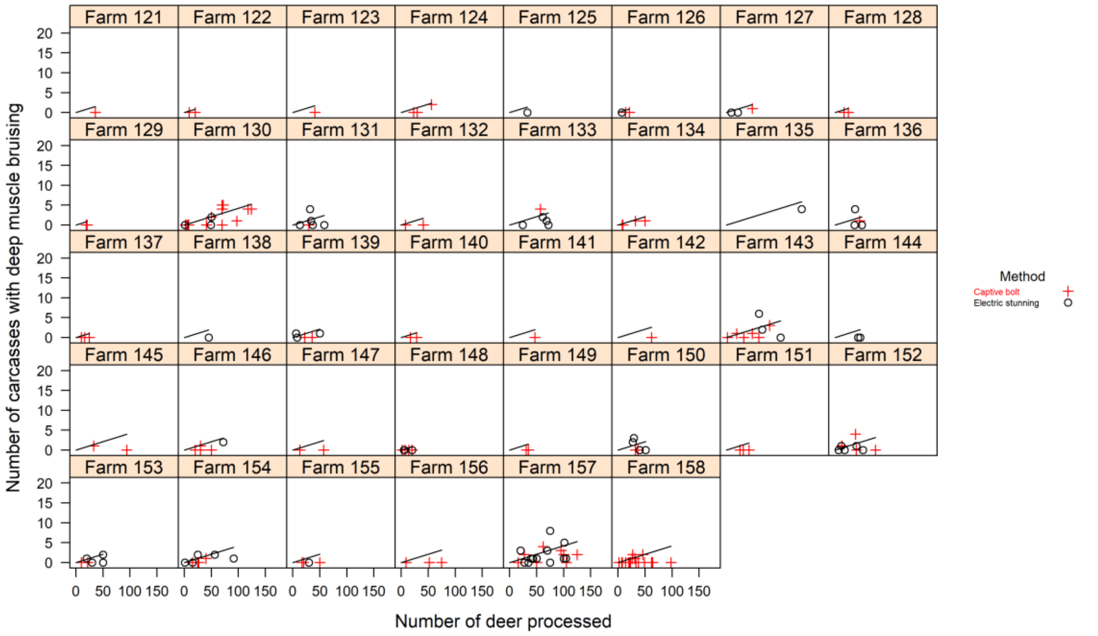


Figure 10 (4 graphs)**:** The number of carcasses with DMB on the number of animals processed for each of the 519 mobs with panels by Supplier. The line is for the overall DMB rate of 4.2%.

Table 6: Ranking of Suppliers by the predicted proportion presenting with deep-muscle bruising (DMB) from a Generalised Linear Mixed Model with Supplier and Transporter as random effects.

Supplier	Proportion DMB	Supplier	Proportion DMB	Supplier	Proportion DMB	Supplier	Proportion DMB
Farm 1	0.098	Farm 41	0.045	Farm 81	0.041	Farm 121	0.038
Farm 2	0.075	Farm 42	0.045	Farm 82	0.041	Farm 122	0.038
Farm 3	0.072	Farm 43	0.045	Farm 83	0.041	Farm 123	0.037
Farm 4	0.068	Farm 44	0.044	Farm 84	0.041	Farm 124	0.037
Farm 5	0.068	Farm 45	0.044	Farm 85	0.040	Farm 125	0.037
Farm 6	0.068	Farm 46	0.044	Farm 86	0.040	Farm 126	0.037
Farm 7	0.064	Farm 47	0.044	Farm 87	0.040	Farm 127	0.037
Farm 8	0.063	Farm 48	0.044	Farm 88	0.040	Farm 128	0.037
Farm 9	0.060	Farm 49	0.044	Farm 89	0.040	Farm 129	0.037
Farm 10	0.060	Farm 50	0.044	Farm 90	0.040	Farm 130	0.037
Farm 11	0.059	Farm 51	0.043	Farm 91	0.040	Farm 131	0.037
Farm 12	0.059	Farm 52	0.043	Farm 92	0.040	Farm 132	0.037
Farm 13	0.057	Farm 53	0.043	Farm 93	0.040	Farm 133	0.037
Farm 14	0.053	Farm 54	0.043	Farm 94	0.040	Farm 134	0.036
Farm 15	0.053	Farm 55	0.043	Farm 95	0.040	Farm 135	0.036
Farm 16	0.052	Farm 56	0.043	Farm 96	0.040	Farm 136	0.036
Farm 17	0.052	Farm 57	0.042	Farm 97	0.040	Farm 137	0.036
Farm 18	0.052	Farm 58	0.042	Farm 98	0.040	Farm 138	0.036
Farm 19	0.051	Farm 59	0.042	Farm 99	0.040	Farm 139	0.036
Farm 20	0.051	Farm 60	0.042	Farm 100	0.040	Farm 140	0.036
Farm 21	0.050	Farm 61	0.042	Farm 101	0.040	Farm 141	0.035
Farm 22	0.049	Farm 62	0.042	Farm 102	0.040	Farm 142	0.034
Farm 23	0.049	Farm 63	0.042	Farm 103	0.039	Farm 143	0.033
Farm 24	0.049	Farm 64	0.041	Farm 104	0.039	Farm 144	0.033
Farm 25	0.049	Farm 65	0.041	Farm 105	0.039	Farm 145	0.033
Farm 26	0.048	Farm 66	0.041	Farm 106	0.039	Farm 146	0.033
Farm 27	0.048	Farm 67	0.041	Farm 107	0.039	Farm 147	0.033
Farm 28	0.048	Farm 68	0.041	Farm 108	0.039	Farm 148	0.033
Farm 29	0.047	Farm 69	0.041	Farm 109	0.039	Farm 149	0.033
Farm 30	0.047	Farm 70	0.041	Farm 110	0.039	Farm 150	0.033
Farm 31	0.047	Farm 71	0.041	Farm 111	0.039	Farm 151	0.032
Farm 32	0.046	Farm 72	0.041	Farm 112	0.039	Farm 152	0.031
Farm 33	0.046	Farm 73	0.041	Farm 113	0.039	Farm 153	0.031
Farm 34	0.046	Farm 74	0.041	Farm 114	0.039	Farm 154	0.030
Farm 35	0.046	Farm 75	0.041	Farm 115	0.039	Farm 155	0.029
Farm 36	0.046	Farm 76	0.041	Farm 116	0.039	Farm 156	0.028
Farm 37	0.046	Farm 77	0.041	Farm 117	0.038	Farm 157	0.028
Farm 38	0.045	Farm 78	0.041	Farm 118	0.038	Farm 158	0.024
Farm 39	0.045	Farm 79	0.041	Farm 119	0.038		
Farm 40	0.045	Farm 80	0.041	Farm 120	0.038		

The predicted proportion presenting with deep-muscle bruising (DMB) by Supplier is from a Generalised Linear Mixed Model with Supplier and Transporter as random effects. These predicted proportions are not the raw proportions but are shrunk towards the mean.

Overall 780 red deer presented with DMB: 527 stags and 253 hinds. The gender of the carcasses presenting with DMB was extracted, but the gender distribution in the mob was not extracted. However, from 15 May to 12 June only 2 stags presented with DMB – presumably due to seasonally (i.e. rut) low number of stags for slaughter - while 31 hinds presented with DMB. Throughout the dataset it is likely gender and slaughter date are confounded throughout the kill season due to differences in R1 growth, and supplier preferences for culling of different genders.

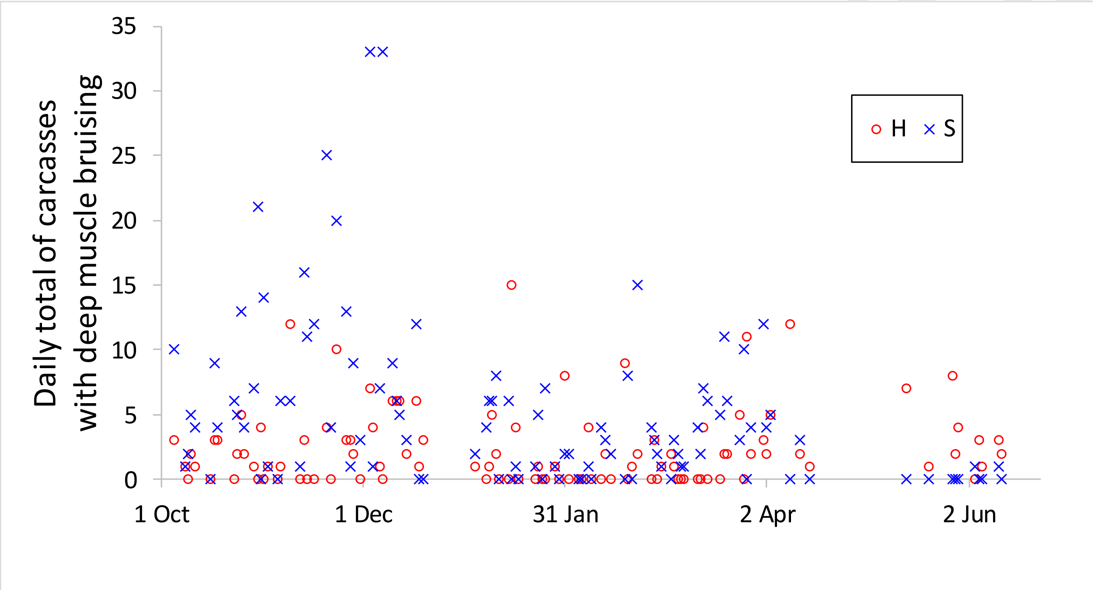


Figure 11: Daily total of carcasses with deep-muscle bruising through time by Gender (H = Hinds, S = Stags).

5.5 Carcass Weight, pH and Gender

Stags had higher carcass weights than hinds, and there was approximately a 2:1 ratio of stags to hinds in the dataset. This aligns with other studies and would be about the expected ratio of stags to hinds slaughtered on a national scale. There is no clear relationship between DMB meat weight and carcass weight for hinds or stags (Figure 12), however the three cases of DMB with the greatest loss of product were observed in stags. Overall there is no evidence that Gender is a factor in the incidence of DMB.

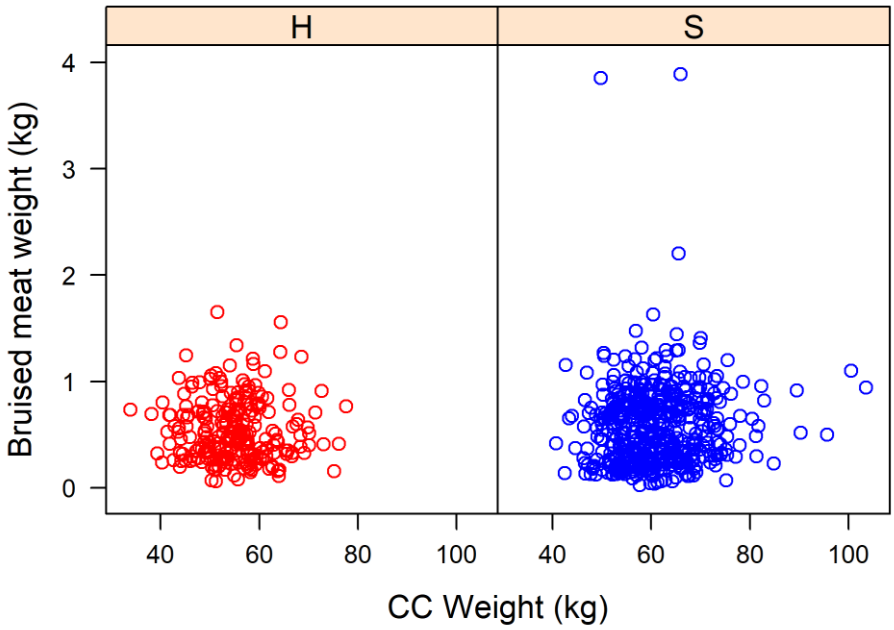


Figure 12: A plot showing deep-muscle bruised meat weight against cold carcass weight (H = Hinds, S = Stags).

There was no clear relationship between the pH of the DMB meat and the cold carcass weight (Figure 13), which was the case in the previous study (Craigie et al., 2018). Given that there were twice as many stags with DMB in the dataset, the greater number of stags with elevated pH (i.e., 6.0 or above) is to be expected (Figure 13). However, the proportion with elevated pH (6.0 or above) was similar: stags 8.1%, hinds 6.2%. There was no apparent relationship between pH of DMB meat and the weight of DMB meat. If it is assumed that high pH meat is a result of pre-slaughter stress, this observation does not suggest that there is a relationship between pre-slaughter stress and the incidence or amount (i.e., weight or tissue) of DMB in the hind legs.

The mean and range of pH in DMB carcass samples (Table 1) was similar to the (unpublished) 2012-2014 Deer Progeny Test (DPT) data. However, the proportion of carcasses with elevated pH was different. In the DPT data set only 2 loin samples out of 914 had a pH ≥ 6.00 and only with only a further 2 between pH 5.90 and 5.99, whereas in the DMB set 7.5% had a pH ≥ 6.00 and a further 6.8% pH 5.90-5.99. This may indicate that some of the individual animals presenting with DMB were more stressed than the general population. The cause of this stress cannot be determined (i.e., it could be either from pain of the DMB injury, or the DMB injury may have been caused by the distressed state of the animal). Although there was no clear relationship between the pH and weight of DMB meat (Figure 14), if weight or amount of damage was considered as a proxy for potential to cause pain then perhaps elevated pH due to pain could be ruled out. However, the area bruised may in fact not relate to the pain induced.

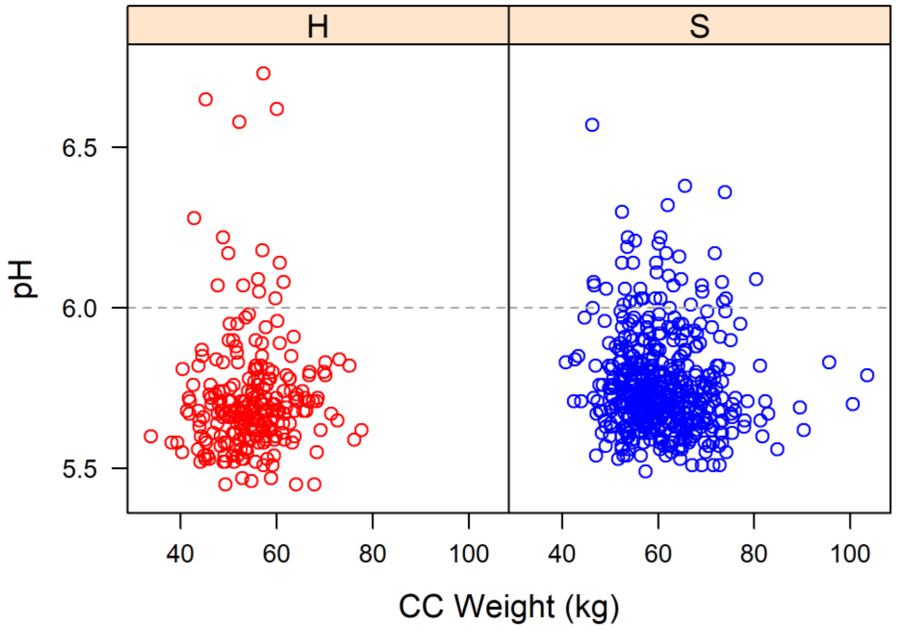


Figure 13: A plot showing pH of deep-muscle bruised meat against cold carcass weight (H = Hinds, S = Stags).

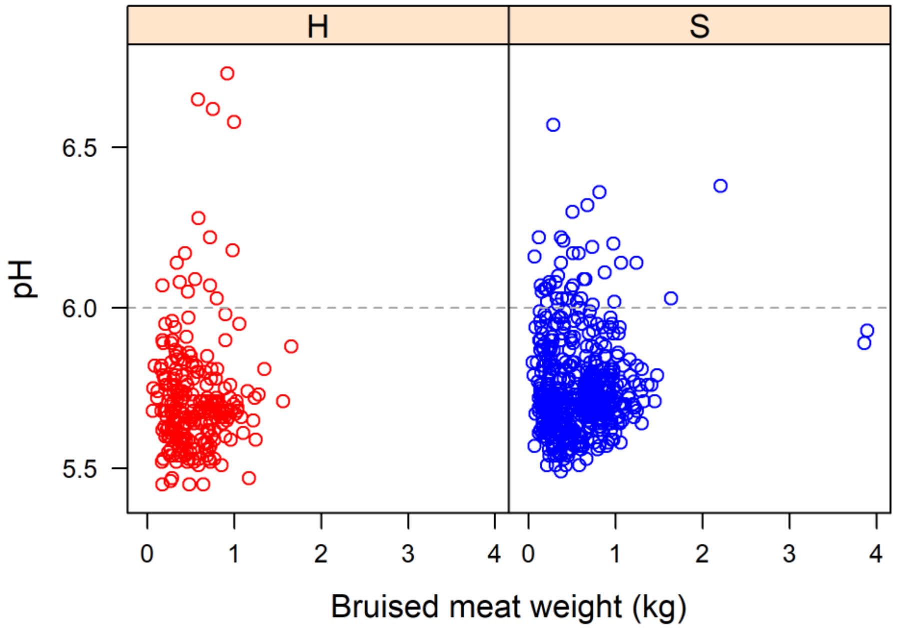


Figure 14: A plot showing pH of deep-muscle bruised meat against weight of deep-muscle bruised meat (H = Hinds, S = Stags).

6. Summary

This study considers the red deer population processed through Venison Packers Feilding from October 2018 to June 2019. The mean incidence of DMB was 4.2%. The overall mean loss of product per DMB carcass was higher than the previous study 0.57kg vs 0.39kg.

The most striking discovery in this study is the lack of obvious risk factors; Gender, Transporter, and stun protocol all showed no obvious trends that identify them as possible causative factors. There is evidence of some variation in the incidence rate of DMB among Suppliers.

The one factor that indicated a trend was Time of Year, where when considering the number of DMB carcasses as a proportion of the daily total kill, the highest proportion of DMB occurred in the six weeks prior to Christmas 2018. This might be attributable to a farm management practice occurring at this time, and a likely candidate would be increased handling and yarding e.g., for velvet antler removal, particularly on rising yearling males immediately prior to slaughter.

A higher than expected proportion of DMB meat presented with elevated pH (i.e., 7.5% with pH ≥6.00 and 14.3% with pH ≥5.90, vs 0.2 and 0.4% respectively in the Deer Progeny Test dataset). The DMB sample pH was measured in a leg muscle not the loin, which might change pH slightly. Elevated pH is associated with pre-slaughter stress; however, it is not clear whether the pre-slaughter stress is a resulted from the DMB or was a causative factor of the DMB.

We now have Supplier, Transporter and mob size for the 269 concurrent mobs that had no DMB. This additional data provides the true incidence of DMB, and helps to identify, suppliers, and their farm management practices that may contribute to the incidence of DMB. We recommend discussing with the transporters and their drivers whether they have any observations on differences between suppliers with no incidence of DMB and those with an incidence. There should also be focus on the October to Christmas period to try and understand the farm management practices that occur at that period that may increase the proportion of DMB in mobs with DMB (i.e. stressed because they were bruised, or bruised as a result of being stressed).

Although a lot of metadata were collected in this study on the DMB carcasses, there is no data individual animal data from the kill summary (Gender, GR, Age, Grade, Carcass weight) on animals processed that had zero incidence of DMB – this includes animals with no DMB in all 518 mobs. Without this data, these risk factors cannot be compared for animals with DMB compared to those without DMB.

There may be other causative factor that could be investigated using DNA genotyping, such as breed-type or relatedness of the animals presenting with DMB, but this would face the same limitations as other data in this study being that no non-DMB carcasses were DNA tissue sampled. This however should be a final avenue of investigation and most likely only used to corroborate observational data from transporters or suppliers.

7. Recommendations

- Approach transporters and their truck drivers to try and identify common management, yard or other differences between suppliers with zero incidence of DMB and those with DMB.
- Further investigations could also be undertaken with a subset of suppliers who have DMB incidence and zero incidence on a case study basis to either corroborate transporter observations or investigate farm system differences if nothing is apparent by general supplier observation.
- Further investigations of individual animal data from the kill summary (Gender, GR, Age, Grade, Carcass weight) on animals processed that had zero incidence of DMB. These risk factors could then be compared for animals with DMB compared to those without DMB.
- Consult DeerPRO Manager to see if they have any supporting data.
- Socialise findings with interested parties (e.g., Venison Processors Technical Committee, Venison Marketers Group, DINZ Venison Marketing Manager, QA Manager, Producer Manager and DeerPRO Manager) to help determine what the next steps (if any) should be taken.

8. Acknowledgements

Thanks to Simon Wishnowski and all the team at Venison Packers Feilding, for their contribution to collecting the DMB meat, making space available to collect measurements, all their patience and perseverance.

9. References

Craigie C., Ward J., Somerton J., Hicks T. 2018. Venison Bruising Report: Preliminary Investigation. Confidential Report to DEEResearch FBP 78503, May 2018