



Minor animal categories

Greenhouse Gas Inventory Research Fund – Final Report

MPI Technical Paper No: 2024/31

Prepared for Ministry for Primary Industries
by Jude Sise (AbacusBio), with support from Garrick Batten (Caprinex Ltd)

ISBN No: 978-1-991330-59-8 (online)
ISSN No: 2253-3923 (online)

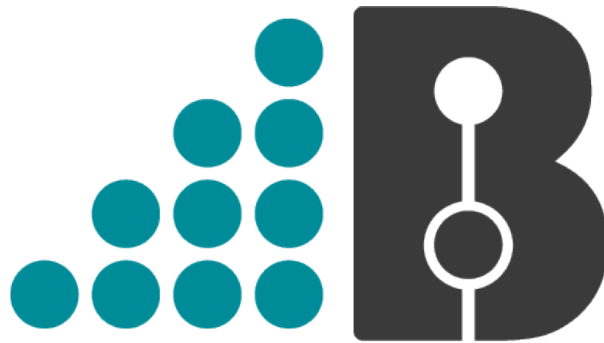
December 2023

Disclaimer

While every effort has been made to ensure the information in this publication is accurate, the Ministry for Primary Industries does not accept any responsibility or liability for error of fact, omission, interpretation or opinion that may be present, nor for the consequences of any decisions based on this information.

This publication is also available on the Ministry for Primary Industries website at <http://www.mpi.govt.nz/news-and-resources/publications/>

© Crown Copyright - Ministry for Primary Industries



Minor animal categories:
M7 Final report
(MPI contract 406944)

Prepared For:

MPI

By:

Jude Sise, with support from Garrick Batten (Caprinex Ltd)

12/12/2023

DISCLAIMER

Every effort has been made to ensure the accuracy of the investigations, and the content and information within this document. However, AbacusBio Limited expressly disclaims any and all liabilities contingent or otherwise that may arise from the use of the information or recommendations of this report.

AbacusBio Limited
PO Box 5585
Dunedin
New Zealand

Phone: +64 (03) 477 6375

Email: jsise@abacusbio.co.nz

Website: www.abacusbio.com

Executive summary

The purpose of this project was to take a comprehensive review of stock estimates and assumptions applied to the minor animal categories within the New Zealand national Greenhouse Gas (GHG) inventory methodology, with key activities, findings and recommendations summarised below:

Part I: Review of the Minor animal categories

A range of data sources have been accessed and evaluated to assess estimated stock numbers for each the minor animal classes, with a brief commentary on each below.

Goats: There are significant anomalies in the official data for goats with approximately 50% more goats reported as slaughtered than present on farm at year end. Further research has therefore been undertaken to understand the underlying population structure of the goat industry, with a summary of results provided in the following section.

Horses: Stock estimates used for horses include a mix of farm, race, show, and pet horses, and with only limited data available, we have been unable to determine the accuracy of reported stock estimates.

Mules and asses: Currently there are no official records for the numbers of mules and asses within New Zealand, with the NZ GHG inventory assuming a constant population of 141 donkeys over time. However, industry estimates suggest that donkey numbers are considerably higher, with recommendations that donkey numbers be increased from 141 to 1500, followed by a follow up review in 5 years (2028).

Poultry: No significant anomalies were identified within the poultry analysis for broiler and layer chickens, however minor differences were identified in the stock estimates reported within the Regional Authority data set (relative to the Statistics NZ dataset). We therefore recommend that consideration be given to transitioning to use of the Regional Authority data enabling separation of the broiler and hen stock classes within the National GHG methodology.

Other poultry: Because ostriches and emus are considerably larger than other stock (ducks and turkeys) included within the “other poultry” class, consideration was also given to separation of ostriches and emus into their own minor animal category group. However, with ostriches and emus accounting for less than 1% of stock within the “other poultry” stock class, inclusion of an additional poultry sub-class is likely to have little impact on GHG outcomes. We therefore recommend consideration of a more detailed tracking system for monitoring ostrich and emu numbs, followed by a follow up review in 5 years.

Alpacas and llamas: Infoshare data for alpacas and llamas is sparse, with limited stock number records available for the 2007-2021 period and no slaughter data available. However, industry estimates of alpaca numbers are considerably higher than reported, with estimates of up to 40 thousand alpacas compared to the 7-8 thousand reported by

Infoshare over the last two years. We therefore recommend that MPI consider implementation of a 'conservative' industry model to estimate historical changes in stock numbers, and to work with both the NZ Alpaca and Llama Associations to improve the accuracy of their registries, with data then made available for use within the National Inventory model.

Part II: Goat population model

Development of a multiyear population model has enabled a close evaluation of reported stock estimates for the dairy, meat, and fibre goat industries over time.

- Data provided by the New Zealand Dairy Goat Co-Operative has been used to develop a detailed model of the dairy sector including estimated changes in stock numbers on hand at year end within each age class and sex over time. Whilst modelled versus reported stock numbers for the dairy goat industry (since 2015) are well aligned, failure to ascertain accurate data around the number of dairy goats farmed by non-DGC suppliers provides a level of uncertainty around total numbers of dairy goats farmed.
- Similar models were also developed to represent the meat and fibre goat sectors, with a 'subtraction model' then used to account for difference between reported and estimated numbers of stock reported and slaughtered. These models showed that whilst there are only very small numbers of meat and fibre goats, feral goat numbers are likely very large, with provisional estimates suggesting they are likely to account for over 80% of total goats in New Zealand. The transitional nature of feral goats being used for pasture management has also created anomalies within the national inventory methodologies, with feral goats expected to account for 50-60% of total goats slaughtered, but less than 20% of total goats on farm at year end.
- With considerable uncertainty over the exact composition of the national herd, a series of recommendation have been developed to enable solidification of the model and potential transition to a Tier 2 reporting methodology.
 - Accessioning and in-depth analysis of changes in both dairy goat production data and slaughter data (for young kids), with a view to solidifying estimates of the proportion of milking goats relative to total goats reported.
 - Engagement of the NZ Dairy goat breed Society to further understand both the geographic locations and likely inclusion as a NZDGC provider.
 - Assessment of the impact of including kids (aged 0-1 years) within the year-end stock estimates with kids currently excluded from the national inventory methodology.
 - Targeted survey of sheep and beef farmers to gain a more in-depth understanding of the use of feral goats for pasture management, enabling decisions around inclusion of these stock within the inventory methodology.

Contents

.....	1
EXECUTIVE SUMMARY.....	1
INTRODUCTION.....	6
PART 1: REVIEW OF STOCK ESTIMATES FOR GOATS, HORSES, DONKEYS, POULTRY, OSTRICHES & EMUS, AND ALPACAS	6
Data sources	6
AgriBase data.....	7
Current stock estimates	9
Goats.....	9
Horses.....	15
Mules and asses	20
Poultry.....	23
Ostriches and emus.....	26
Alpacas and llamas.....	30
PART II: DEVELOPMENT OF AN ADVANCED POPULATION MODEL FOR GOATS	40
Overview	40
Dairy goat module	41
Does (NZDGC model)	41
Bucks (NZDGC model)	45
Total dairy goat stock estimates.....	48
Dairy goat Slaughter.....	50
Meat module	51
Meat goat slaughter.....	53
Fibre module	54
Fibre goat slaughter	57
Subtraction model	57
Pastoral goat estimates	57
Feral goat estimates.....	59
Discussion.....	62
Dairy goat model parameters.....	64
Exclusion of kids from the national inventory:.....	64
Impact of feral goats in pasture management	65
Discussion / Recommendations	65
ACKNOWLEDGMENTS.....	66

APPENDIX 1: BACKGROUND INFORMATION AND REFERENCES	67
BACKGROUND	67
FERAL GOATS	69
THE 1980s FARMED GOATS	71
DAIRY GOATS	72
ANGORA GOATS	72
CASHGORA GOATS	73
CASHMERE GOATS	73
PASTORAL GOATS	73
THE EARLY 1990s FARMED GOATS	73
FERAL GOATS (now)	74
GOAT INDUSTRY REFERENCES	76
APPENDIX 2: MEAT AND FIBRE GOAT POPULATION ESTIMATES	79
.....	1
EXECUTIVE SUMMARY	1
INTRODUCTION	6
PART 1: REVIEW OF STOCK ESTIMATES FOR GOATS, HORSES, DONKEYS, POULTRY, OSTRICHES & EMUS, AND ALPACAS	6
Data sources	6
AgriBase data	7
Current stock estimates	9
Goats	9
Horses	15
Mules and asses	20
Poultry	23
Ostriches and emus	26
Alpacas and llamas	30
PART II: DEVELOPMENT OF AN ADVANCED POPULATION MODEL FOR GOATS	40
Overview	40
Dairy goat module	41
Does (NZDGC model)	41
Bucks (NZDGC model)	45
Total dairy goat stock estimates	48
Dairy goat Slaughter	50
Meat module	51
Meat goat slaughter	53

Fibre module	54
Fibre goat slaughter	57
Subtraction model	57
Pastoral goat estimates	57
Feral goat estimates.....	59
Discussion.....	62
Dairy goat model parameters.....	64
Exclusion of kids from the national inventory:	64
Impact of feral goats in pasture management	65
Discussion / Recommendations	65
 ACKNOWLEDGMENTS.....	 66
 APPENDIX 1: BACKGROUND INFORMATION AND REFERENCES.....	 67
BACKGROUND	67
FERAL GOATS.....	69
THE 1980s FARMED GOATS.....	71
DAIRY GOATS	72
ANGORA GOATS	72
CASHGORA GOATS	73
CASHMERE GOATS	73
PASTORAL GOATS.....	73
THE EARLY 1990s FARMED GOATS.....	73
 FERAL GOATS (now).....	 74
 GOAT INDUSTRY REFERENCES.....	 76
 APPENDIX 2: MEAT AND FIBRE GOAT POPULATION ESTIMATES.....	 79

Introduction

The NZGHG inventory currently uses Tier 1 methodology for the minor animal categories (goats, horses, mules & asses, swine, poultry, and alpacas), with a combination of country specific and IPCC default emission factors applied to estimate emissions based on annual stock estimates. Shifting to a Tier 2 methodology would require inclusion of additional data, including making allowance for changes in animal type (meat versus dairy), farming practices (including manure management protocols), and other factors such as average live weight, reproduction, survival, and carcase data across each of the different stock types.

In 2018, MPI commissioned AbacusBio to develop ‘multi-year’ population models for the sheep, cattle, and deer industries, and that then lead to the ‘2020 lifestyle block analysis project’ which was focussed on gaining a greater understanding of the numbers of sheep, cattle and deer that may exist outside of the APS sampling frame, and their subsequent impact on GHG emission estimates.

A key finding from both projects, is that there was a need to take a longitudinal view on stock number estimates, and that differences in slaughter rates in one year have a flow-on effect to stock numbers in subsequent years. This was identified as particularly pertinent for goats, where over the last 10 years, number of goats slaughtered are on average 50% higher than number of goats reported as present on farm at year end.

A range of anomalies were also identified within some of the other minor animal category stock classes, with the purpose of this project being to:

- **Part 1:** Undertake a review of the stock estimates and methodologies being used for the minor animal categories within the National GHG inventory model (including goats, horses, poultry, alpacas, and llamas) and develop recommendations for enhancements if needed.
- **Part 2:** Develop a multi-year population model for goats, accounting for changes in goat numbers in the dairy, meat, and fibre goat industries, enabling recommendations around improvements to the annual estimates of goats used within the National GHG inventory model.

Part 1: Review of stock estimates for goats, horses, donkeys, poultry, ostriches & emus, and alpacas

Data sources

A range of data sources have been accessed and evaluated for use within this review. The major data sources are listed below, and with no one ‘definitive’ data source for any of the species evaluated, combinations and subsets of data used to provide commentary on stock estimates. It is almost important to note that there is very little historical data available, where for most of the categories evaluated, the Statistics NZ data is the only readily available data source for stock estimates prior to 2017.

1. Annual estimates
 - a. Stock and carcase weight (CWT) estimates downloaded from the Statistics NZ Infoshare website¹
 - b. Regional and Territorial Authority data for the 2017-2022 period (as supplied by MPI for use in this project)
2. Supporting data sources
 - a. Animal numbers contained within the AgriBase database, with stock estimates classified according to farm type, area, region, and date of reporting, with further commentary provided below.
 - b. Rural decisions Maker's (RDM) survey data², as supplied by Manaaki Whenua for the use in the 2021 Lifestyle block analysis project³.
 - c. Additional information provided from Industry stakeholders including the New Zealand Goat Co-operative, and historical goat data accessed from the Ministry of Agriculture and Fisheries (MAF), the Meat and Wool Board, and early (unpublished) census data.

AgriBase data

A snapshot of data within the AgriBase database was accessed by MPI for use in this project. This data download (generated on the 17th of May) contains information linked to 146,670 farm properties. Input data is provided on a voluntary basis, and typically collected/updated when either a new user is added, or information is collected for other purposes (such as emergency service access). Stock estimates are therefore only updated on an ad-hoc basis, and whilst it contains an incredible valuable resource for understanding farm activity over time, stock numbers cannot be used to directly infer stock numbers at any given point of time.

Because the data is not updated on a regular basis, this also creates apparent anomalies in the pattern of data added.

- Figure 1 shows a summary of stock estimates grouped according to year of entry for stock classes included in the minor animal categories review. This shows distinct periods of activity, with large numbers of goats and horses added to the database in 2008, and again in the 2014, 2019-2022 periods.
- Figure 2 shows the number of records added by region, with no discernible pattern in regional activity, and the 2014 and (to a lesser extent) 2020 peaks clearly reflected in the farm activity data.

Whilst the AgriBase data cannot be used as an absolute point of reference it has provided valuable insight into the population estimates detailed within this report, with further information provided within the individual minor animal category sections below.

¹ <https://infoshare.stats.govt.nz/>

² <https://www.landcareresearch.co.nz/discover-our-research/environment/sustainable-society-and-policy/survey-of-rural-decision-makers/>

³ MPI contract 406437 project report: Lifestyle block analysis

Figure 1. Stock numbers for 146,670 farms included within the AgriBase data, grouped according to year of reporting.

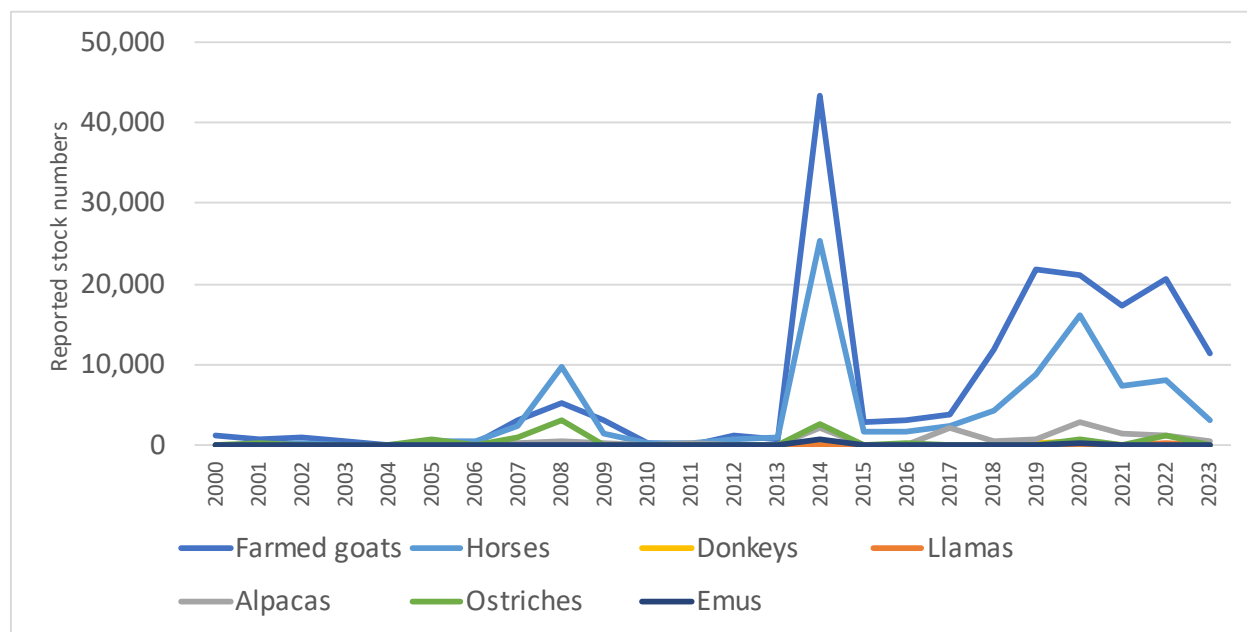
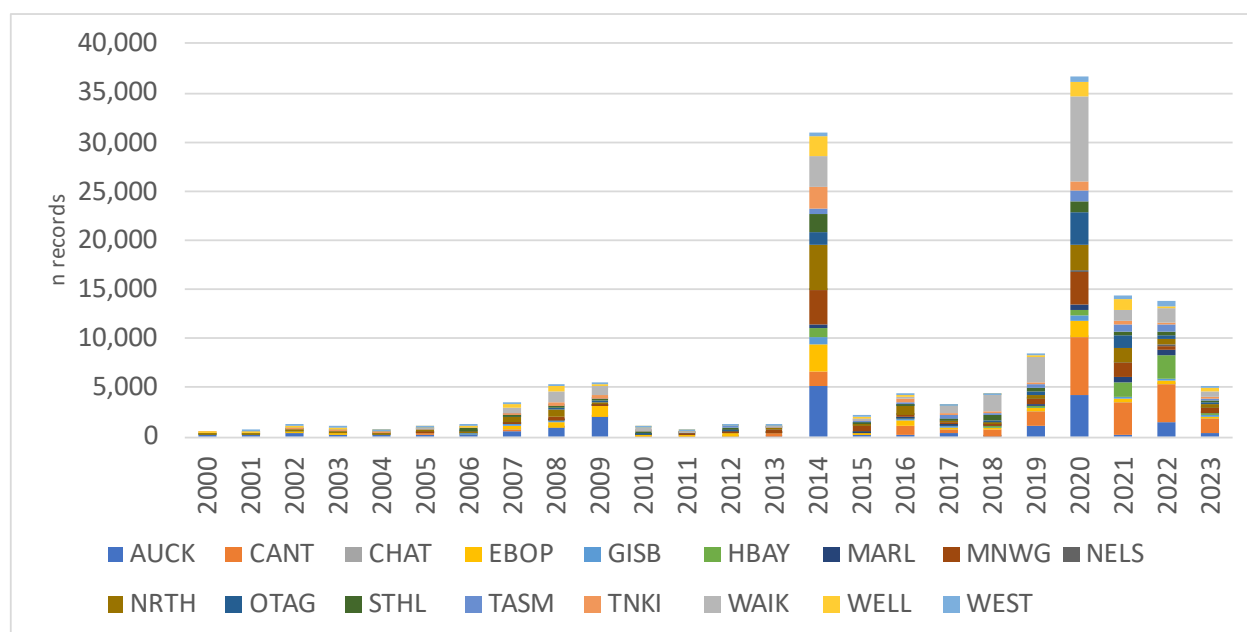


Figure 2. Number of records added/modified grouped according to record date and region.



Current stock estimates

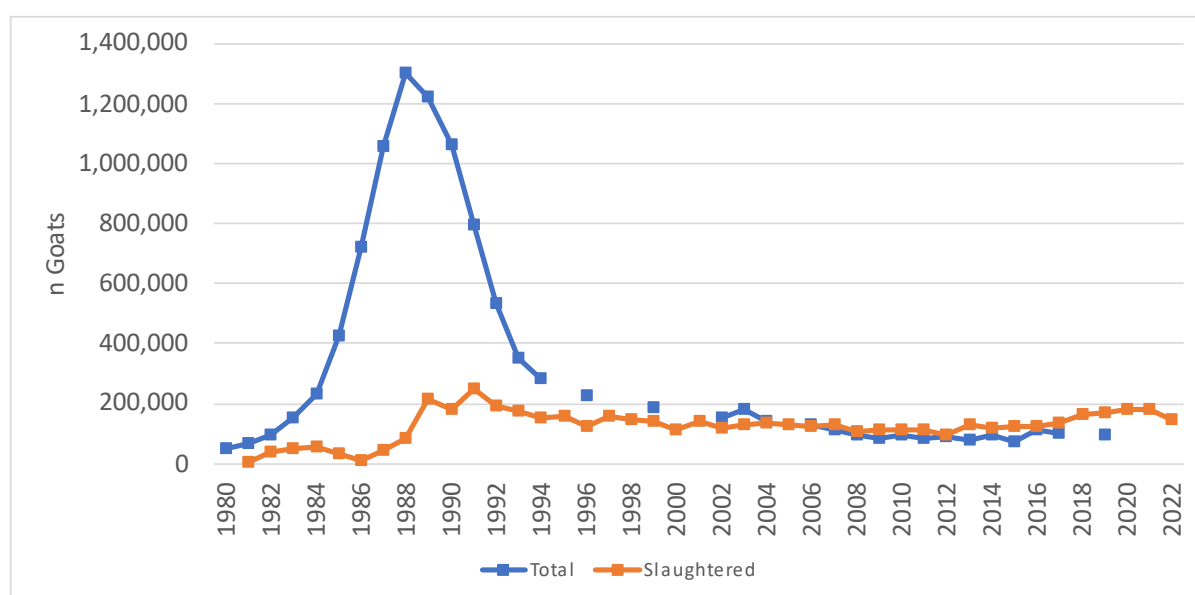
Goats

Annual estimates

Figure 3 shows Infoshare data for the number of goats reported as present on farm and slaughtered between 1980 and 2022, with these figures used as the basis for estimating greenhouse gas emissions throughout this period. The major expansion in goat numbers throughout the 1980s was driven by an explosion of farmed goat numbers reflecting strong fibre markets for mohair, cashmere and cashgora. At this point in time, farmers were also seeking diversification from less than satisfactory returns from other livestock following the dismantling of pastoral farming subsidies from 1984, with feral goats playing a major part within the expansion⁴.

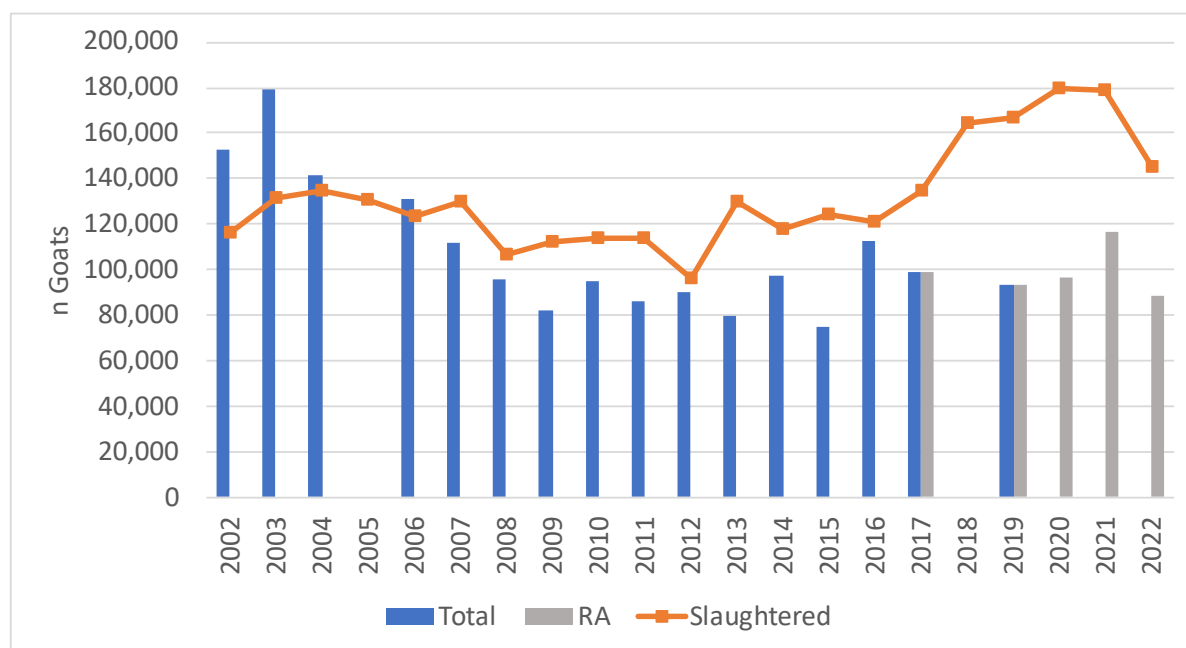
Whilst herd numbers built through the 1980's, numbers then dropped, where by 2002, the population had achieved a relatively steady state of around 100,000 goats on hand. Figure 4 shows a more detailed breakdown of the Infoshare combined with the Regional Authority data for this period, with the Regional Authority data providing additional data points through the 2020-22 period, and numbers of goats slaughtered consistently higher than those reported as present on farm.

Figure 3. Infoshare data for the number of goats reported as present on farm and slaughtered between 1980 and 2022.



⁴Garrick Batten, personal communication.

Figure 4. Infoshare combined with Regional Authority data for the number of goats reported as present on farm and slaughtered between 2002 and 2022.



Industry types

From an industry perspective, a policy paper prepared by MPI in October 2019⁵ suggested that 3 subcategories could be used to increase the accuracy of emission estimates for goats, with a breakdown of stock estimates by goat breed shown in Figure 5. These suggested changes were based on assumptions made by Burggraaf et.al 2019⁶, who suggested that dairy goats accounted for 3% of the total goat population in 2019, increasing to 67% by 2017, with the remaining goat population split equally between meat and fibre goats. However, in the absence of the accurate population data, these changes have not yet been implemented, with a key objective of this project being the review of additional data sources, and development of a multi-year goat population model for consideration.

⁵ <https://www.mpi.govt.nz/dmsdocument/40184/direct>

⁶ Burggraaf, V., Rollo, M., de Klein, C., Luo, J. 2019. (unpublished) A review of greenhouse gas emissions inventory methodology for farmed goats in New Zealand.

Figure 5. Extract from the 2019 MPI policy paper (Revisions to the national Inventory for goats).

Table 1: Comparison of current and proposed goat populations, split by industry

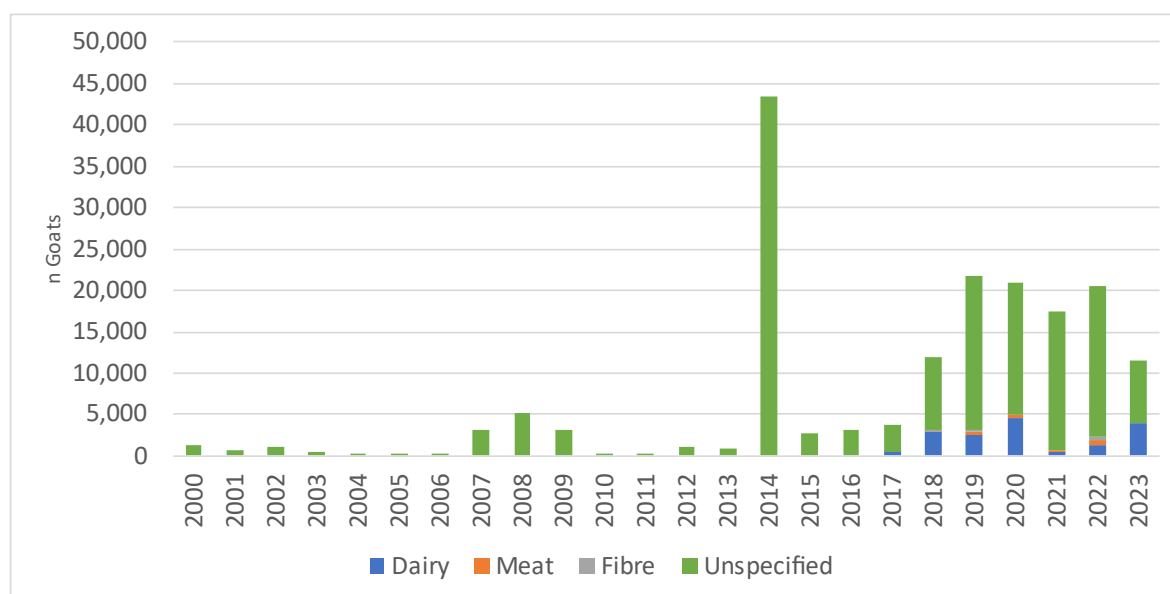
Year	Current inventory	Proposed goat population split by industry			Total goat population
	Dairy goats	Dairy goats	Fibre goats	Meat goats	
1990	37,426	31,887	515,507	515,507	1,062,900
2005	30,738	52,482	41,819	41,819	136,120
2017	25,387	67,721	16,678	16,678	101,076
Percentage change 1990-2017	-32%	112%	-97%	-97%	-90%

AgriBase stock numbers

AgriBase have 5,396 property records with one or more goats. Figure 6 shows the distribution of goat records by sub-class and reporting year with a total of 114,000 goat records added to the AgriBase dataset between 2015 and 2023. This is consistent with the Regional Authority data (117,000 in 2022), and the 102,000 estimated using the AgriBase data assuming that numbers reported in 2014 were correct, and that losses averaged at 10% per year (Figure 7).

- It is however important to note that whilst the average goat lifespan is estimated at 8-12 years⁷, this varies by industry, with the average lifespan for dairy goats estimated at 6 and 8 years for does and bucks respectively⁸, and up to 14 years for goats on lifestyle blocks.

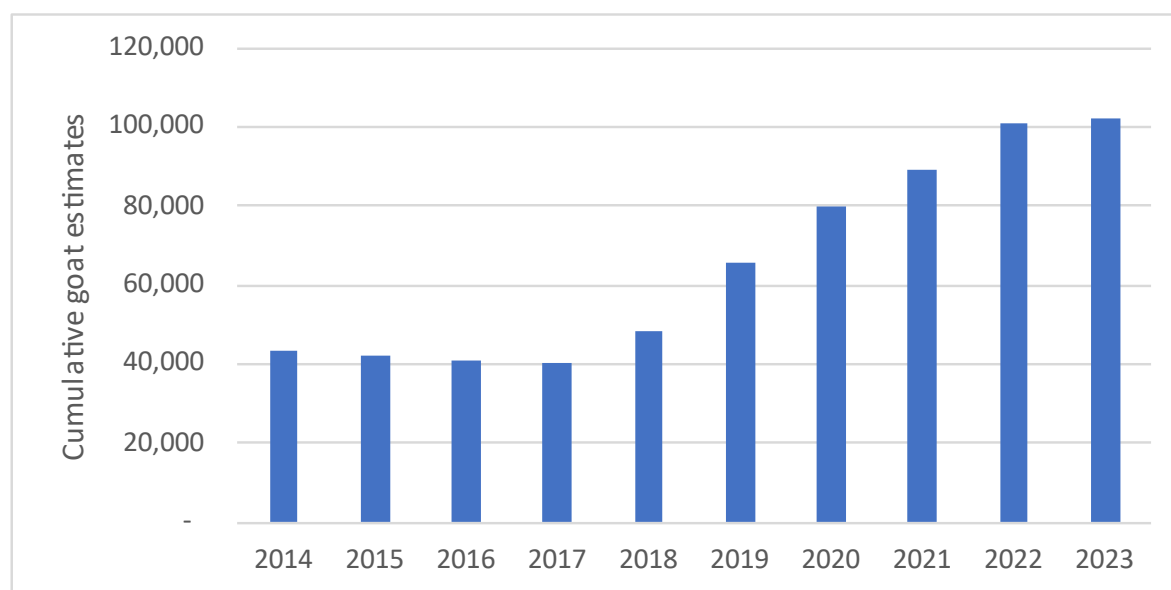
Figure 6. AgriBase data, for 5,396 properties registered as having one or more goats, with total goat numbers aggregated according to year of reporting and sub-class.



⁷ <https://savvyfarmlife.com/how-long-do-goats/>

⁸ <https://www.nzdgb.co.nz/goat-health>

Figure 7. Estimated goat numbers assuming the base number reported for 2014 was correct, with new properties registered increasing total goat numbers to 102,000 (assuming average losses of 10% per annum).



AgriBase Breed type

Of the 114,00 goats reported since 2015, 84% of goats were classified as type 'unspecified', with 14% identified as dairy goats, and just 1% for fibre and meat goats respectively (Table 1). Average numbers of goat per farm also varied, with the average herd size for dairy farms estimated at 532, compared to 157 for fibre and 66 for meat. Within the unspecified sub-class, average goat numbers were considerably lower, with these goats assumed to mainly represent the pastoral goat population, and actual numbers expected to fluctuate according to feed availability and location.

Table 1. Number of properties and total goat numbers, aggregated by goat sub-class type (2015-2022 series data).

Goat sub-class	Properties		Goat numbers		Average per farm
	n	%	n	%	
Dairy	31	1%	16,499	14%	532
Meat	23	1%	1,513	1%	66
Fibre	5	0%	783	1%	157
Unspecified	2,994	98%	95,281	84%	32
Total	3,053	100%	114,076	100%	37

Table 2 shows a breakdown of the AgriBase data by farm type, where for the 2015-2023 period, 50% of goats were recorded within AgriBase sheep and beef farm categories, and 33% within properties identified as goat farms, with an average of 255 goats/property recorded. Goats on dairy farms⁹ and lifestyle blocks accounted for another 11% of total

⁹ Note that records for dairy goats varied by farm type, with the majority of dairy goats reported associated with the sheep & beef or goat farm categories.

goats recorded with the remaining 6% spread across a range of 24 other AgriBase farm types.

Table 2. 2015-2023 AgriBase data for goats (aggregated by farm type).

Farm type (AgriBase category)	N farms		N goats		Average per farm
	n	%	n	%	
Sheep and beef (SNB, BEF and SHP)	804	26%	57,490	50%	72
Goat farming (GOA)	147	5%	37,555	33%	255
Dairy farms	236	8%	6,689	6%	28
Lifestyle block	1550	51%	5,889	5%	3.8
Other	316	10%	6,453	6%	20
Total	3,053	100%	114,076	100%	37

Rural decisions maker survey data

The 2021 RDM survey data included data for 222 respondents reporting goats, with an average of 5.9 goats per farm (Table 3). These figures are slightly higher than those calculated for the AgriBase lifestyle block data, and with only 40% of respondents being GST registered, it is possible that lifestyle blocks could account for greater than 5% of the total goat population.

Table 3. Summary of the RDM 2021 survey data for goats.

Farm type (AgriBase category)	N respondents	N goats	Average per farm	% farms GST registered
Dairy goats	46	257	5.6	32%
Angora goats	170	998	5.9	43%
Dairy and Angora goats	5	57	11.4	0%
Total	222	1312	5.9	40%

Dairy Goat Co-Operative data

Data provided by the New Zealand Dairy Goat Co-operative (NZDGC)¹⁰ show that the total number of dairy goats registered with DGC and on hand at year end has ranged from 54-69,000 between the 2015 and 2022 milking seasons (Table 4).

- These figures are in line with estimates provided by Burgraaf et.al (2019)¹¹, who estimated that in 2019 there were 66,100 milking does in NZ, with approximately 80% of the milk processed by NZDGC (52,880 milking does, versus 55,479 reported for the 2018-19 season).

With data not yet available prior to the 2015-16 season, it has not yet been possible to reconcile historical stock estimates, however the more recent data shows dairy goat numbers peaking in the 2020-21 season, with the reduction in the number of doe kids on hand at the end of that year reflecting future reductions in doe numbers.

¹⁰ <https://www.dgc.co.nz/>

¹¹ Burgraaf et.al (2019). A review of greenhouse gas emissions inventory methodology for farmed goats in New Zealand; MPI technical paper, May 2019.

Table 4. Summary of consolidated dairy goat data (provided by the NZ Dairy Goat Co-operative).

	Adult Stock on hand (30 June)					Kids				Production
Season	Milking Does	Dry does	Bucks	Total	Change	Doe kids	Buck kids	Total	Change	kg GMS /doe
2015-16	53,313	1,776	2,241	57,330		17,057	1,062	18,119		97
2016-17	-	-	-	-		-	-	-		-
2017-18	53,492	1,611	2,063	57,166		17,184	1,295	18,479		102
2018-19	55,479	2,346	1,860	59,685	4%	21,098	1,265	22,363	21%	109
2019-20	62,332	3,197	1,823	67,352	13%	25,354	1,611	26,965	21%	105
2020-21	63,909	3,717	1,818	69,444	3%	22,510	1,667	24,177	-10%	96
2021-22	55,965	4,949	1,938	62,852	-9%	16,384	1,631	18,015	-25%	86
2022-23	49,330	5,731	1,446	56,507	-10%	12,224	1,061	13,285	-26%	90

Meat and fibre goat data

Garrick Batten (Caprinex Ltd) was contracted to undertake a comprehensive review of historical industry data for the meat and fibre sectors. As part of this Garrick has developed estimates of changes in the numbers of bucks and does for both industries over time and has also invested considerable effort into understanding feral goat numbers, with commentary and references prepared by Garrick included as Appendix 1.

Figure 8 shows estimates for changes in the number of meat goats over time, with estimates for the fibre sector shown in Figure 9, and the raw data provided by Garrick tabulated in Appendix 2. Whilst there has been a dramatic reduction in the number of fibre goats over time, they still account for a significant part of the industry and with estimates of 14,300 fibre + 5,000 meat goats in 2022, these two categories account for 21% of reported stock numbers (Stats NZ) for that year.

Figure 8. Estimated changes in the number of Meat (Boer) goats over time.

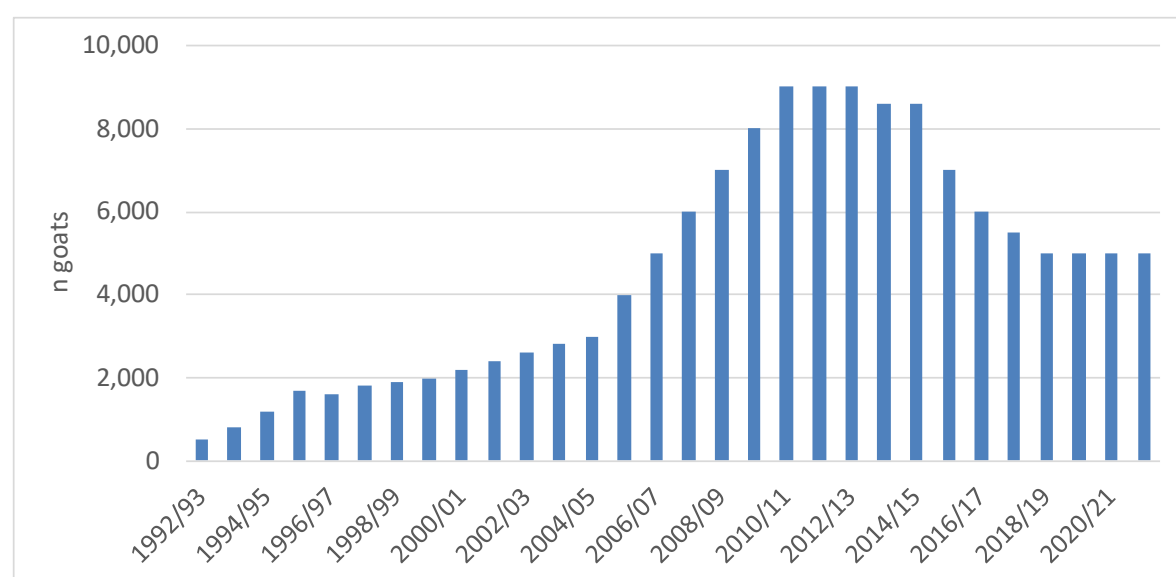
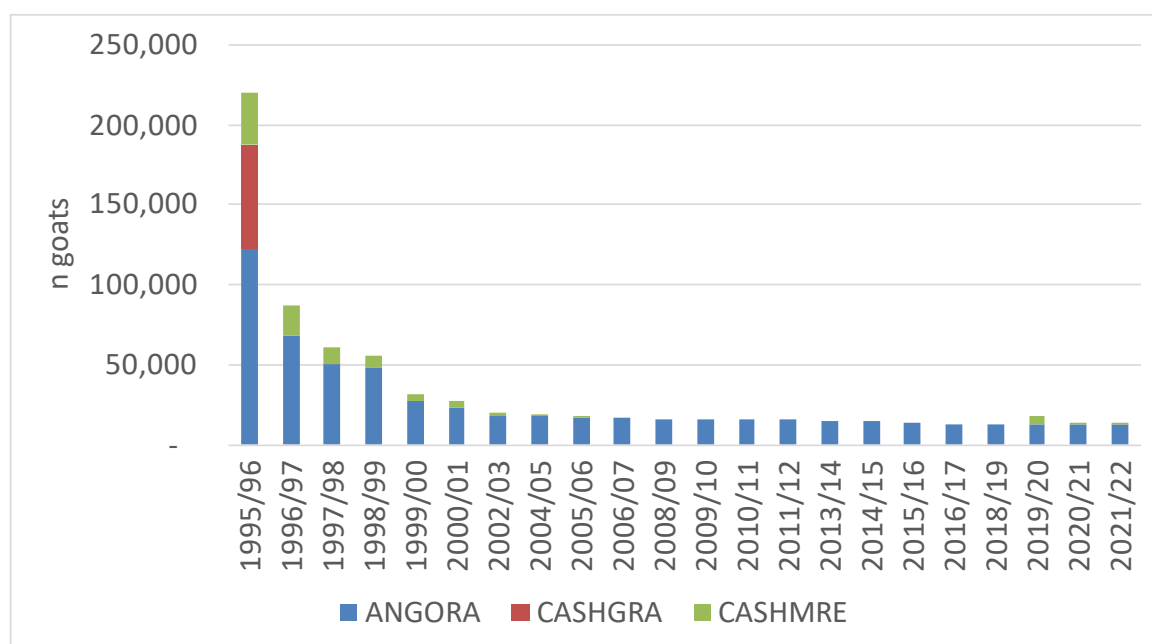


Figure 9. Estimated changes in the number of Fibre (Angora, Cashgora, Cashmere) goats over time.



Discussion

With significant inconsistencies in the Infoshare data for the number of goats reported versus slaughtered, further research has been undertaken to understand the underlying structure of the goat industry, including the impacts of feral goats within the goat slaughter statistics.

This has involved development of a multi-year goat population model, with a full description of the model itself, and recommendations included within the “Part II: Development of an advanced population model for goats” section of this report.

Horses

Annual estimates

Figure 10 shows Infoshare data for the number of horses reported as present on farm at year end (including racehorses), and the number slaughtered within that financial year. Regional Authority data for the 2017-2022 period is also shown with horse numbers dropping from 40,000 to 34,000 in 2022.

- Whilst slaughter data is present for the 1997-2001 seasons, total horse numbers were not available. Conversely total horse numbers were available for the 2017-2021 seasons, but no slaughter data was found.

The absence of data in some seasons makes it difficult to comment on the apparent reduction in total horse numbers, however, there is considerable variability in the ratio of number of horses slaughtered versus reported. This variation results in an average cull rate of 9% in the 90’s, compared to 3% in later years. These changes do not appear to be linked to slaughter of younger horses, with little difference in average CWT over time. Figure 11 shows estimates of average CWT which ranges from 252 to 272 kg (average = 264) with only

one obvious outlier (304 kg) for the 1999/2000 season. Using an average mature weight of 550 kg, this equates to an average dressing percentage of 48%.

Figure 10. Infoshare and Regional Authority data for the number of horses reported as present on farm and slaughtered between 1990 and 2021.

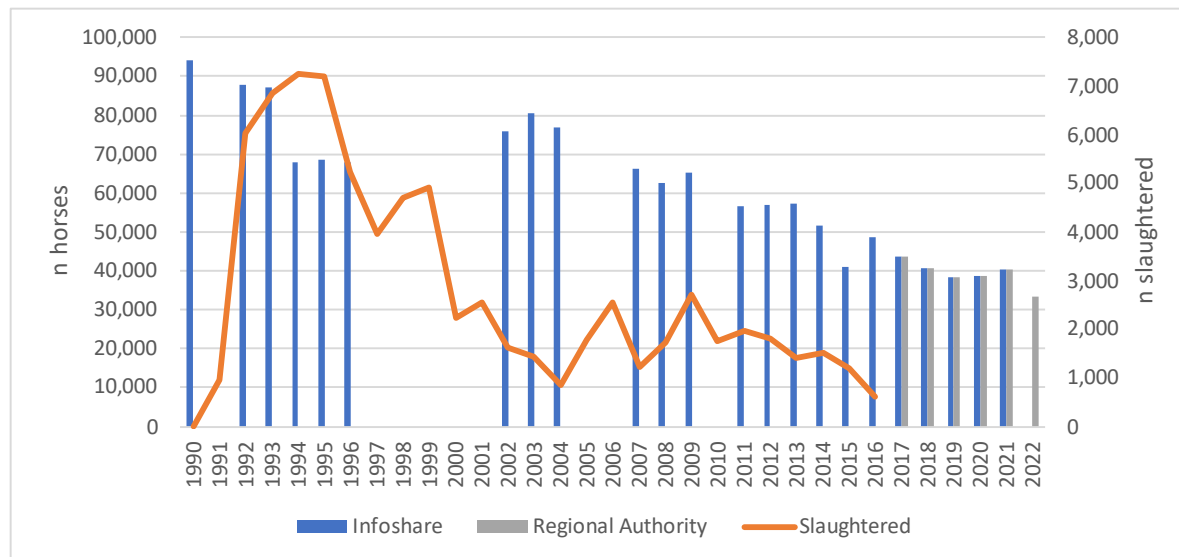
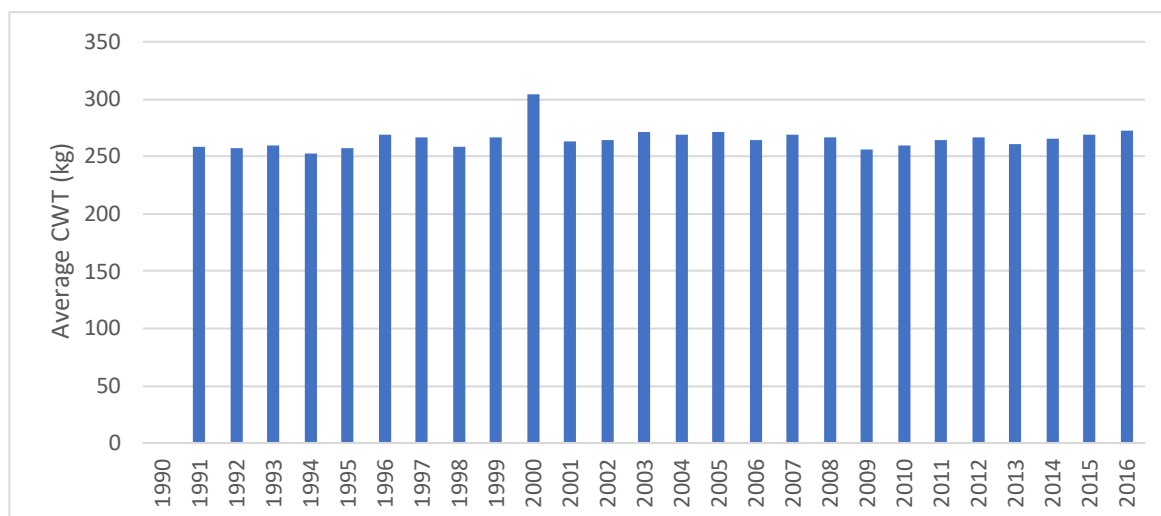


Figure 11. Average CWT of horses slaughtered.

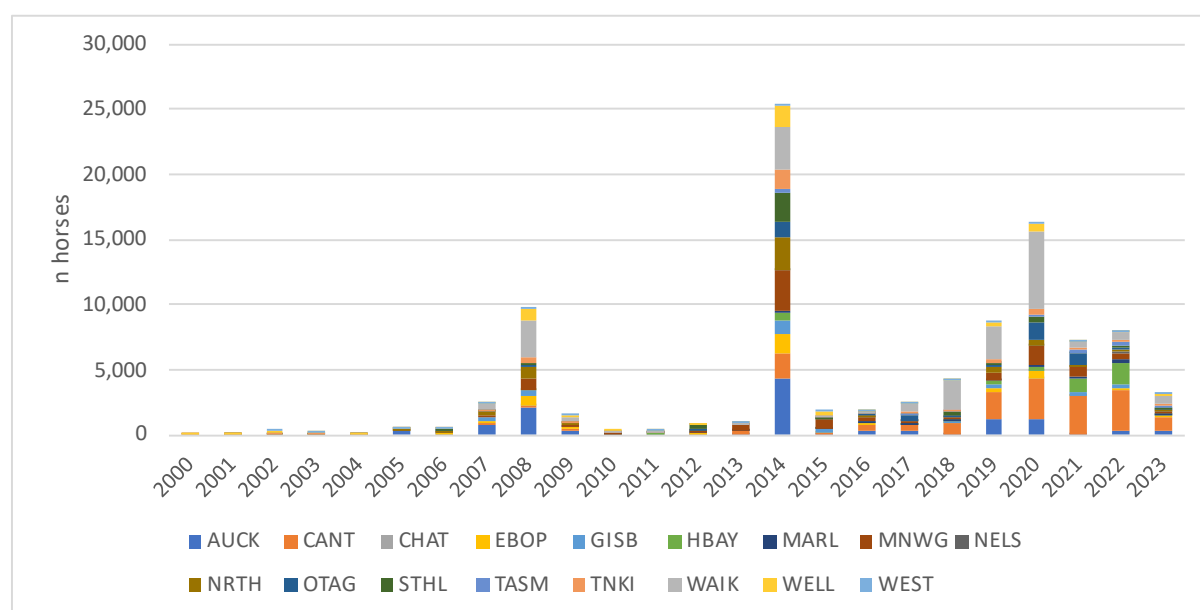


With the horse industry including a mix of farm, race, show, and pet horses, there is a need to ensure that the underlying stock estimates are representative of the relative proportions included within each of these categories. And with many show/pet horses expected to be housed on lifestyle blocks, AgriBase and the 2021 RDM survey data was used to evaluate potential differences in actual versus reported horse numbers.

AgriBase Horse numbers

AgriBase have 17453 property records with one or more horses. Figure 12 shows the distribution of horse records by regions and reporting year with a total of 99,653 horses included within the AgriBase dataset between 2000 and 2023.

Figure 12. AgriBase data, for 17,000 properties registered as having one or more horses, with total horse numbers aggregated according to year of reporting and region.



With the AgriBase data only updated when new records become available for any given property, these records cannot be used as a direct indication of total horse numbers, with no allowance made for seasonal losses (including deaths and culls). In addition, there is no guarantee that properties reporting horses in the early 2000's continue to run horses today, with the number of horses on lifestyle blocks expected to vary considerably over time.

Table 5 shows a breakdown of the AgriBase data by farm type, with horse farming/ breeding accounting for 8% of farm properties, and 28% of total horses reported at an average of 19.9 horses per farm. In comparison, lifestyle blocks account for 37% of farm properties but only 23% of horses, and at an average of 3.4 horses per farm, these numbers are expected to vary widely. Similarly, approximately half of all horses are on other property types, with the majority of these linked to sheep and beef farming enterprises (74%), 10% linked to dairy farm enterprises, and the remaining split over 41 other AgriBase farm type classifications.

Table 5. Number of properties and total horse number, aggregated by property type.

N properties	Properties		Horse numbers		Average per farm
	n	%	n	%	
Horse farming/breeding	1,352	8%	26,888	28%	19.9
Lifestyle blocks	6,491	37%	21,956	23%	3.4
Other	9,813	56%	47,809	49%	4.9
Total	17,654	100%	96,653	100%	5.5

With horse farming and breeding likely to be the least variable of the 3 different horse datasets, further analysis of this subset of data shows that there is considerable variation in the number of horses registered within AgriBase over time (Figure 13). With collection of

data often linked to external events, some variability is expected, however, no explanation has been found for the very large peak seen in 2014. The regional distribution is dominated by Auckland and Waikato, although a wide geographic spread is evident (Figure 14).

Figure 13. Total AgriBase horse numbers for properties identified as “horse farming and breeding.”

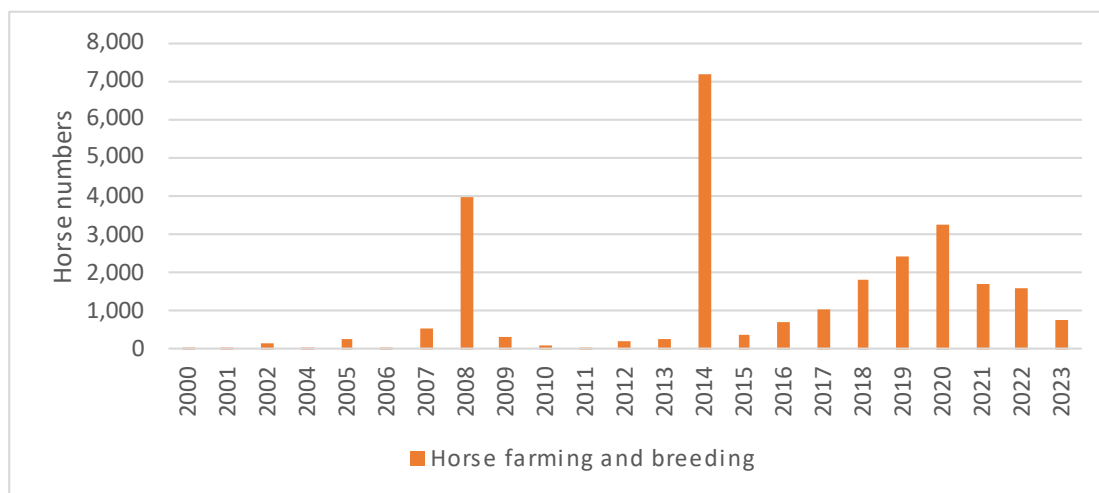
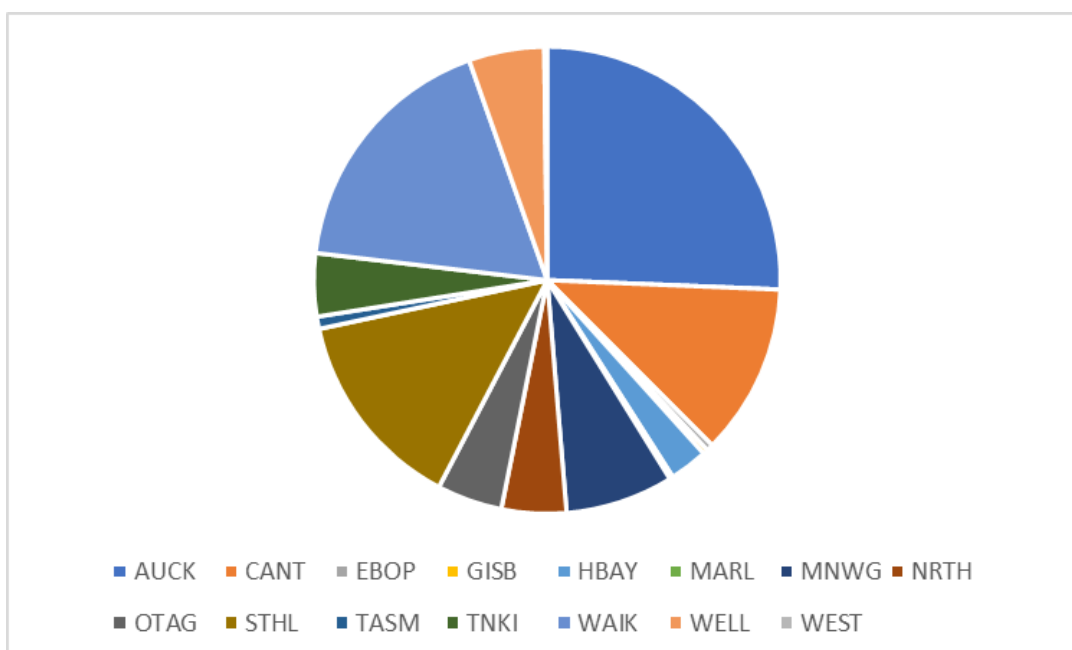


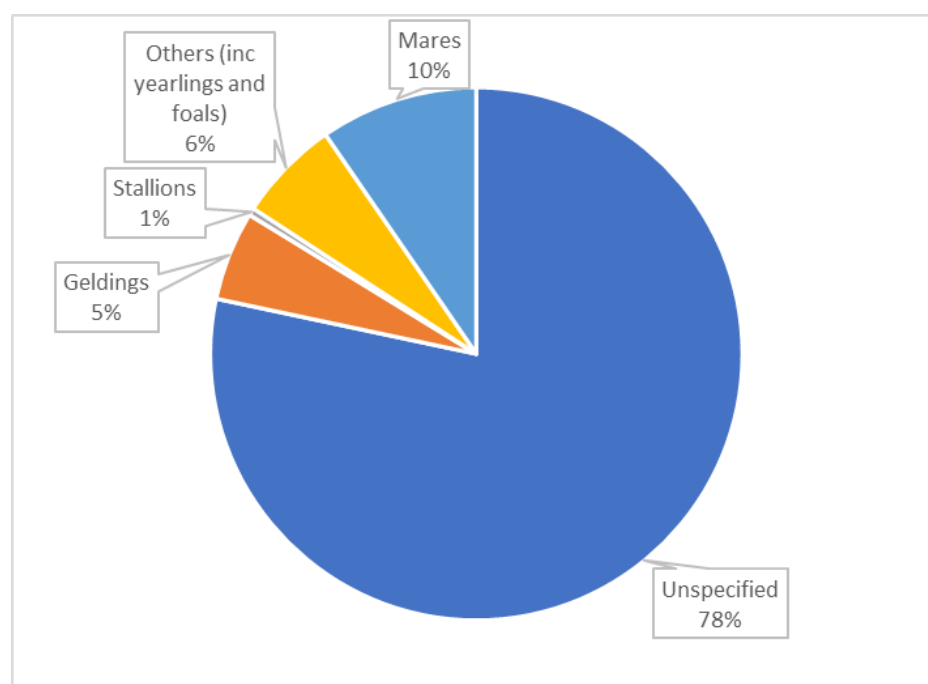
Figure 14. Regional distribution of AgriBase horse data for 2014.



AgriBase Stock classes

In addition to total horse numbers, AgriBase also contains records for stock numbers by class. Figure 15 shows a summary of the estimated proportions of stock within each class, with 78% of animals included within the “unspecified type” category, and insufficient information to attempt to gain a more accurate understanding of the underlying population structure (stock class and age) of the industry.

Figure 15. AgriBase stock class estimates¹².



Rural decisions makers survey

The 2021 RDM survey data included data for 691 respondents reporting horses, with an average of 3.3 horses per farm. These figures are consistent with the 3.4 reported for lifestyle blocks within the AgriBase data (Table 5 above), and with the RDM data showing that only half of the lifestyle blocks being registered, it is possible that the numbers of horses on lifestyle block are higher than reported.

Discussion / Recommendations

With large amounts of missing data, it has not been possible to obtain an accurate estimate of changes in horse numbers over time.

If culling data for the 2017-2021 seasons were to be made available, it may be possible to confirm the expected cull rates of approximately 3% (over all horse types) and evaluate the literature for expected survival of race, working and pet horses, and creation of a model to estimate changes in horse number over time. However, this would be speculative only and not suitable for implementation within the inventory.

Alternatively, the rural decision makers data could be used to estimate the potential number of horses on non-GST registered farms. Table 6 shows an example of this where only 50% of horses in the AgriBase lifestyle block category are assumed to be registered, resulting in a 13% increase in total horse numbers per year. Whilst these projections are likely to reflect reality, in the absence of solid data, there is insufficient evidence to justify recommendations for implementation.

¹² Note that no animals were included in the "Horses – mares" category, with the number of mares calculated as total horses minus the sum of all other categories.

Table 6. Draft estimates of revised horse numbers based on 50% reporting of the lifestyle block relative to other farm types.

		2017	2018	2019	2020	2021	2022
Reported							
Reported horse numbers		43,684	40,525	38,445	38,647	40,276	33,531
Estimated (50% lifestyle blocks GST registered)							
AgriBase Farm Type	GST	2017	2018	2019	2020	2021	2022
Horse farming & breeding (28%)	100%	19,112	17,730	16,820	16,908	17,621	14,670
Lifestyle blocks (23%)	50%	15,699	14,564	13,816	13,889	14,474	12,050
Other (49%)	100%	24,187	22,438	21,286	21,398	22,300	18,565
GST adjusted estimates		49,360	45,791	43,441	43,669	45,510	37,888

We therefore recommend:

1. Further information be sourced from AgriBase including working with them to further understand the unexpected peak observed for 2014, and any additional information they may have on the rate of database updates, and external events impacting on data collection.
2. That MPI seek to work directly with the racing and show horse industry, to gain a better understanding of the underlying population dynamics, including expected lifespans of horses within the race, show, and pet horse categories.
3. That in the interim, no changes are made to account for non-GST registered stock within the annual Inventory model, with a recommendation for a follow up review to be undertaken in 5 years (2028).

Mules and asses

Currently there are no official records for the numbers of mules and asses within New Zealand, which are not farmed commercially or used as working animals in New Zealand, and the NZ GHG inventory assuming a constant population of 141 donkeys over time.

Industry feedback

Anecdotal, data provided Ann Heffernan of the NZ donkey and mule association (<https://www.donkey-mule.org.nz/>) suggest stock numbers may be higher than estimates used within the inventory, with general comments provided by Ann paraphrased below.

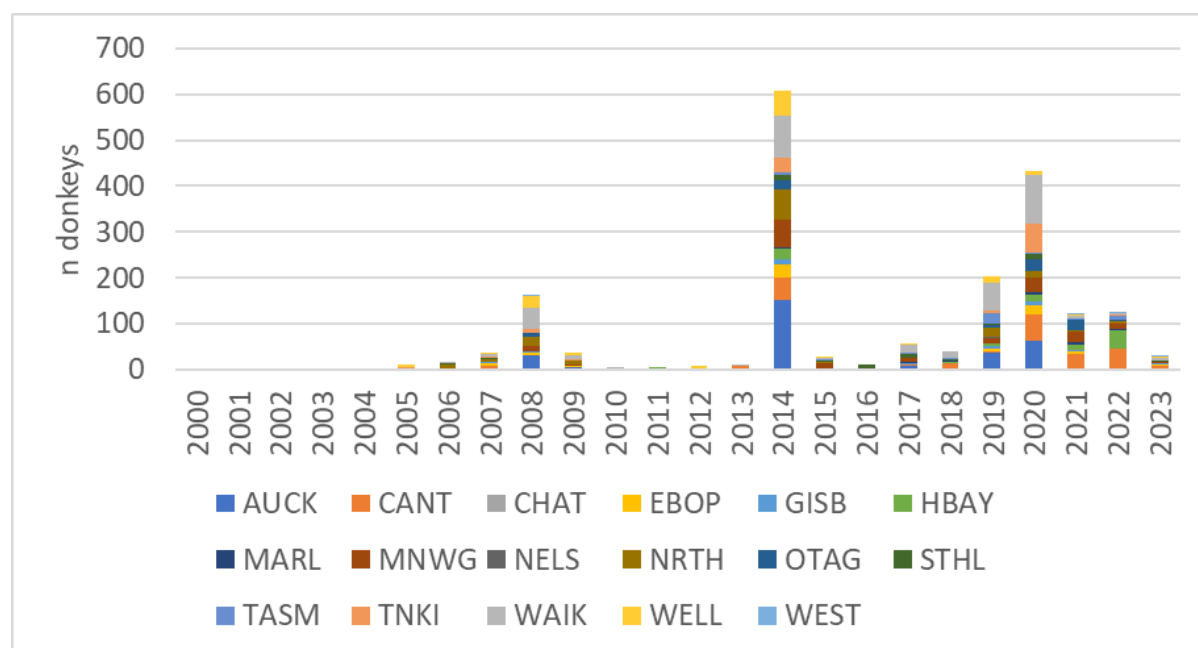
- “Donkeys: For the AMMD (miniature donkeys) I got a figure of 296. For the rest of the breeds including crossbreeds so that covers English/Irish, the Mammoths, the Australian Teamsters and even some Ponui Island(feral) donkeys that are known to have come off the island I have got a figure of 1257. So that figure tallies to 1553”
- “Mules – I got a number of 35 from the registry. At the moment their numbers are increasing slowly because there is a fad of people wanting mules.”

General comments: “Donkeys can live for up to 30 years, but numbers are going down. Many donkeys not registered (due to cost of micro-shipping) but increasing pressure to do so by vets. Registries are also being upgraded, so I am expecting the quality of data to improve.”

AgriBase data

Figure 16 shows a summary of the AgriBase data for donkeys, grouped according to year and region, with a total of 1950 donkeys recorded on AgriBase at present, which is in alignment with total stock estimates provided by Ann. Of the 1950 donkeys recorded, 44% of them are recorded as being present within the lifestyle block categories versus 34% on sheep, beef or sheep& beef farms, and the remained distributed over a range of farm types.

Figure 16. AgriBase data, for 852 properties registered as having one or more donkeys, with total donkey numbers aggregated according to year of reporting and region.

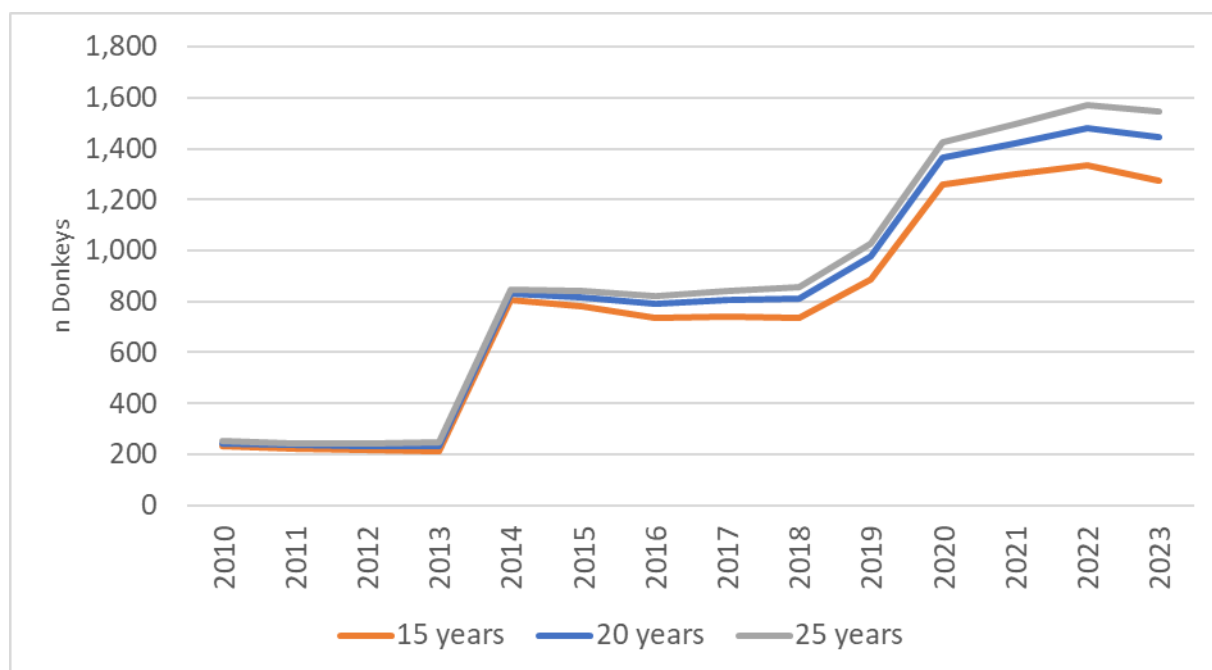


The 2021 RDM survey dataset did not contain any information on donkeys, however, analysis of the wider data set indicated that 56% of lifestyle blocks were not GST registered¹³. This supports the notion that donkey could be significantly higher than originally thought, and with donkeys on lifestyle blocks also expected to live longer than average, a series of “back of the envelope” calculations have been undertaken based on average lifespans of 15, 20 and 25 years.

Figure 17 shows the results from these analyses, where the AgriBase stock estimates have been cumulated (after adjustment for losses), resulting in total donkey numbers increasing from just over 200 in 2010 to 1300-1600 by 2022. These results are closely aligned with the estimated provided by Ann, and likely more representative of the donkey (and mule) estimates currently used within the national inventory model.

¹³Contract 406437: Lifestyle block analysis M02 report (June 2022): Table 8

Figure 17. Back of the envelope calculation for estimated donkey numbers (based on the AgriBase data, and an average lifespan of 15-25 years).



Discussion / Recommendations

The AgriBase data combined with feedback suggests that donkey numbers are considerably higher than the 141 currently used within the Inventory. Whilst the AgriBase data does not provide a solid representation of stock on hand at any fixed point in time, it does provide a framework on which to estimate likely stock numbers. With information provided by Ann, suggesting that the donkey population is in decline – then it is reasonable to assume that results modelled using a 25 life-span (Figure 17 above) are indicative of minimum stock estimates for 2023.

We therefore recommend:

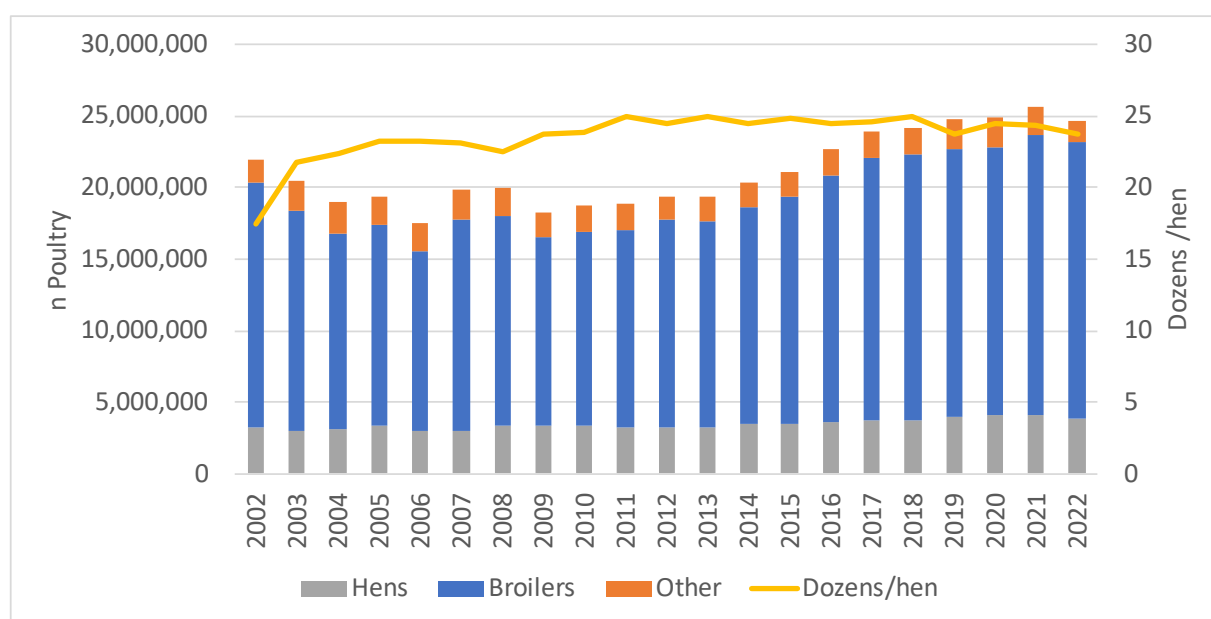
1. That MPI supports the donkey and mule association to improve the accuracy of their registries and provide up-to-date data for use in the national GHG inventory.
2. That in the interim, donkey numbers be increased from 141 to 1500, with a further review of the use of static donkey numbers to be undertaken in 5 years (2028).

Poultry

Annual estimates

Figure 18 shows Infoshare data for poultry, with the numbers of chickens used for egg production (hens) relatively consistent over time, and production data within the expected ranges (21-25 dozen per year^{14,15}). These results are mirrored in the Regional Authority data for the 2017-2022 period (Figure 19) with inclusion of additional reporting classes (chicken breeding stock, pullets) resulting in minor differences in numbers reported within the Hen and Other poultry classes. Table 7 shows a breakdown of the Infoshare and Regional Authority estimates for 2022, where the chicken breeding stock, pullet, and other poultry categories have been combined for the purposes of comparison.

Figure 18. Infoshare data for poultry.



¹⁴ <https://www.purinamills.com/chicken-feed/education/detail/how-long-do-chickens-lay-eggs-goals-for-laying-hens#:~:text=Laying%20hens%3A%20How%20many%20eggs,get%20shorter%20in%20the%20fall>

¹⁵ <https://www.eggfarmers.org.nz/about-eggs/did-you-know>

Figure 19. Regional Authority data for poultry, compared to total Infoshare poultry numbers.

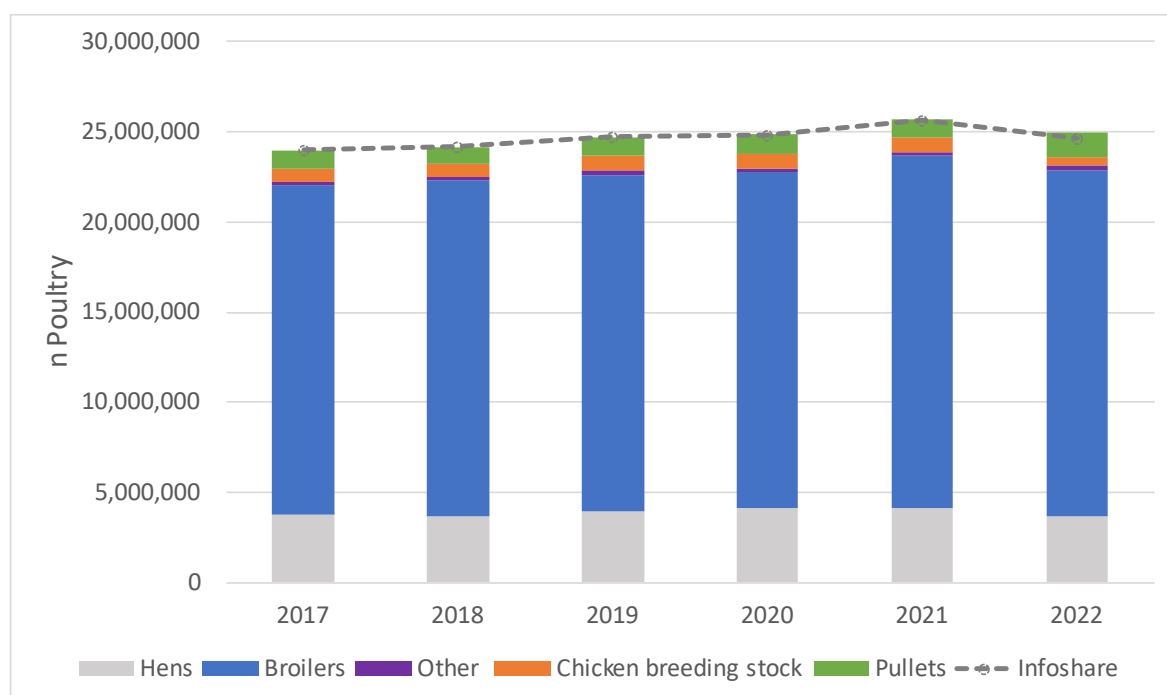


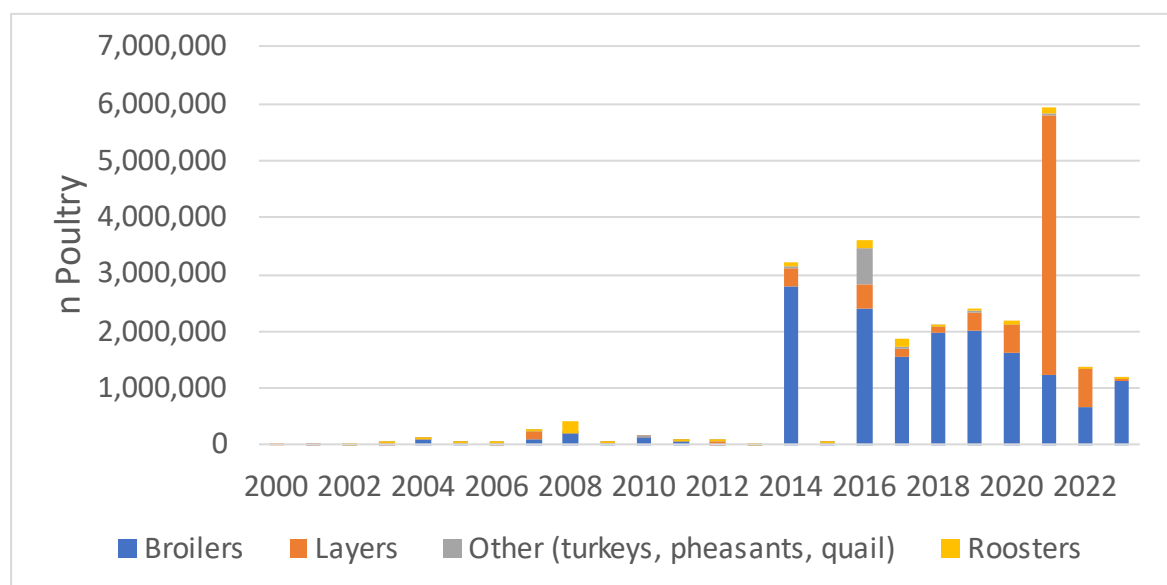
Table 7. Comparison of the 2022 season Infoshare and Regional Authority data for Poultry.

Sub-class	Infoshare		Regional authority		
	Number	% of total	Number	% of total	% change
Hens	3,886,669	16%	3,658,782	15%	-6%
Broilers	19,248,140	78%	19,248,140	77%	0%
Other	1,525,842	6%	2,056,075	8%	+35%
Total	24,660,651	100%	24,962,997	100%	+1%

AgriBase

Figure 20 shows a summary of poultry data recorded in AgriBase, with a total of 25 million poultry birds recorded over time. Whilst there is only limited data prior to 2014, analysis of the 2014-2023 datasets shows minor differences to that observed in Table 7 (above), with a larger proportion of poultry included within the hen class (30%) and fewer animals in the broiler class (64%). Roosters account for 50% of stock included within the “other” subclass, with Turkeys, pheasants and gulls making up the balance of the AgriBase dataset.

Figure 20. AgriBase data, for 407 properties registered as having poultry, with total poultry numbers aggregated according to year of reporting and poultry sub-class.



Discussion / Recommendations

No significant anomalies were identified within the poultry analysis. However, with minor differences in the percentage of birds included within the broiler and layer hen sub-classes, consideration could be given to transitioning to use of the Regional Authority data for use in the Nitrogen excretion calculations. Table 8 shows the impact of changes in both the number and proportion of poultry allocated to each of the 3 reporting classes, where:

- Using the Regional Authority stock estimates results in a 1% increase in estimated N excretions (assuming no changes in the relative proportions of hens, broilers, and other poultry types).
- Use of the regional Authority stock classifications results in a further increase in total estimated N excretion (2.2% relative to current).

Table 8. Impact of changes in the proportion of poultry allocated to each of the 3 reporting classes on total N excretion estimates for 2022.

Subclass	IPCC default N _{ex}	% in each sub-class		Total N ex (Tonnes)		
		Infoshare	RA	Infoshare proportions		RA proportions
				24.660 M	24.963 M	24.963 M
Hens	0.42	16%	15%	1,632	1,652	1,537
Broilers	0.39	78%	77%	7,507	7,599	7,507
Other	0.60	6%	8%	916	927	1,234
Total				10,055	10,178	10,277
% change relative to current (using 2022 Infoshare data)					1.01%	2.21%

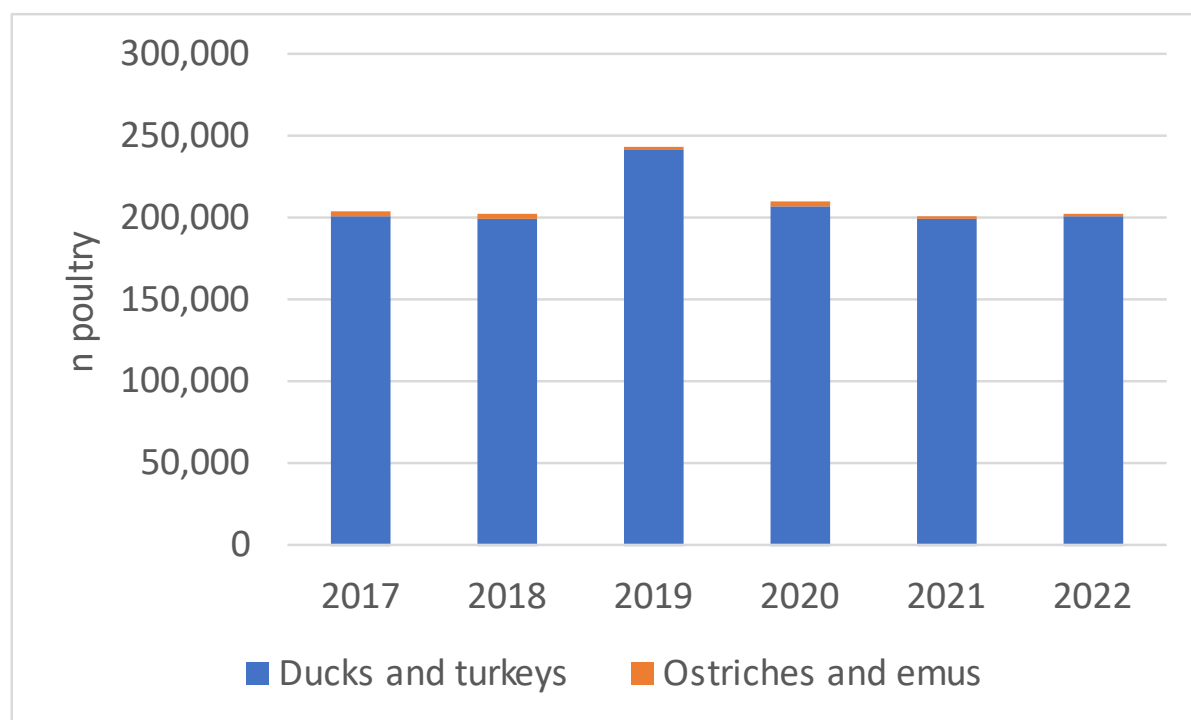
We therefore recommend:

1. That MPI transitions to use of the Regional Authority data for poultry (from 2017 onwards), enabling separation of the broiler and hen stock classes within the inventory methodology.

Ostriches and emus

Within the national inventory, ostriches and emus are included along with ducks and turkeys in the 'other poultry' group. Whilst the Regional Authority data shows that ostriches and emus currently account for less than 1% of the "other category group (Figure 21), differences in liveweights suggest that separation of ostriches and emus into a separate category group could be an important consideration, with the nitrogen excretion values for the "other poultry" classes¹⁶ set to the IPCC default value of 0.6 kg N/head/year.

Figure 21. Regional Authority data for the "other poultry" group.



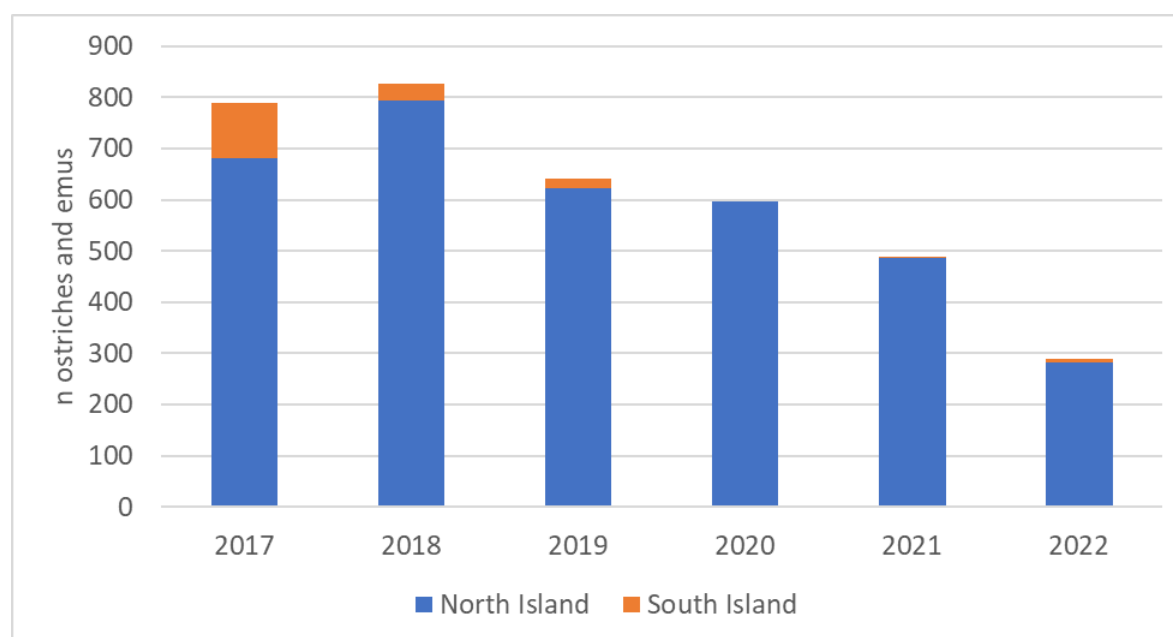
Annual estimates

There is very little publicly available information on the numbers of ostriches and emus in New Zealand, with these categories not included within the Infoshare data set provided by Statistics NZ, and the national GHG inventory stating that these animals are very rare with only 739 ostriches estimated as present in 2015.

Figure 22 shows the Regional Authority data for the number of Ostriches and Emus in New Zealand, with reported stock numbers continuing to reduce (790 in 2017 to 289 in 2022), and most remaining birds located in the North Island.

¹⁶ Section 5.6.22, <https://www.mpi.govt.nz/dmsdocument/13906-detailed-methodologies-for-agricultural-greenhouse-gas-emission-calculation>

Figure 22. Regional Authority data for the number of Ostriches and Emus in New Zealand.



AgriBase ostrich and emu data

Figure 23 shows a summary of Ostrich and Emu data recorded in AgriBase, with a total of 11,921 birds recorded, of which 83% are ostriches and 17% emus. Looking at results for the last 3 years, the number of ostriches and emus recorded in AgriBase is significantly higher than numbers recorded within the Territorial Authority data, suggesting that the annual estimates may be too low. It is possible that some of this discrepancy is due to the presence of ostriches and emus on lifestyle blocks. However, with only 5% of total birds linked to lifestyle properties within the AgriBase data set, and very low numbers of reported within the 2021 RDM dataset¹⁷, this seems unlikely.

Additionally with the average lifespan of ostriches reported as 30-40 years in the wild, and even longer in captivity^{18,19}, it appears unlikely that these discrepancies are due to issues associated with bird survival, with further research required.

¹⁷ Total of 14 ostriches and 3 emus reported from the 3,779 2021 RDM respondents.

¹⁸ <https://birdfact.com/articles/how-long-do-ostriches-live>

¹⁹ <https://teara.govt.nz/en/exotic-farm-animals/page-4>

Figure 23. AgriBase data, for 342 properties registered as having Ostriches and/or Emus, with total poultry numbers aggregated according to year of reporting and class.

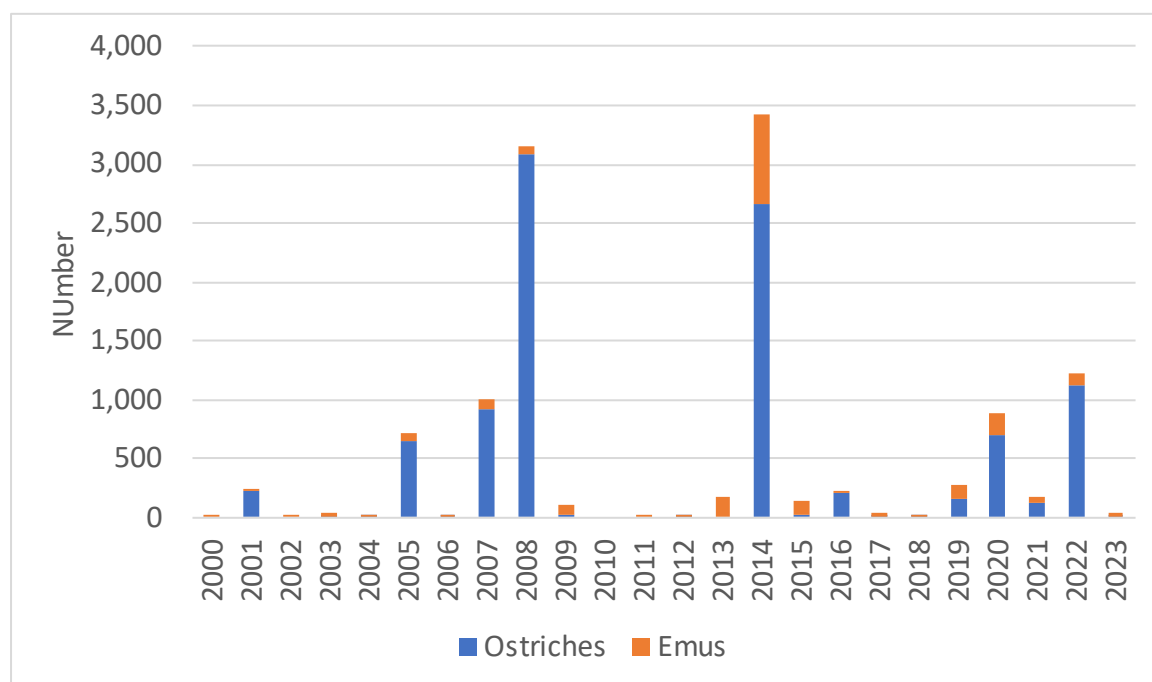


Table 9. Breakdown of the AgriBase data for 342 properties registered as having Ostriches and/or Emus.

	Subclasses			Total	% of total	% on lifestyle blocks
	Ostriches	Emus	Ostriches & Emus			
n Farms	132	182	28	342		
n Ostriches	9,535	0	418	9,953	83%	3%
n Emus	0	1,590	378	1,968	17%	20%
Total	9,535	1,590	796	11,921	100%	5%

Industry data

Ostriches: Internet searches for information pertaining to the numbers of Ostriches and emus in New Zealand, identified a historical article published by the NZ Herald back in 2002²⁰ suggesting that Ostrich number were significantly higher than reported 20 years ago, with up to 8,000 ostriches slaughtered per annum. There are also website references to the New Zealand Ostrich Association, however, discussions with Rosemary Blunden from Kowhai Grove Ostrich farm²¹ confirmed that the NZ Ostrich Association is no longer active and that ostrich numbers are in decline, with Rosemary estimating that there only a small number of operators, and likely less than 1,000 Ostriches NZ today. This estimate is slightly at odds with stock numbers reported within the AgriBase dataset, but with ostriches typically slaughtered (for meat) at around 100 kg (10-14 months), then the AgriBase data may simply reflect the time of data collection, with finishing stock included within the

²⁰ <https://www.nzherald.co.nz/business/ostrich-industry-needs-more-farmers-to-fill-export-orders/XAD5JNGFFUJJYVWAZA5NG3KCII/>

²¹ <http://www.kowhaigroveostrich.co.nz/>

records. Rosemary also confirmed that many of the ostrich growers do so in conjunction with dry stock farming operations. This increases the likelihood of reporting within the annual surveys, with the trends shown in Figure 22 (Regional Authority data) reflecting the decline in Ostrich numbers reported by Rosemary, and therefore likely representative of the ostrich industry.

Emus: Several historical references linked to emu farming were identified^{22, 23} with emus primarily farmed for emu meat and oil, but no further information on farmed stock numbers. References relating to the presence of feral emus in the Chatham Islands, and around East Cape²⁴ were also identified, but with feral stock currently excluded from the national inventory methodology, no further attempts were made to quantify total emu numbers.

Discussion

Whilst historical estimates are likely higher than previously reported, the Ostrich industry is in decline, with no substantive evidence to suggest that stock numbers are higher than reported.

Further research could be undertaken to understand discrepancies between the AgriBase data and reported stock estimates. However, in the absence of ostrich slaughter data, it is unlikely that these discrepancies will be resolved with a recommendation to evaluate capture of slaughter data for future use.

Similarly, no substantive evidence has been found to suggest that emu numbers are higher than reported. However, with the AgriBase data suggesting that emus account for 17% of total stock within the combine ostrich emu category, and that 20% of emus are housed on lifestyle blocks, it is likely that emu numbers are higher than reported.

Differences in liveweight (ducks 1-5 kg²⁵ turkey: 13.5 kg²⁶, adult ostrich female: 100-130 kg²⁷, adult emu: 50-60 kg²⁸) also support the introduction of a separate category for ostriches and emus. However, with no certainty over either ostrich or emu stock numbers, separation of these stock classes into sub-categories is unlikely to create further increases in the accuracy of inventory estimates at this stage.

We therefore recommend that:

1. That MPI consider introduction of a separate minor animal category stock class to enable more detailed tracking of Ostrich and emu numbers, and if that recommendation was to be accepted then:

²² <https://theresasjoquist.com/2011/04/emu-farming-in-new-zealand/>

²³ <https://www.nzherald.co.nz/property/reality-check-emu-farming/LMUR464ATKSD5ODUUDNC2WAU2I/>

²⁴ <https://www.birdingnz.net/forum/viewtopic.php?t=10750>

²⁵ <https://fowlguide.com/how-much-do-ducks-weigh/>

²⁶ https://en.wikipedia.org/wiki/Domestic_turkey

²⁷ <https://www.pbs.org/wnet/nature/blog/ostrich-fact-sheet/>

²⁸ <https://nationalzoo.si.edu/animals/emu>

- a. that MPI work with the International GHG community to understand the impacts of potential changes in N excretion rates (due to liveweight differences) if there was sufficient data to support change within the national GHG inventory methodology.
- b. that MPI work with meat processors to gain a greater understanding of Ostrich and emu slaughter data with a view to understanding discrepancies between the AgriBase data and reported stock estimates.
- c. That a further review of both ostrich and emu stock estimates is undertaken in 5 years (2028).

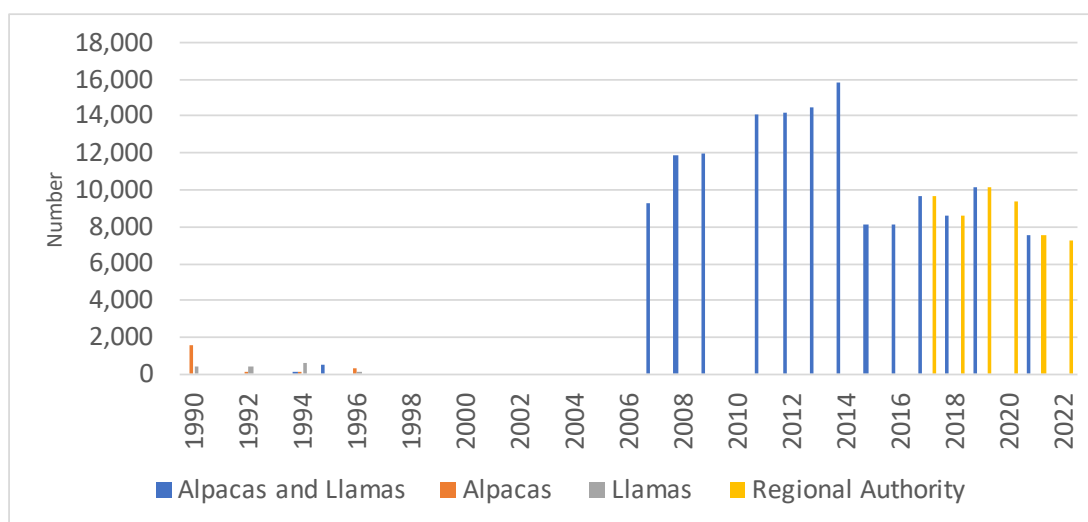
Alpacas and llamas

Annual estimates

Infoshare data for alpacas and llamas is sparse, with limited stock number records available for the 2007-2021 period and no slaughter data available. Figure 24 shows the Infoshare and Regional Authority data for Alpacas and llamas from 1990-2022, with total stock numbers reported to have dropped from just under 16,000 in 2014 to 7,500 in 2021.

- In the absence of slaughter data, it is not possible to determine the cause of this reduction.
- Further research is recommended to determine if this drop is due to artifacts in the historical data collection, or due to economic factors resulting in some farmers choosing to reduce stock numbers and/or exit the business.

Figure 24. Infoshare and Regional authority data for changes in the number of Alpacas and llamas recorded as on farm 30 June each year.



AgriBase

Figure 25 shows a breakdown of AgriBase data, with a total of 13,067 Alpacas and 611 llamas recorded since the year 2000. With an average lifespan of 20-25 years, and a typical breeding female producing up to 15 offspring²⁹, the AgriBase data supports the notion that the annual estimates for this group of animals may be higher than reported. This may be

²⁹ <https://www.cornerstonestud.co.nz/>

due to the prevalence of alpacas on lifestyle blocks, with lifestyle blocks accounting for an average of 30% of total recorded stock numbers over the 2007-2023 period (Figure 26). Average numbers of alpaca also varied slightly with lifestyle blocks averaging 7.3/farm versus 9.5 for other farm types.

Figure 25. AgriBase data, for 1,068 properties registered as having one or more alpacas or llamas, with total numbers aggregated according to animal type and year of reporting.

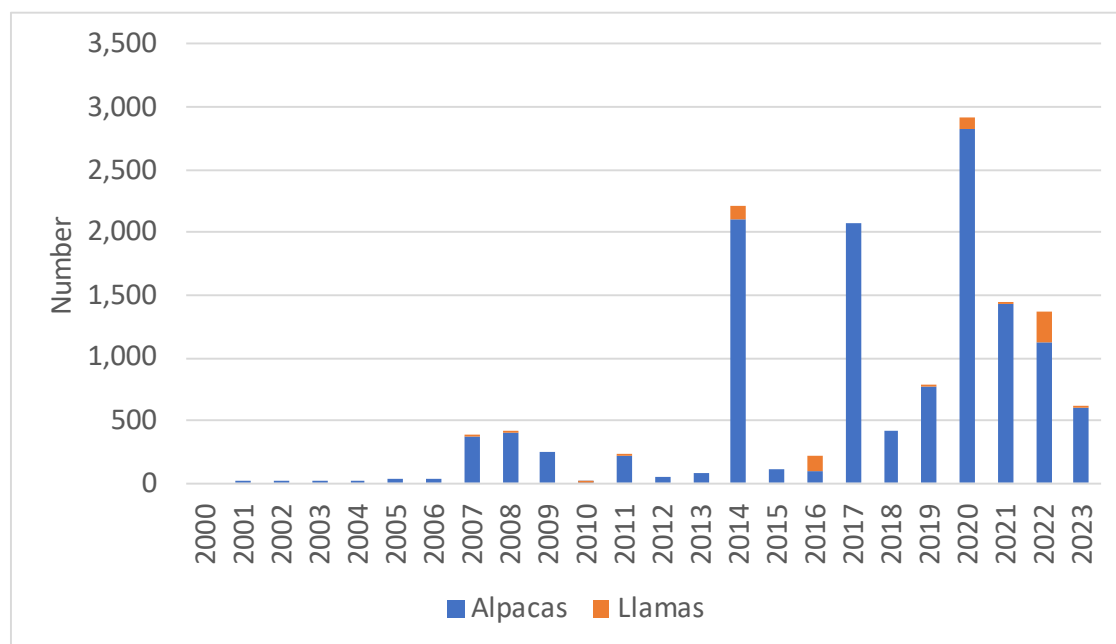
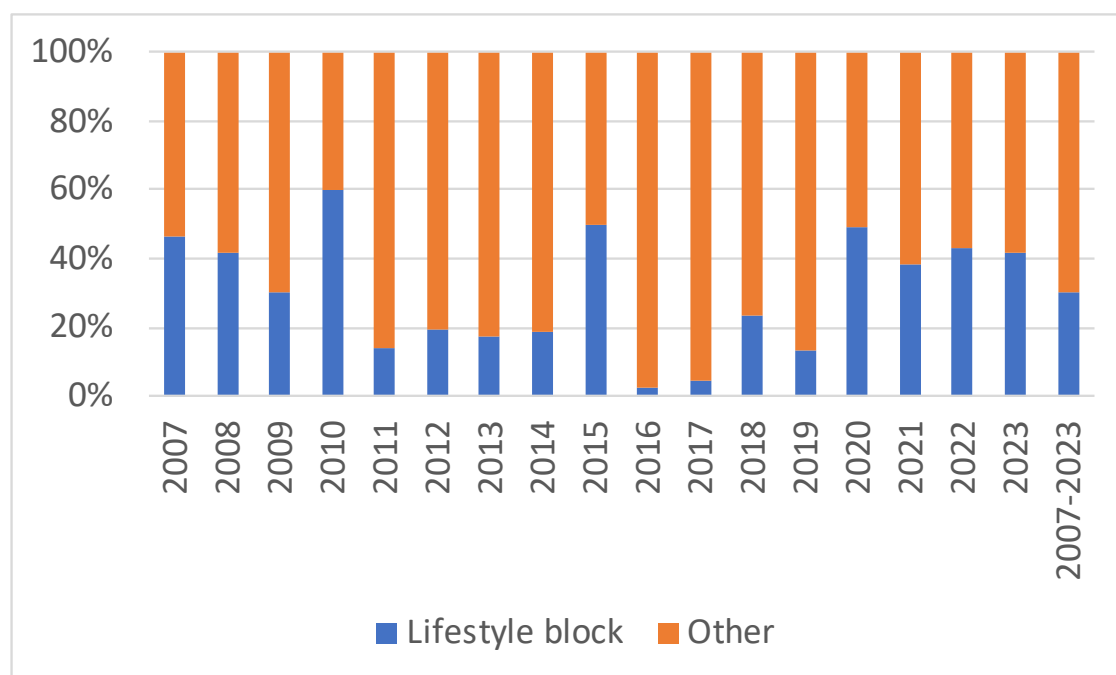


Figure 26. Proportion of alpacas and llamas recorded on lifestyle blocks as opposed to other AgriBase farm categories.



Rural decisions makers survey

Similar results were observed in the 2021 RDM survey data, where the average number of alpacas and llamas per farm was estimated at 9.4. Approximately half of the respondents with alpacas and or llamas were not GST registered, with the total number of non-GST registered stock estimated at 36%. These animals are likely not included within the statistics, with Table 11 showing a revised estimate of total stock numbers for the 2017-2022 season. This has involved adjustment of the stock numbers assuming that:

- 30% of stock reported within the annual estimates are assumed to be linked to lifestyle blocks.
- 36% of livestock are not GST recorded, resulting in an 11% increase in total stock numbers over time.

Table 10. RDM 2021 survey data for Alpacas and llamas.

	Alpacas only	Llamas only	Alpacas and llamas	Total	Non-GST reg
n farms	94	8	5	107	58
n alpacas	935	0	22	957	322
n llamas	0	35	13	48	42
Total	935	35	35	1005	364
per farm	9.9	4.4	7.0	9.4	6.3
% of total	93%	3%	3%	100%	36%

Table 11. Revised estimates for the total number of Alpacas and llamas to account for non-GST registered lifestyle blocks.

	2017	2018	2019	2020	2021	2022
Regional Authority	9,649	8,619	10,185	9,366	7,578	7,288
Lifestyle blocks (30%)	2,895	2,586	3,056	2,810	2,273	2,186
GST adjustment (36%)	1,042	931	1,100	1,012	818	787
Revised total	10,691	9,550	11,285	10,378	8,396	8,075

Industry data - Alpacas

Birth data

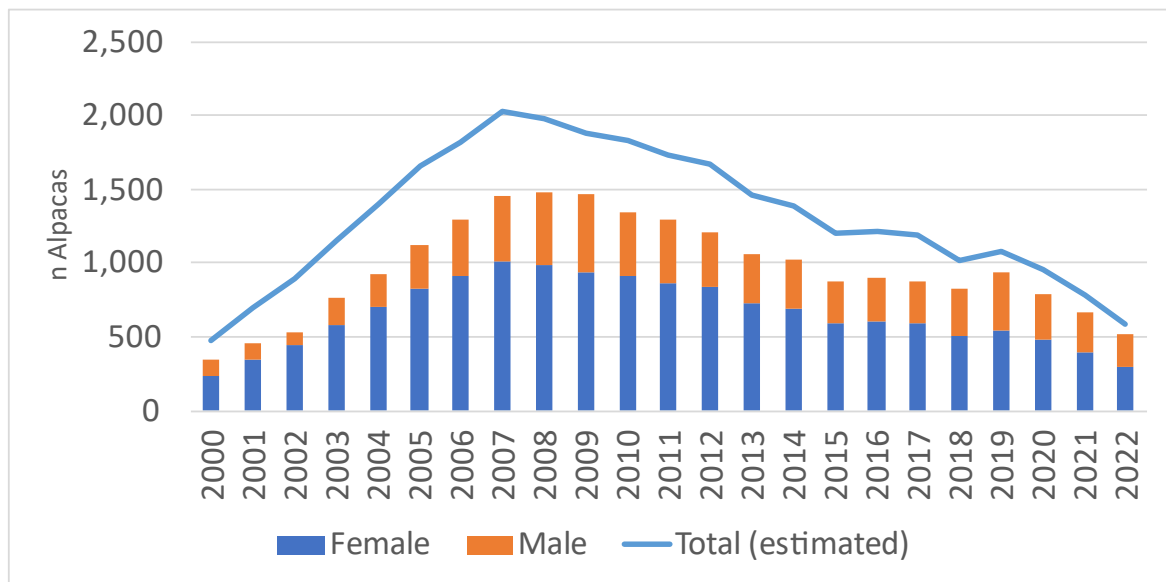
Data provided by Sue Richards from the NZ Alpaca Association was used to develop a series of theoretical population estimates based on the number of live births (cria) registered between 2000 & 2023, with further comments provided by Sue outlined below.

1. *The NZ alpaca Association as very active between 2000 and 2010, with nearly all breeders registered and actively recording the number of female alpacas born.*
2. *Records for the number male alpacas born are more sparse, due to the fact that many male alpacas are sold as companion animals and not included within the registries.*
3. *the average lifespan of an alpacas is estimated at 10 years, but there is a high degree of variation amongst different flocks/herds, so caution should be used in interpreting the results.*

4. *The proportion of breeders utilising the national database has reduced, and whilst total stock number have thought to have reduced, there is currently no accurate method for estimating total stock numbers. Therefore, stock estimates resulting from the use of the Alpacas Association data, can only be used as a conservative baseline comparison.*
5. *My estimate is that there is probably somewhere between 35,000 and 40,000 alpacas in NZ.*

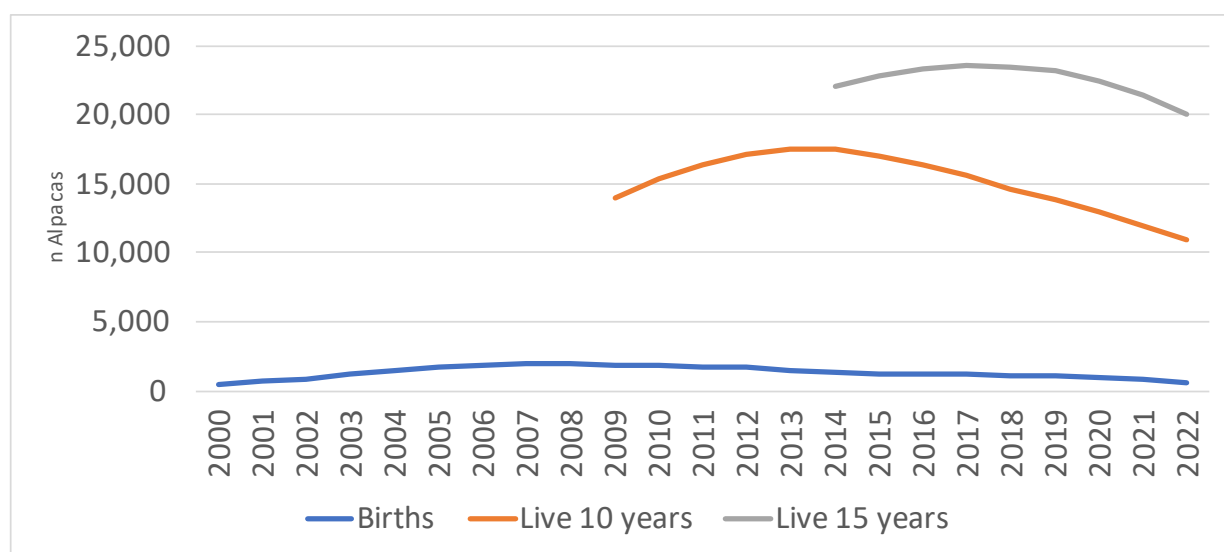
Figure 27 shows a summary of data extracted from the NZ alpaca birth register for male and females (including both Huacaya and Suri breed types). With registered breeders typically retaining females cria for use as breeding stock, and males often sold as pets/companion animals, total births have been estimated by doubling the number of recorded female births, with the proportion of males registered ranging from 19-75%.

Figure 27. Reported numbers of alpacas registered, compared to estimated total, which is based on the numbers of female cria registered (assuming 50% female, 50% male births).



A simple model was then developed to estimate total stock numbers assuming an average lifespan of either 10 or 15 years (Figure 28). This results in average stock estimates of 15,000 and 22,000 alpacas over time, with an average of 14-20 births per adult alpaca on farm. This is lower than the 35,000-40,000 estimated by Sue, with Sam Matritz of Cornerstone alpaca stud, also suggesting that total numbers would exceed 40,000 (pers comm).

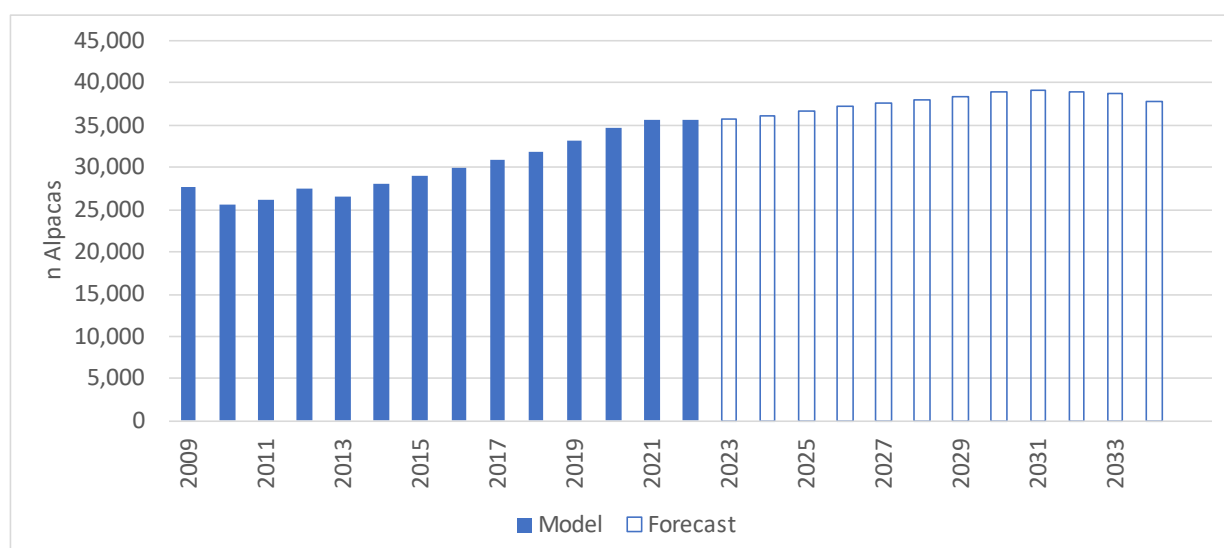
Figure 28. Estimated alpaca numbers, assuming an average life span of 10 or 15 years.



The model was then extended to account for the inclusion of non-registered stock, with Figure 29 providing stock estimates for a scenario where:

- The proportion of births registered increases from 50% in 2000 and increases by 5% per annum through to 2010 (100%). The proportion of births registered then drops steadily, prior to plateauing at 25% by 2020, with forecast results based on no changes in the numbers of births post 2022.
- Assuming an average lifespan of 15 years, this results in the population stabilising at 35,000 to 40,000 from 2020 onwards, with an average of 14 adults/cria born/year.

Figure 29. Scenario 1: Estimated alpaca numbers based on a 15-year lifespan, and current population size of 35,000-40,000 alpacas.



Anecdotal data

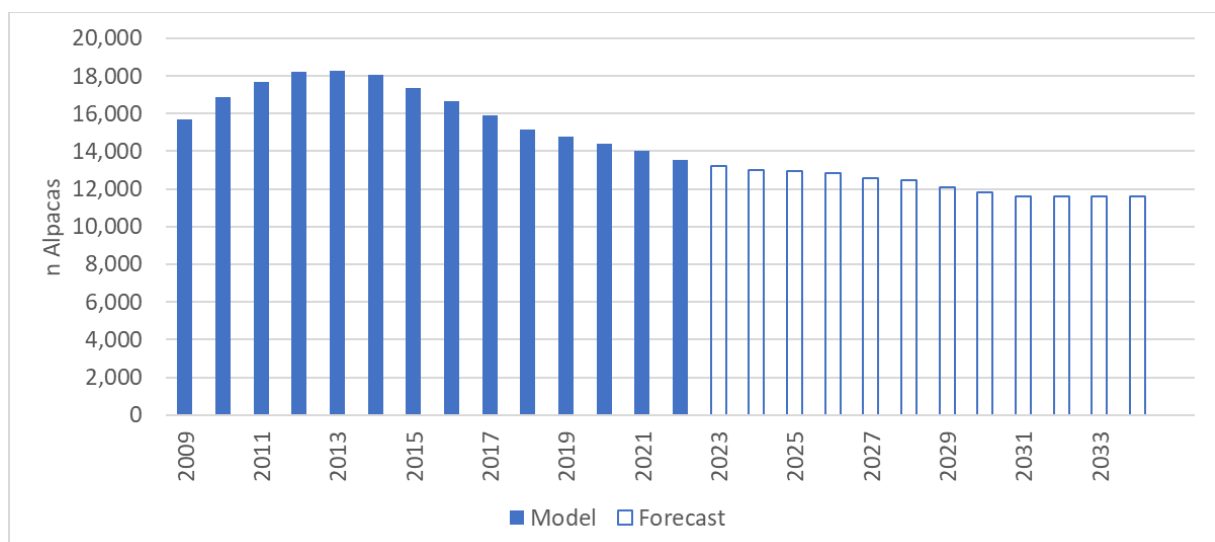
An alternative source of anecdotal data provided by Ricard Farquhar (Farm Accountant Trust), suggested that Alpaca were less than half of the 35-40,000 reported by Sue and Sam above with Richard data including:

- **Shearing data:** *"We have two main shearing operators in New Zealand, and combined they are telling me that in the last season being from Sept 2022 to April 2023 they have shorn just on 12,000 alpacas in New Zealand. Add to that they are a number (6-8) smaller more local operators which we would estimate shear about a further 1,500 to 2,000 alpacas each season. That would put the New Zealand Alpaca herd around 13,500 to 14,000 head".*
- **Conversations:** *"In talking with members of Alpaca Association, asking for the number of alpacas they own, plus the number of known alpacas on lifestyle block and other farms in their area, we have a figure of just over 13,300 alpacas in New Zealand".*

A second scenario was therefore developed to assess the impact of these stock estimates on historic and future predictions (Figure 30). This required recalibration of the model, where:

- The proportion of births registered increases from 73% in 2000 and increases by 3% per annum through to 2010 (100%). The proportion of births registered then drops steadily, prior to plateauing at 51% by 2022, with forecast results based on no changes in the numbers of births post 2022.
- The reported reduction in stock numbers also resulted in reductions in average lifespan (10 years), and the ration of adults: cria born per year (10).

Figure 30. Scenario 2: Estimated alpaca numbers based on a 10- year lifespan, and current population size of 13,000-14,000 alpacas.



Scenario comparison

With significant variation in stock estimates developed for each of the 2 scenarios, the next step in the process was to undertake a comparison of the AgriBase, RDM and modelled estimates relative to results reported by Statistics NZ. Results for this comparison are shown in Table 12, where:

- With no separation between alpacas and llamas within the official Statistics New Zealand data sets, both stock classes have been included for the purposes of comparison.
- The 11% increase shown for the RDM data reflects the adjustment made to the official data to account for non-GST registered farms and lifestyle blocks (see Table 11).
- Industry estimates suggest that alpaca numbers are up to 4 times higher than reported, however in the absence of official data, care should be taken in the interpretation of these results.

Table 12. Comparison of AgriBase and modelled stock estimates for 2022

	Stats NZ	RDM adj ¹	AgriBase	Scenario 1	Scenario 2
Reported/Modelled stock numbers (2022)	7,288	8,075	13,067	35,579	13,500
% Change		+11%	+79%	+388%	+85%

Industry data - Llamas

Llama data was extracted from the New Zealand Llama Association (NZLA) with a total of 2,611 stock registered, of which 51% are recorded as females, and 87% as purebreds (llamas & lamas)³⁰.

Type	Female	Other	Total	% female	% recorded
Alpaca	1	1	2	50%	0%
Alpaca 3/4 Vicun	0	1	1	0%	0%
Guanaco	32	22	54	59%	2%
Huarizo	26	31	57	46%	2%
Lama	334	360	694	48%	27%
L-G	101	90	191	53%	7%
Llama	819	738	1557	53%	60%
Llama/Guanaco	15	4	19	79%	1%
Not recorded	11	26	37	30%	1%
Total	1339	1272	2611	51%	100%

With the NZLA registry containing no information on the status of animals (alive, dead), a simple model was developed to calculate changes in estimated stock numbers based on recorded date of birth and expected lifespan. Figure 31 shows the age distribution of

³⁰ <https://llamas.org.nz/registry/>

animals within the database (by birth year) and Figure 32 changes in stock numbers based on average lifespans of 10, 15 and 20 years.

Figure 31. Age distribution of llamas recorded within the NZLA registry.

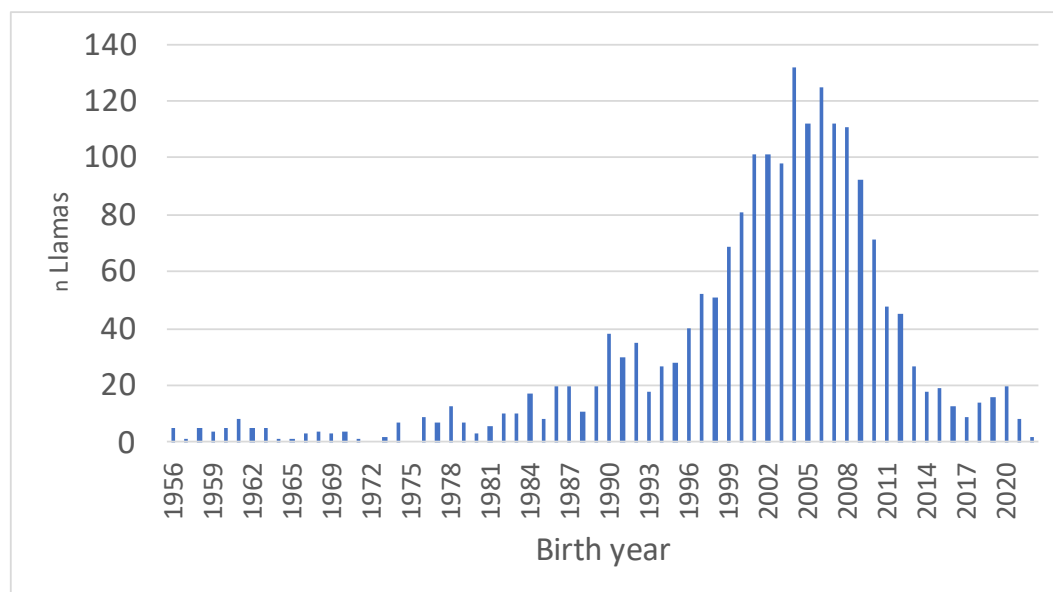
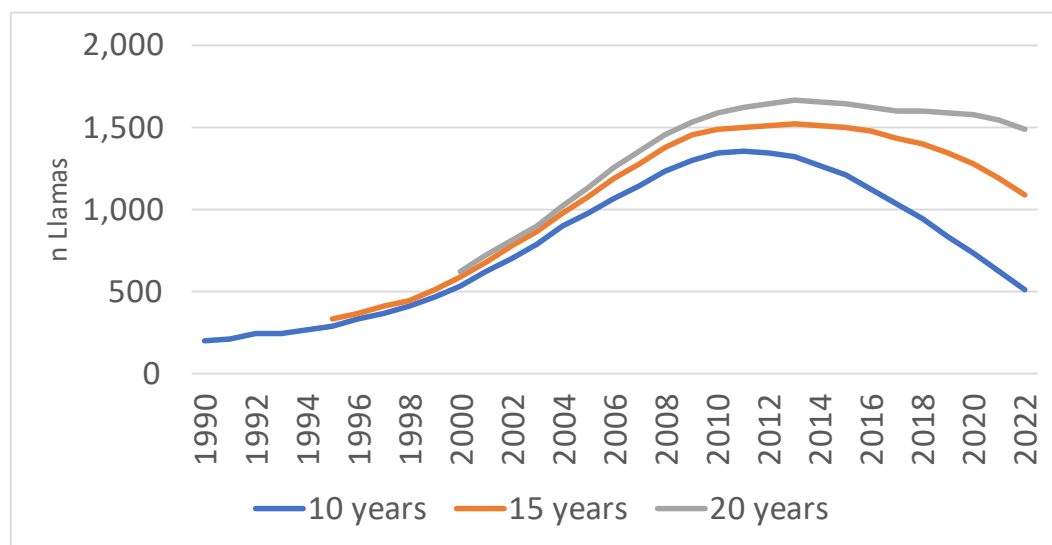


Figure 32. Estimated llama numbers, assuming an average life span of 10,15 or 20 years.



With only small numbers of animals registered prior to 1990, stock estimates for 1990 are low, increasing to peaks of 1350, 1490 and 1595 by 2010 for the 10, 15 and 20-year models respectively. Anecdotal information provided by Judy Webby, president of the NZLA, suggested that the 20-year model is likely most representative of the NZ llama population, with the current population estimated at 1,500 llamas³¹, and reported average lifespans of 15-25 years³².

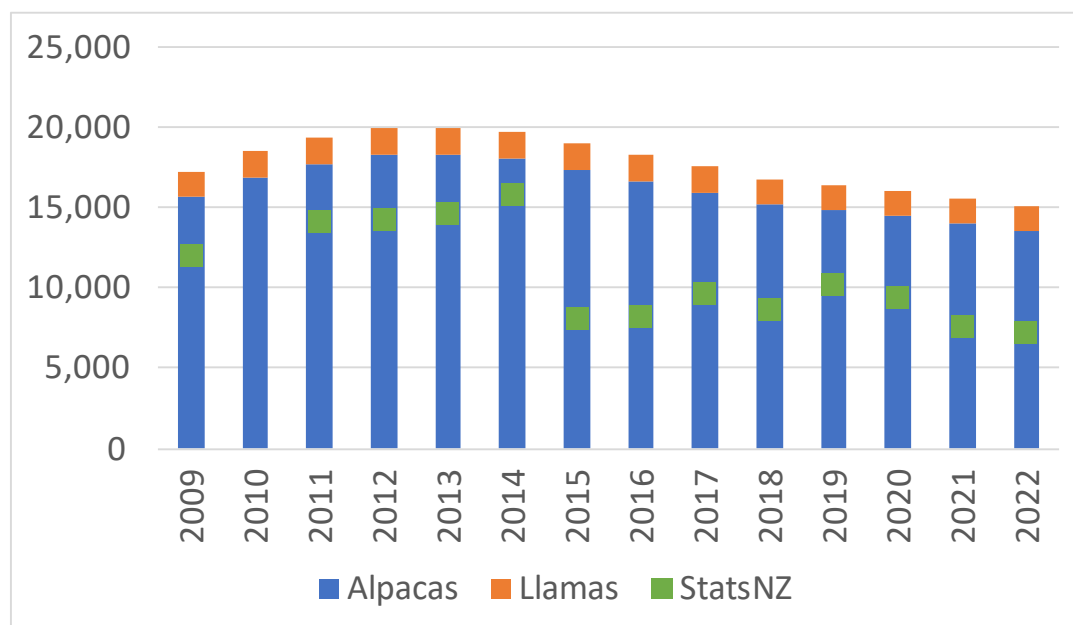
³¹ Judy Webby, pers. comm.

³² <https://en.wikipedia.org/wiki/Llama>

Discussion / Recommendations

Stock estimates: With current industry estimates ranging from 13,000 to 40,000 alpacas, it has not been possible to develop an accurate estimation of changes in alpaca numbers over time. However, with a conservative estimate of 13,000 alpacas for 2022, industry data suggests that alpacas are significantly higher than reported (Figure 33), and consideration could be given to use of these (conservative) stock estimates within the national inventory model.

Figure 33. Comparison of modelled industry estimates compared to reported numbers of Alpacas and Llamas (by year).



Emission factors: Another aspect of concern is the linking of the Nitrogen excretion value for alpacas (and llamas) to the default 1990 values applied to sheep. A quick Wikipedia search suggests that at 130-200 kg, llamas are approximately twice as heavy as alpacas (48-84 kg). Whilst both the AgriBase data, and industry data (Figure 33 above) suggest that llamas account for only 5% of total stock numbers, consideration could be given to splitting of these stock classes within both the animal production survey questions, and within the GHG Inventory model itself.

Recommendations: We therefore recommend:

1. That MPI supports the Alpaca Association and NZLA to improve the accuracy of their registries and provide up-to-date data for use in the national GHG inventory.
2. That in the interim, stock estimates are increased to 75% of modelled outcomes, with information from both the alpaca and llama registries used to provide population estimates from 2023 onwards.
 - a. Note that consideration could also be given to increasing stock numbers to reflect 100% of modelled outcomes, however with a high degree of uncertainty, a more cautious approach has been recommended.

3. That the question used within the annual surveys are updated to enable splitting of the alpacas and llama data, and that the emission factors applied to both methane and nitrogen excretion, are adjusted accordingly.

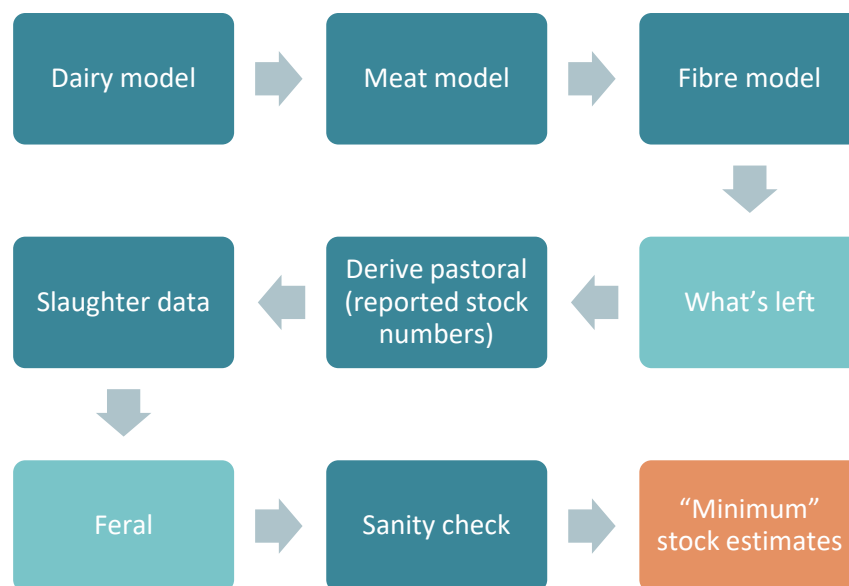
Part II: Development of an advanced population model for goats

Overview

This section of the report builds on work undertaken within initial phases (part 1) of the project, with stock estimates from each of the different goat sectors combined to create a multi-year population model. Figure 34 shows an overview of the overall structure of this model, with estimated stock numbers from the dairy, meat and fibre goat sectors, combined with reported stock estimates to derive estimates for pastoral goat numbers. A subtraction model is then used to account for differences between reported stock numbers and slaughter data, with these stocks assumed to be a combination of feral and pastoral goats either on lifestyle blocks or on farm for intermittent periods of time, and therefore not captured within the annual end of year stock estimates.

It is important to note that due to uncertainty around some input assumptions, stock estimates for the pastoral and feral goat sectors should be viewed as speculative only, with further commentary provided in the “Subtraction model” section below.

Figure 34. Overview of the structure of the goat population model.

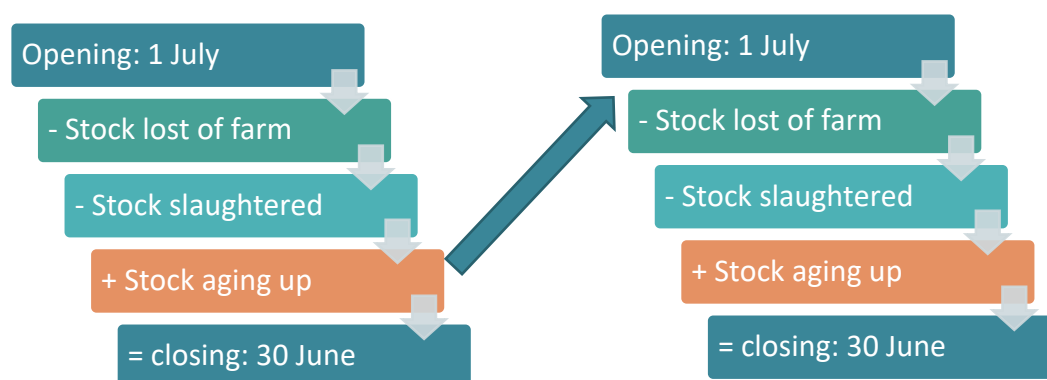


With each of the different sectors, a multi-year model is required to account for the transition of animals between stock classes and years (Figure 35), where for example, the number of mixed age does on hand at the start of any given year, has a direct impact on the number on hand at the beginning of the next year.

Within a ‘static’ model, opening and closing numbers would be expected to remain constant, with an expectation that the incoming replacement does replace breeding stock

slaughtered or lost on farm. However, this is often not the case, and the current inventory model therefore relies on data collected through the annual agricultural census to estimate stock numbers at the beginning of each year. This does, however, lead to potential discrepancies between reported and expected stock numbers, with a multi-year approach required for a more depth evaluation of changes over time.

Figure 35. Multi-year model for the transition of animals between stock classes and years.



A series of individual population model modules have therefore been developed for each of the dairy, meat, and fleece goat sectors, and calibrated according to a range of expected industry parameters, including stock estimates for both bucks and does by age. A simplified version has also been developed for use in determining stock estimates for the pastoral/feral goat sector, with a detailed description of each of the sector model modules below.

Dairy goat module

Does (NZDGC model)

Data supplied by NZDGC has been used as a basis of stock estimates within the dairy goat modules. A series of steps have been undertaken to estimate the number of does by age with these steps including:

- Step 1: Provisional estimates of historical stock numbers back to the 2004-05 season. Note that (due to the sparsity of the data) no attempt has been made to provide historical estimates back to 1990, however, this could be considered as part of a shift to Tier 2 inventory methodology (if required).
- Step 2: Estimation of the total number of kids born each season.
- Step 3: Implementation of the multi-year model based on expected survival and slaughter rates.

Step 1: Table 13 shows estimated numbers of NZDGC does by age, where a simple linear curve was used to increase the number of milking does from 42,000 in the 2004-05 season to 53,000 as reported for the 2015-16 season (see Table 4 above).

- No attempt was made to estimate the number of dry does on hand throughout this period, with these figures assumed to remain constant, and accounting for 3-4% of the adult doe group.

Stock number records for other years were as reported, except for the 2016-17 season, for which no data was available, and results estimated as an average of the 2015-16 & 2017-18 seasons.

Table 13. Stock number assumptions based on estimated and reported numbers of does.

Season	Record type	Milking does	Dry does	% dry	Kids
2004-05	Estimated	42,000	1,700	4.0%	
2005-06		43,000	1,700	4.0%	
2006-07		44,000	1,700	3.9%	
2007-08		45,000	1,700	3.8%	
2008-09		46,000	1,700	3.7%	
2009-10		47,000	1,700	3.6%	
2010-11		48,000	1,700	3.5%	
2011-12		49,000	1,700	3.5%	
2012-13		50,000	1,700	3.4%	
2013-14		51,000	1,700	3.3%	
2014-15		52,000	1,700	3.3%	
2015-16	Reported	53,313	1,776	3.3%	17,057
2016-17	Estimated	53,403	1,694	3.2%	17,121
2017-18	Reported	53,492	1,611	3.0%	17,184
2018-19		55,479	2,346	4.2%	21,098
2019-20		62,332	3,197	5.1%	25,354
2020-21		63,909	3,717	5.8%	22,510
2021-22		55,965	4,949	8.8%	16,384
2022-23		49,330	5,731	11.6%	12,224

Step 2: Estimated and reported numbers of does (Table 13) were then used to calculate the number of kids weaned assuming that 25% of does milking are maiden does (DGC data) and that weaning rates for mixed age (200%) and maiden (80%) does result in average weaning rate of 170% over both stock classes³³.

Table 14 shows annual estimates for both the number of mixed age and maiden milking does on hand, and the number of kids weaned, with stock estimates for the 2004-05 season calculated as:

- $n \text{ mixed age does} = 42,000_{\text{milking does}} * (1 - 25\%_{\text{maiden}}) + 1,700_{\text{dry does}} = 33,200$
- $n \text{ maiden does} = 42,000_{\text{milking does}} * 25\%_{\text{maiden}} = 10,500$
- $n \text{ kids} = 33,200_{\text{mixed age does}} * 200\% + 10,500_{\text{maiden does}} * 80\% = 74,800$
- $n \text{ doe and buck kids} = 74,800 * 50\% = 37,400$

³³ NZDGC – pers comm.

Table 14. Estimated numbers of Mixed age, maiden does and kids weaned.

Season	Does		Kids		
	Mixed age does	Maiden does	Kids (weaned)	Does	Bucks
2004-05	33,200	10,500	74,800	37,400	37,400
2005-06	33,950	10,750	76,500	38,250	38,250
2006-07	34,700	11,000	78,200	39,100	39,100
2007-08	35,450	11,250	79,900	39,950	39,950
2008-09	36,200	11,500	81,600	40,800	40,800
2009-10	36,950	11,750	83,300	41,650	41,650
2010-11	37,700	12,000	85,000	42,500	42,500
2011-12	38,450	12,250	86,700	43,350	43,350
2012-13	39,200	12,500	88,400	44,200	44,200
2013-14	39,950	12,750	90,100	45,050	45,050
2014-15	40,700	13,000	91,800	45,900	45,900
2015-16	41,761	13,328	94,184	47,092	47,092
2016-17	41,745	13,351	94,171	47,086	47,086
2017-18	41,730	13,373	94,158	47,079	47,079
2018-19	43,955	13,870	99,006	49,503	49,503
2019-20	49,946	15,583	112,358	56,179	56,179
2020-21	51,649	15,977	116,079	58,040	58,040
2021-22	46,923	13,991	105,039	52,519	52,519
2022-23	42,729	12,333	95,323	47,662	47,662

Step 3: The number of doe kids weaned is then used to implement the multi-year model framework, where survival rates of does age 0-1 years (90%), 1-2 years (92%) and mixed age does (92%) are assumed to remain unchanged over time. Cull rates of does in the 0-1 and 1-2 age classes are also assumed to remain relatively constant, with changes in population size expected to primarily impact on the mixed age class where:

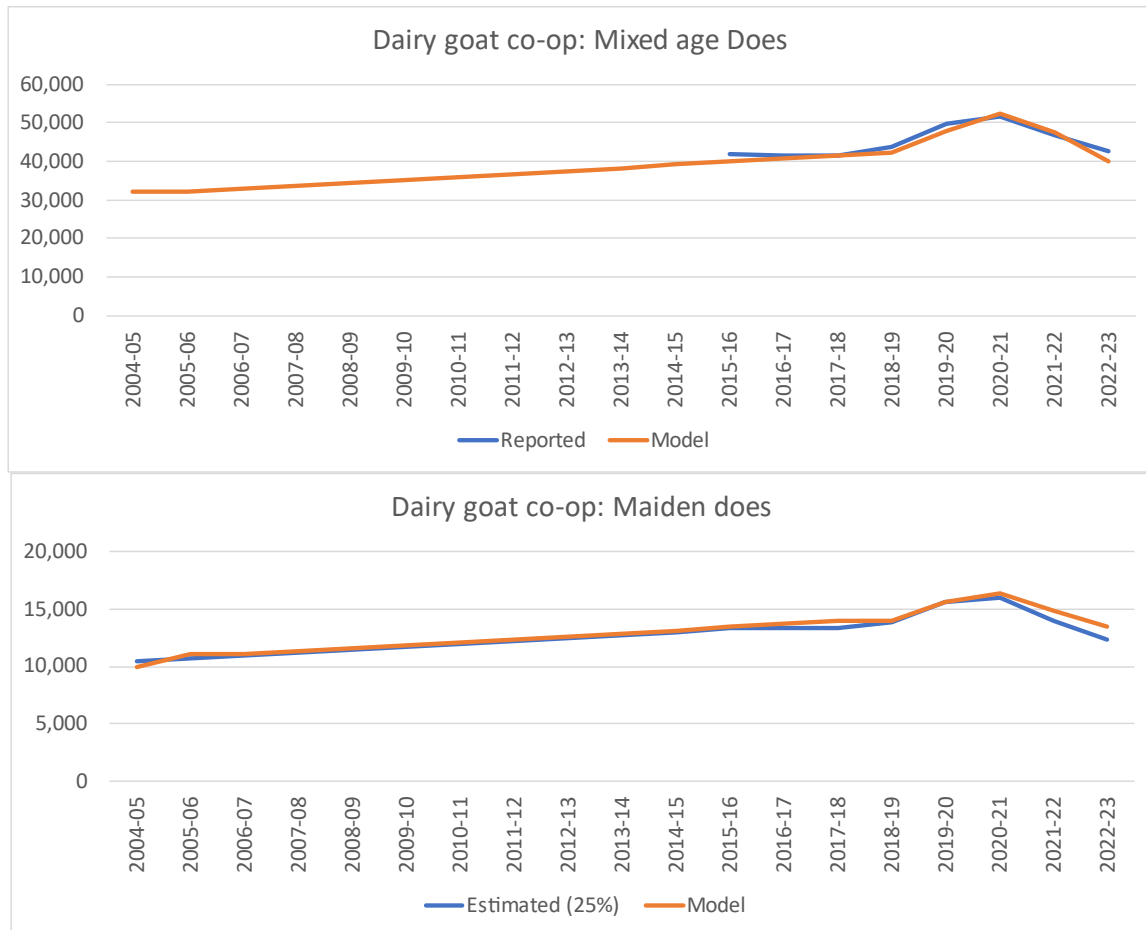
- 50-70% of surviving doe kids are culled prior to 30 June, with the remaining kids transitioning into the 1-2 age class.
- 20% of surviving does in the 1-2 age class are culled (post kidding) with these losses reflecting removal of stock from the herd due to poor performance.
- 10-30% of the mixed age does are culled each year, with the cull rate in this age group used to effectively calibrate the model to reported stock estimates.

Figure 36 shows a comparison of reported versus modelled numbers of mixed age and maiden does, where:

- Reported numbers are based on actual data for the 2015-16 season onwards, including 75% of milking does (25% maiden and included within the 1-2 age class) plus 100% of dry does.

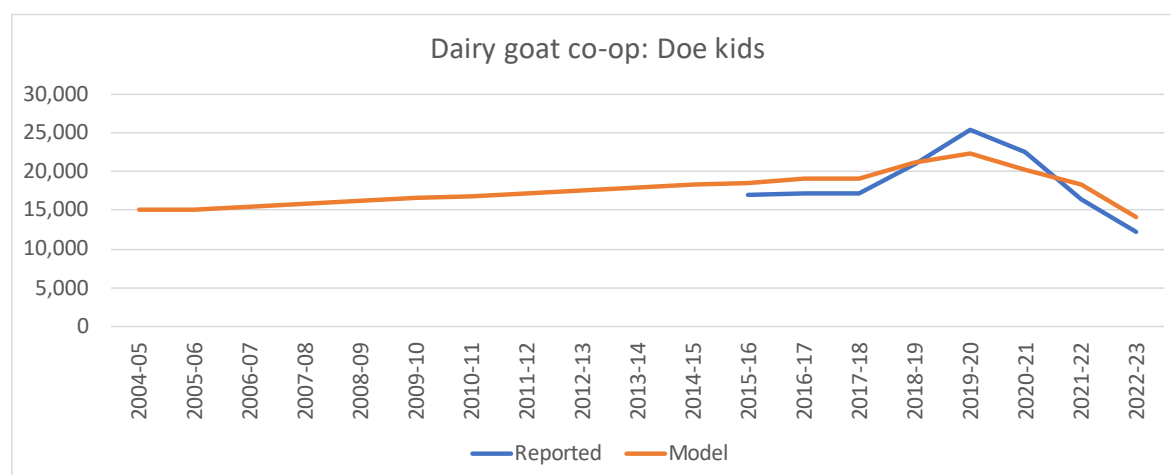
- Modelled numbers are based on assumed survival and slaughter parameters described above, with cull rates for the mixed age class set to reflect estimated and reported increases and decreases in mixed age doe numbers over time:
 - 17% through to 2016-17
 - 8-10% for 2018-19 & 2019-20 – reflecting the increase in the number of milking does (as reported by NZDGC)
 - 20-30% for the last 3 years (2020-21 to 2022-23)

Figure 36. Reported versus modelled numbers of mixed age (top) and maiden does (bottom).



Whilst these results show a close correlation between reported (estimated) and modelled stock numbers, in the absence of accurate slaughter data (by age) it is not possible to accurately characterise farmer behaviour. For the mixed age doe class, a similar pattern of results can also be achieved by increasing slaughter rates in the 0-1 age class (60%) and decreasing it within the mixed age class (13%). However, use of these parameters creates spurious results for the maiden doe (1-2 years) stock class, with the current model set-up expected to provide the most accurate characterisation of the industry given the limited information available. This is supported by modelled versus reported numbers of doe kids (Figure 37), with modelled results within 15% of reported kid numbers, and no attempt to further calibrate the model through adjustment of maiden doe survival rates.

Figure 37. Reported versus modelled numbers of doe kids.



Bucks (NZDGC model)

In dairy production, the number of bucks on hand is directly linked to the number of bucks required to service the does, however with only limited information on the average age of use³⁴ two separate scenarios were evaluated:

Scenario 1: Assume an average mating ratio of 20 buck's doe, with 80% of bucks first mated at 1-2 years of age, and 20% of those retained for use as mixed age bucks prior to culling post mating.

The number of bucks required was then calculated (for DGC suppliers in the 2004-05 season) as:

- $33,200 \text{ does} / 20 \text{ does/buck} / 1.2_{20\% \text{ used twice}} = 1,383 \text{ bucks required}$

Results are then adjusted to account for survival in the 1-2-year-age-group:

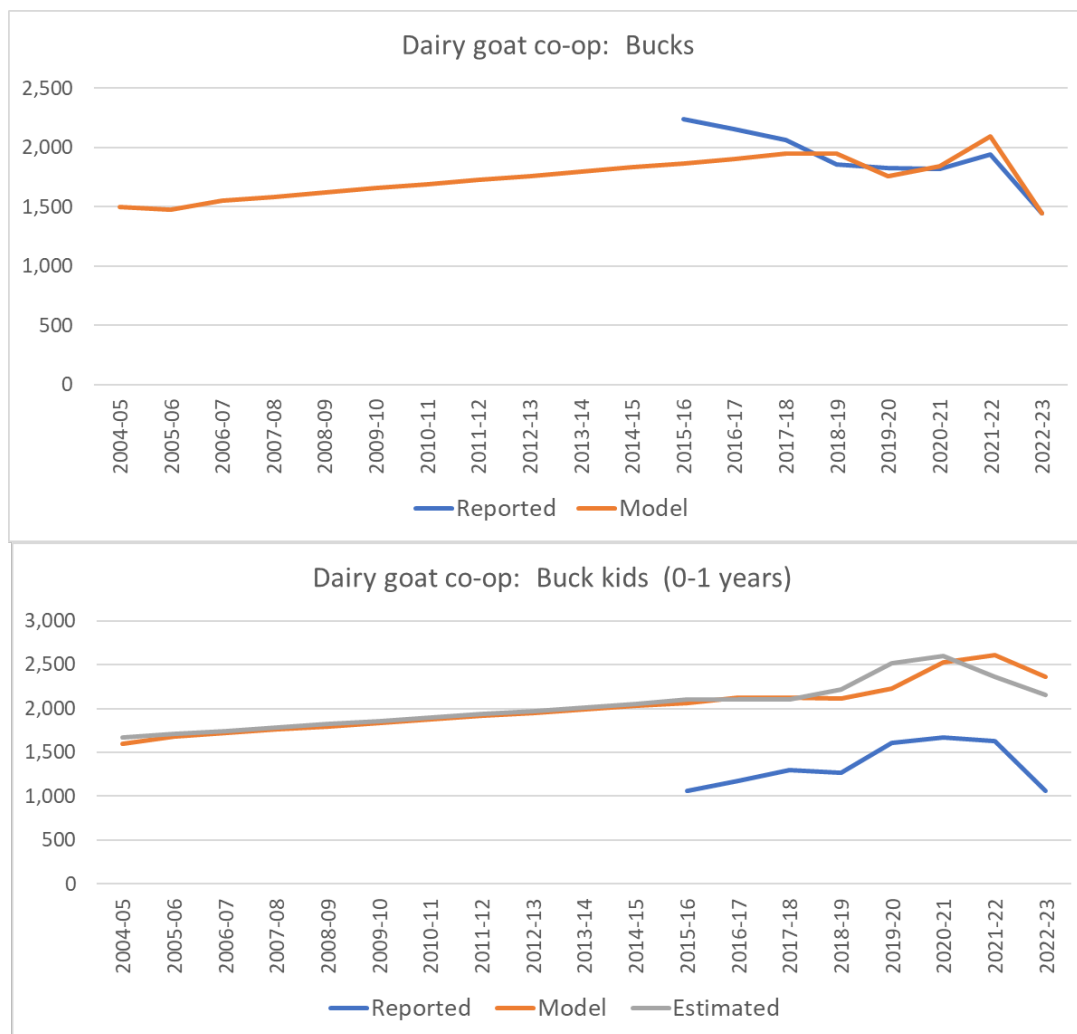
- $1,383_{\text{required}} / 0.92_{\text{survival}} = 1,671$

As per Step 3 of the doe model, the number of buck kids weaned is then used to implement the multi-year model framework, where survival rates of bucks aged 0-1 years (90%), 1-2 years (92%) and mixed age (92%) are assumed to mimic doe survival rates and remain unchanged over time. Using these assumptions, the model was then calibrated to align estimated and modelled numbers of bucks in the 0-1 age class and reported versus modelled in the adult buck classes. Figure 38 shows a comparison of reported versus modelled number of bucks on hand at the end of the year (top), and reported versus estimated and modelled number of buck kids (bottom) where:

³⁴ Question: What is the average age of a buck when its used? Answer: DGC (pers. comm): "We don't know actually – we could get an idea from buck kids versus bucks. Most bucks get used once with a few extra held for "just in case". In general, most bucks last 2 years and then a few special ones maybe last 3-4 years.

- 95% of kids of surviving kids are assumed to be slaughtered prior to June 30, resulting in a strong correlation between estimated numbers of bucks required, and modelled outcomes.
- As the herd size grew, none of the bucks in 1-2-year age group were slaughtered, with all surviving bucks transitioning to the mixed age stock class, and then slaughtered post mating (100% slaughter rate per annum).
- Once the starting herd contracting, 10-40% of bucks in the 1-2-year age group were slaughtered, enabling alignment of reported versus estimated buck numbers.

Figure 38. Reported versus modelled numbers of bucks and buck kids, where the model has been calibrated according to estimated number of Bucks required to service does (Buck scenario 1).



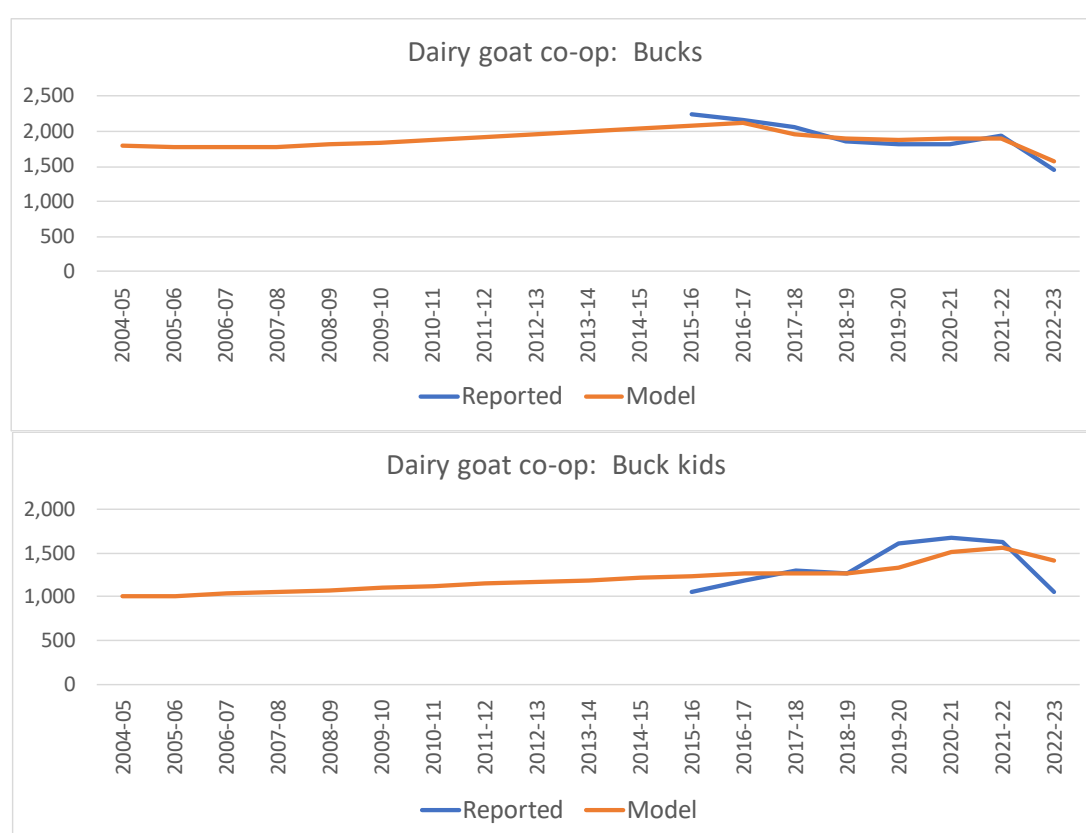
Whilst this scenario presents a relatively accurate representation of total buck numbers, calibration of the model using estimated versus report buck numbers, resulted in anomalies within both stock classes where:

- The 95% slaughter rate used to calibrate expected versus modelled number of kids in the 0-1 age group on hand at year end, resulted in insufficient stock reaching the 1-2 and mixed age stock classes, with a modelled deficit of 400 in the 2015-16 season.

- In contrast reported numbers of kids are significantly lower than estimated, suggesting that the slaughter numbers in the first year are significantly higher, and that some bucks are kept on hand and used for multiple years.
- Alternatively, if the number of does mated/buck increases from 20 to 30, then this approved the alignment between estimated and reported numbers of buck kids, however, that then worsens the shortfall identified within the mixed age group and is not seen as a realistic representation of the industry.

Scenario 2: The second scenario involved direct calibration of the model according to report stock numbers (Figure 39). These results were achieved by applying slaughter rates of 97% of surviving stock in the 0-1-year and 15% in 1-2-year age groups, with variable slaughter rates (40-80%) in the mixed age group used to align reported versus modelled outcomes.

Figure 39. Reported versus modelled numbers of bucks and buck kids (Scenario 2).



Whilst both scenarios enable calibration of the model to reflect the total number of dairy bucks reported by NZDGC, results from Scenario 2 are more strongly aligned with the reported stock estimates and have been assumed to be the 'best' representation of the dairy goat buck stock numbers. However, with buck numbers representing less than 5% of total dairy goat numbers (excluding kids), inclusion of either scenario within an updated version of the national inventory model is expected to have little impact on overall emission outcomes for goats.

Total dairy goat stock estimates

Non-DGC suppliers

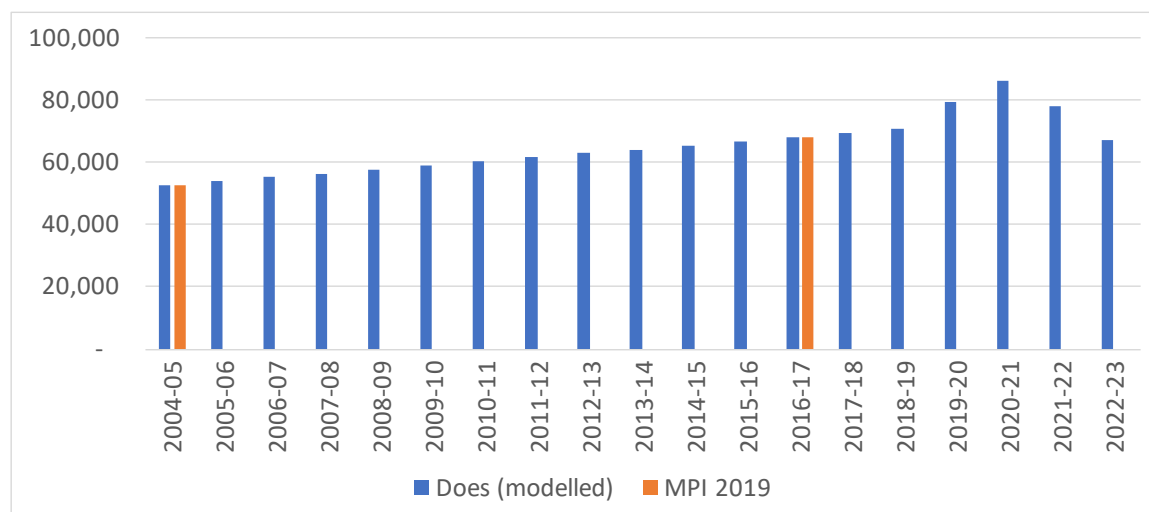
As outlined in Part I of this report, stock estimates provided by DGC are in alignment with earlier estimates developed by Burgraaf et.al, who estimated that in 2019 were 66,100 milking does in NZ, with approximately 80% of the milk processed by NZDGC (52,880 milking does, versus 55,479 reported for the 2018-19 season).

Whilst it has not been possible to ascertain the exact proportion of total goat milk production processed by DGC, recent estimates have ranged from 42%³⁵ to 90%³⁶. Feedback from DGC suggested that the recent reduction in total doe numbers was likely due to a reduction in DGC market share (pers. comm), with DGC suppliers now expected to account for 75-80% of total milk production.

In order to account for non-DGC suppliers, a simple scaling factor has been applied, with NZDGC producers assumed to account for 80% of milk production. This results in a 25% increase in total stock estimates, with no changes in the underlying age structure of does and bucks within the national herd.

Does: Figure 40 shows a comparison of model outcomes for does in the 1-2 and mixed age stock classes (post scaling), with results very closely aligned with 2019 MPI policy paper (Revisions to the national Inventory for goats).

Figure 40. Comparison of modelled doe numbers versus reported number of dairy goats.



Bucks: Inclusion of bucks from the 1-2-year and mixed age stock classes results in a 3-4% increase in stock numbers (3%), resulting in modelled estimates being slightly higher than previously reported. This could be offset by increasing the proportion of the industry

³⁵ <https://www.interest.co.nz/rural-news/123275/big-money-invested-picking-new-dairy-winner-hasnt-turned-out-well-investors>

³⁶ <https://www.mpi.govt.nz/funding-rural-support/primary-growth-partnerships-pgps/current-pgp-programmes/caprino-innovations-nz/>

represented by DGC suppliers from 80 to 85%, however for the purposes of this analysis, the 80% factor has been retained for consistency.

Kids: Results presented to date show strong alignment between reported and modelled outcomes for both does and bucks, however the national stock estimates indicate that kids (0-1 age class) are likely often omitted from annual stock reporting.

Figure 41 shows an example of survey data required for goats, and whilst there is a specific request to include all age groups within survey results, partitioning of the question into stock primarily used for milk versus other productions systems may create ambiguity, with kids not specifically referenced within the survey question.

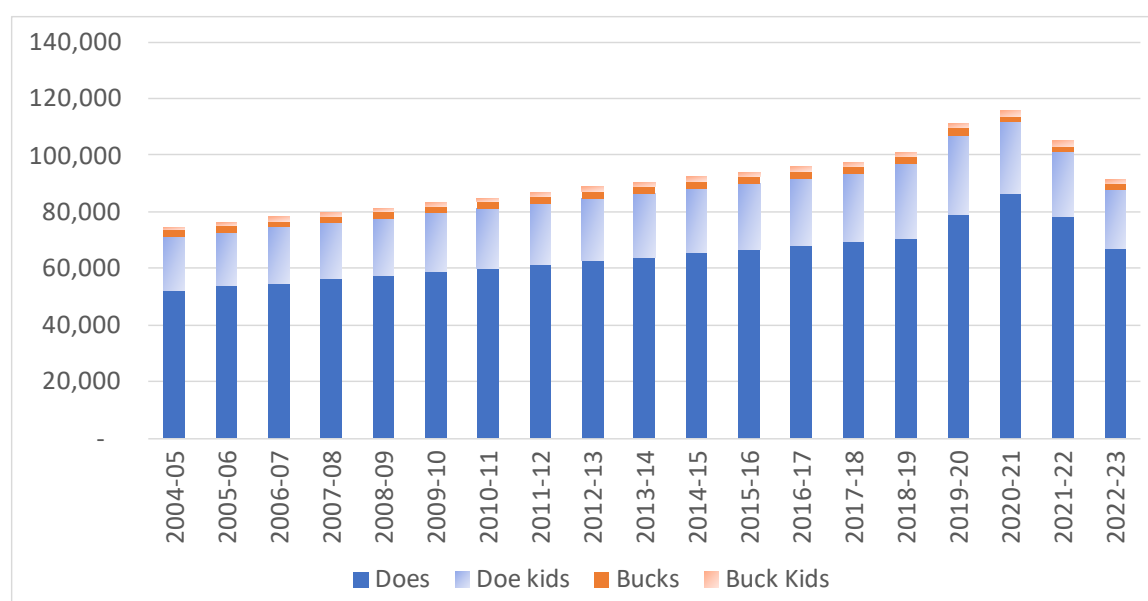
Figure 41. Animal Production Survey question pertaining to goats.

63 On 30 June 2022, how many of each type of **other farmed livestock** were on the farm, whether they were owned by the farming business or not?

goats (don't include wild goats)	number
• dairy goats used primarily for milk (include all ages)	8040
• goats used primarily for meat and/or other purposes (include all ages)	8045

Figure 42 shows model outcomes for total stock numbers (including kids) with kids estimated to account for approximately 25% of stock on hand at year end. This is higher than the 21% reported by Burgraaf et.al, 2019³⁷, but with closer alignment between reported and modelled outcomes for the 1–2-year-old does (18.1% vs 17.9%), this is expected to have little impact on overall population model outcomes.

Figure 42. Modelled numbers of does and bucks (including kids), assuming NZDGC producers account for 80% of the total NZ dairy goat industry.



³⁷ Burgraaf et.al (2019): Table 3

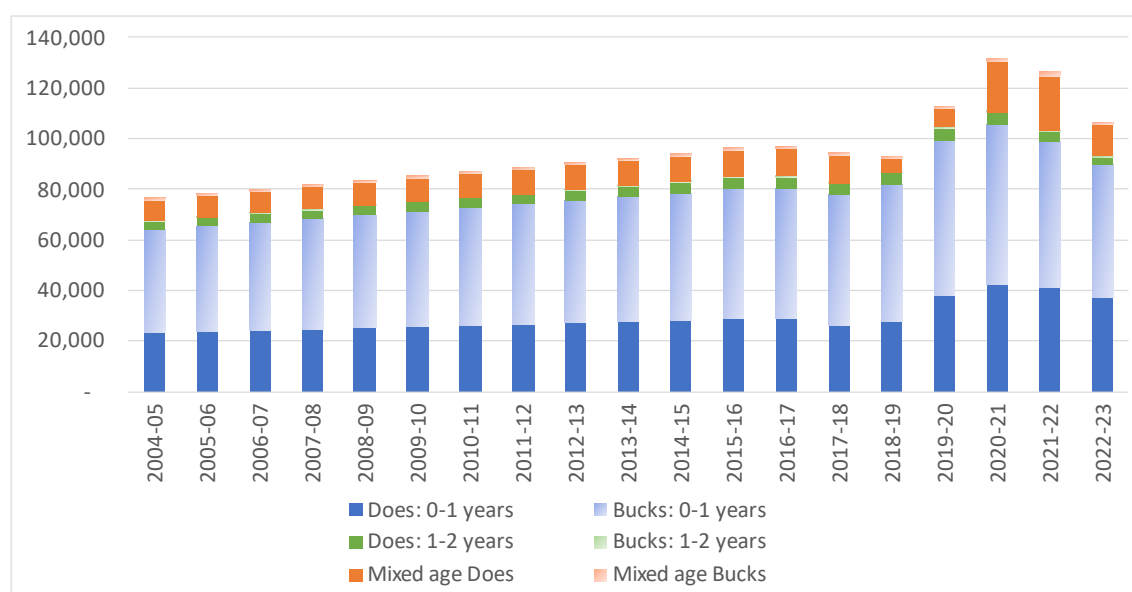
From an inventory perspective, with kids not currently included within the national inventory model (which is based on a Tier 1 methodology), kid numbers are irrelevant - however if a decision were to be made to transition to a Tier 2 reporting system, then consideration should be given to using the higher replacement rates (25%), as reported by NZDGC.

Dairy goat Slaughter

With the overarching goat population model dependent on combined stock estimates from the dairy, meat and wool sectors, and slaughter data used to derive pastoral and feral goat outcomes, slaughter estimates from each of these sectors are key inputs into determining feral and pastoral goat outcomes.

Figure 43 shows estimated dairy goat slaughter numbers (based on modelled outcomes) with the steep increases observed in the last few seasons reflected the downsizing of the national herd, including increases in the proportion of both doe kids, and mixed age does slaughter relative to earlier years.

Figure 43. Estimated numbers of dairy goats slaughtered (assuming that slaughter patterns for DGC suppliers are representative of the national herd).



Surplus kids

To date, the slaughter assumptions reported within the model represent the numbers of stock removed from the herd, excluding expected losses due to on farm deaths (misadventure, natural causes). Whilst this definition holds for most stock classes, consideration also needs to be given to both live exports, and age at death/slaughter within the kid stock classes.

To account for these factors within the dairy module, live export data³⁸ was used to estimate the number of surplus kids sold, assuming that all exports are all from the dairy sector, and that all stock exported expected to be in the 0-1 age group category. The remaining kids were then partitioned into groups including:

1. **Cabritos:** Kids raised for finishing, and typically slaughtered at around 9.5 kg (6-12 weeks of age). Within New Zealand, DGC is the only group known to cater to Cabrito production, with suppliers required to finish 50% of surplus kids, and Cabrito slaughter data provided for inclusion within the national slaughter statistics.
2. **Bobbies:** Kids slaughtered/disposed of at birth, and not included within the national slaughter statistics.

Figure 44 shows estimates of surplus kid numbers, with only the Cabrito estimates used to represent kid slaughter within the wider model.

Figure 44. Surplus kid estimates, with kids slaughtered as Cabritos included with the dairy goat slaughter dataset.

Figure 44 removed as data in confidence.

Meat module

Data provided by Garrick Batten on Boer goats has been used to populate the meat module. Figure 45 shows modelled versus reported changes in the number of Boer does over time, and Figure 46, modelled and reported age group outcomes, where:

- Survival rates are in alignment with those applied within the dairy module, at 90%, 92% and 95% for the 0-1, 1-2 and mixed age groups respectively.
- Slaughter rates have been used to calibrate the model (by age group), with slaughter rates low for all stock classes prior to the 2010-11 season enabling increases in model stock numbers as per the reported data, and then increasing from 2010 onwards as total numbers of does fell.
 - 0-1 age group: 5%-25%
 - 1-2 age group: 10-50%
 - Mixed age group: 0-25%

Similar results were also achieved for bucks, where total buck numbers peaked at 1,900 in the 2010-11 season (Figure 47) with 55% assumed to be mixed age bucks, and similar numbers in the 0-1 and 1-2 age classes (Figure 48).

³⁸ <https://infoshare.stats.govt.nz/TradeVariables.aspx?DataType=TEX>

Figure 45. Comparison of modelled versus reported changes in the number of meat (Boer) goat does over time.

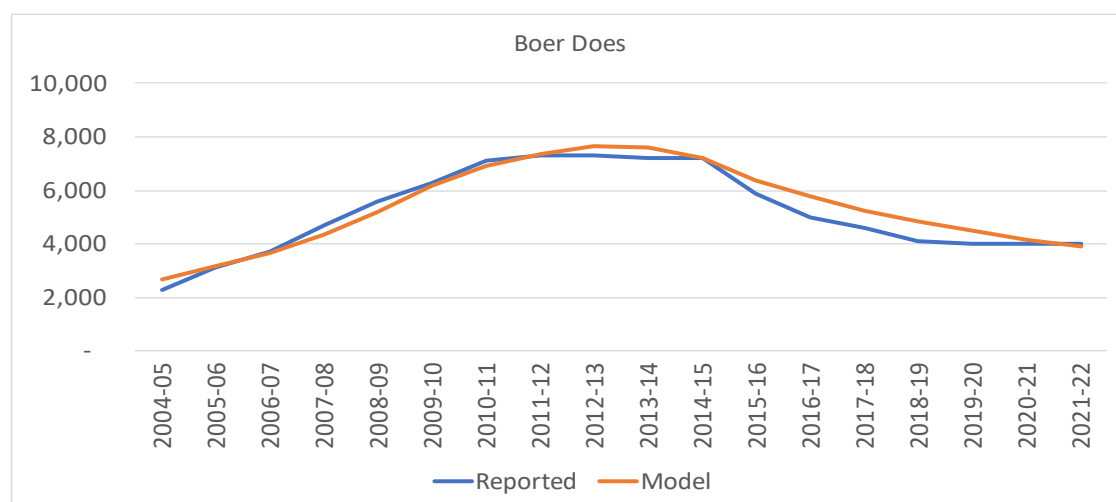


Figure 46. Comparison of modelled versus reported changes in the number of meat (Boer) goat does (by stock class over time.

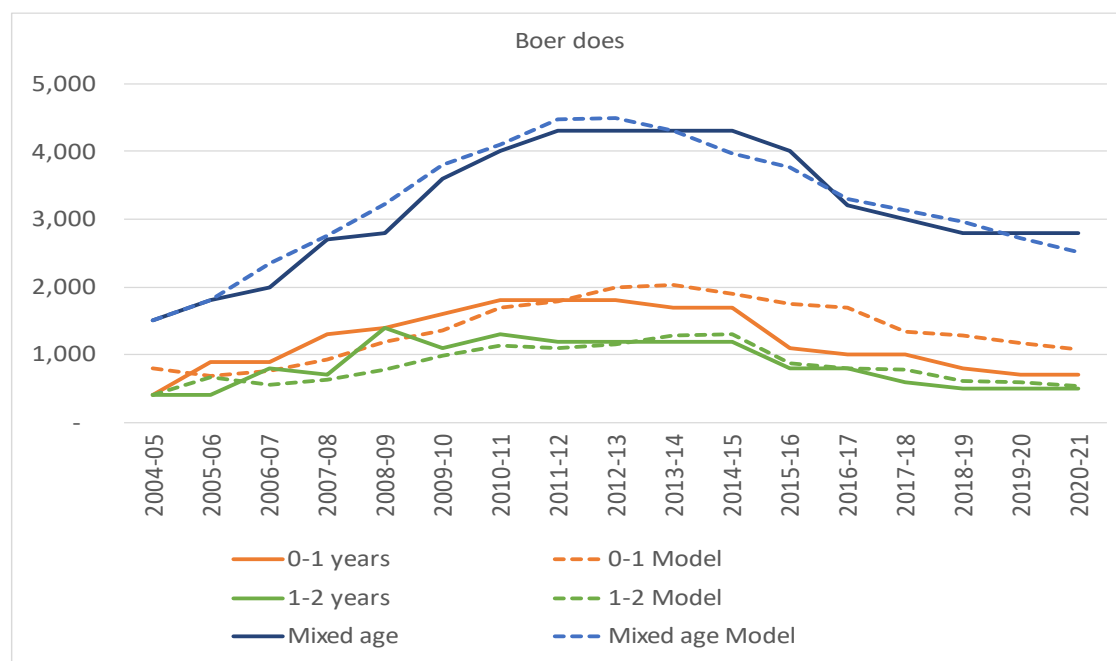


Figure 47. Comparison of modelled versus reported changes in the number of meat (Boer) goat bucks over time.

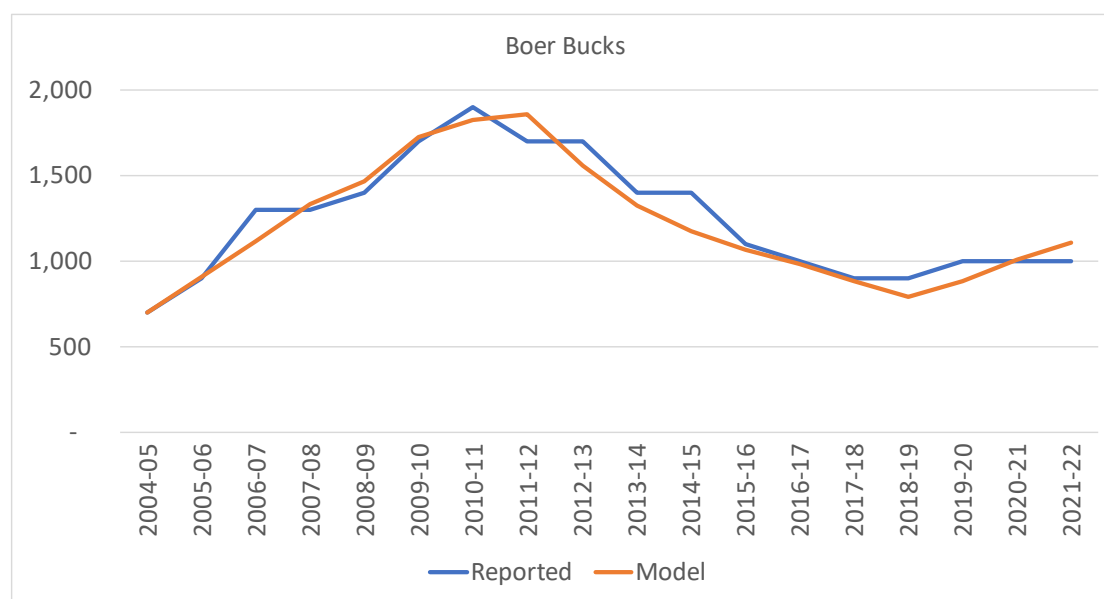
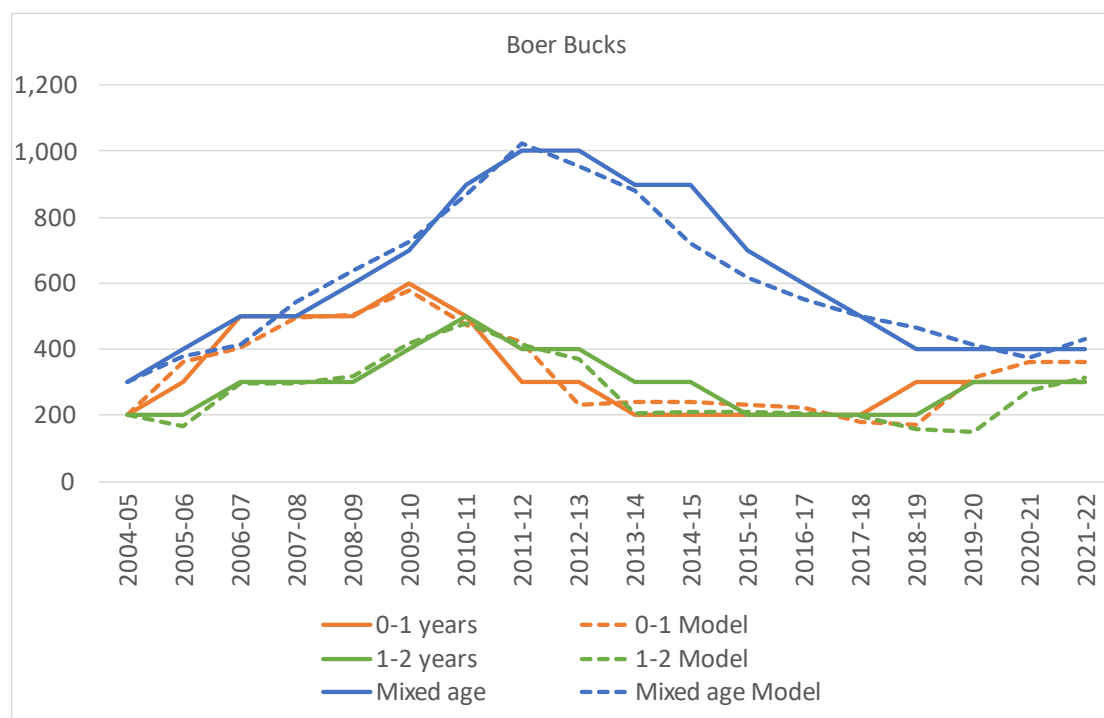


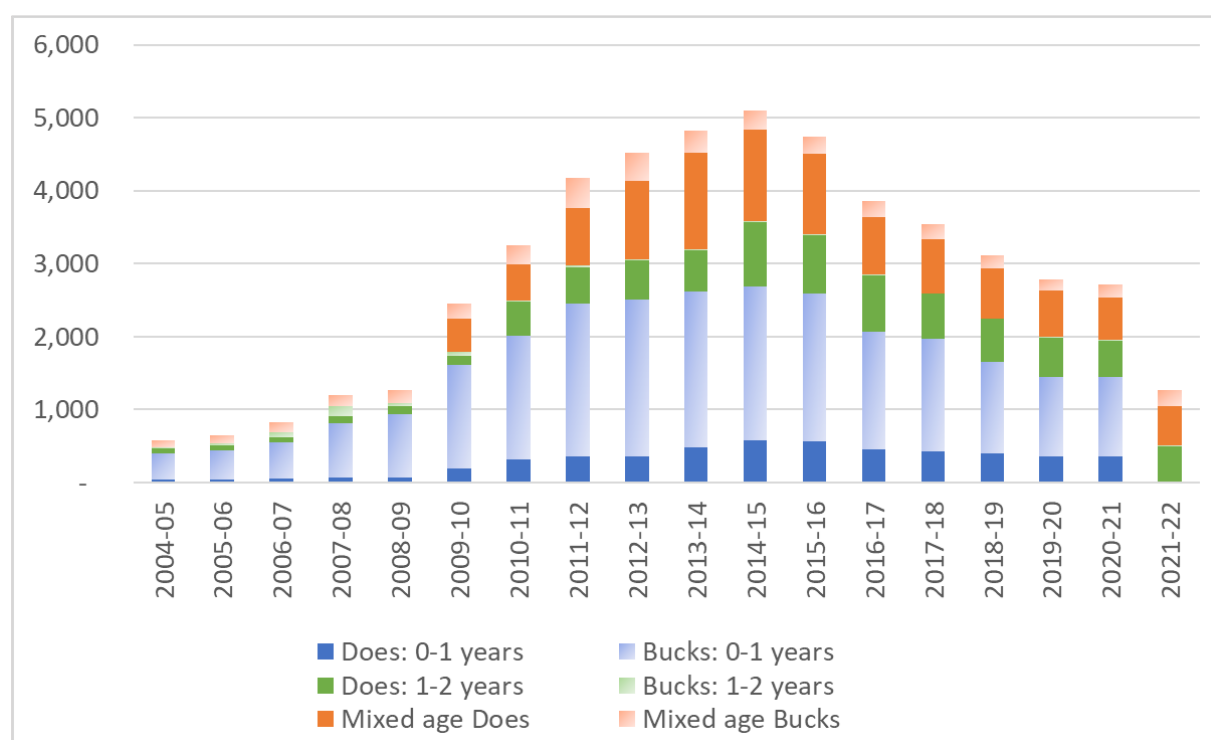
Figure 48. Comparison of modelled versus reported changes in the number of meat (Boer) goat bucks by stock class over time.



Meat goat slaughter

Figure 49 shows changes in the estimated number of meat goats slaughter, with the pattern of slaughter mimicking changes in reported stock numbers, and the slaughter data dominated by culling of young bucks once they reach slaughter weight (25-30 kgs live-weight) at 6-8 months of age.

Figure 49. Estimated number of Boer (meat) goats slaughtered.



It is important to note, that within any of the industry sectors, the ability to slaughter goats is heavily dependent on both the availability and capacity of meat processors capacity to slaughter goats on demand. Therefore, it is highly likely that in some seasons, young bucks will still be present on farm at year end (30 June).

Fibre module

Data provided by Garrick Batten on Boer goats has been used to populate the fibre module, where with very few Cashmeres or Cashgora goats remaining, this module effectively reflects stock numbers for the Angora goat industry.

Figure 50 shows modelled versus reported changes in the number of Angora does over time, and Figure 51 modelled and reported age group outcomes, where:

- Survival rates are the same as those applied within the meat module, at 90%, 92% and 95% for the 0-1, 1-2 and mixed age groups respectively.
- Slaughter rates have been fixed within each of the age groups, where within a relatively stable (albeit declining) population, doe slaughter appears to have remain consistent at 10% for the 0-1 age group, 5% for the 1-2 age group, and 30% for mixed age does.

Similar results were also achieved for bucks (Figure 52) with an average of 3,000 angora bucks (including wethers) on hand over time. Results for the individual stock classes were a little more ambiguous, with minor discrepancies in the number of young bucks required to achieved reported stock numbers in the 1-2 and mixed stock classes (Figure 53). However,

with reported stock numbers rounded to the nearest 500, these anomalies are likely due to rounding errors, and no attempt has been made to made further adjustments through ‘fine tuning’ of the cull rates within the 0-1 age group (92%).

Figure 50. Comparison of modelled versus reported changes in the number of fibre (Angora) goat does over time.

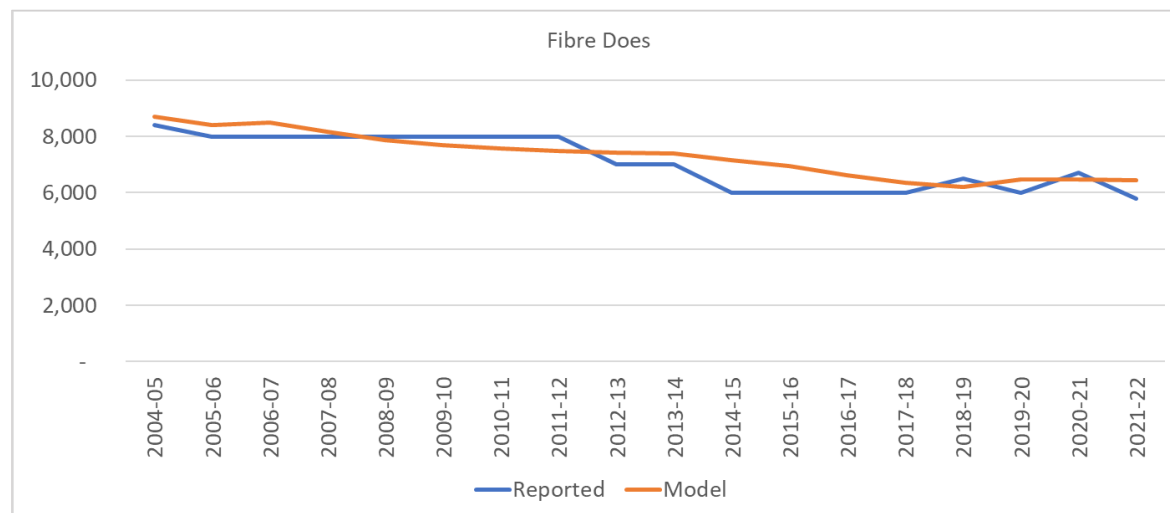


Figure 51. Comparison of modelled versus reported changes in the number of fibre (Angora) goat does (by stock class) over time.

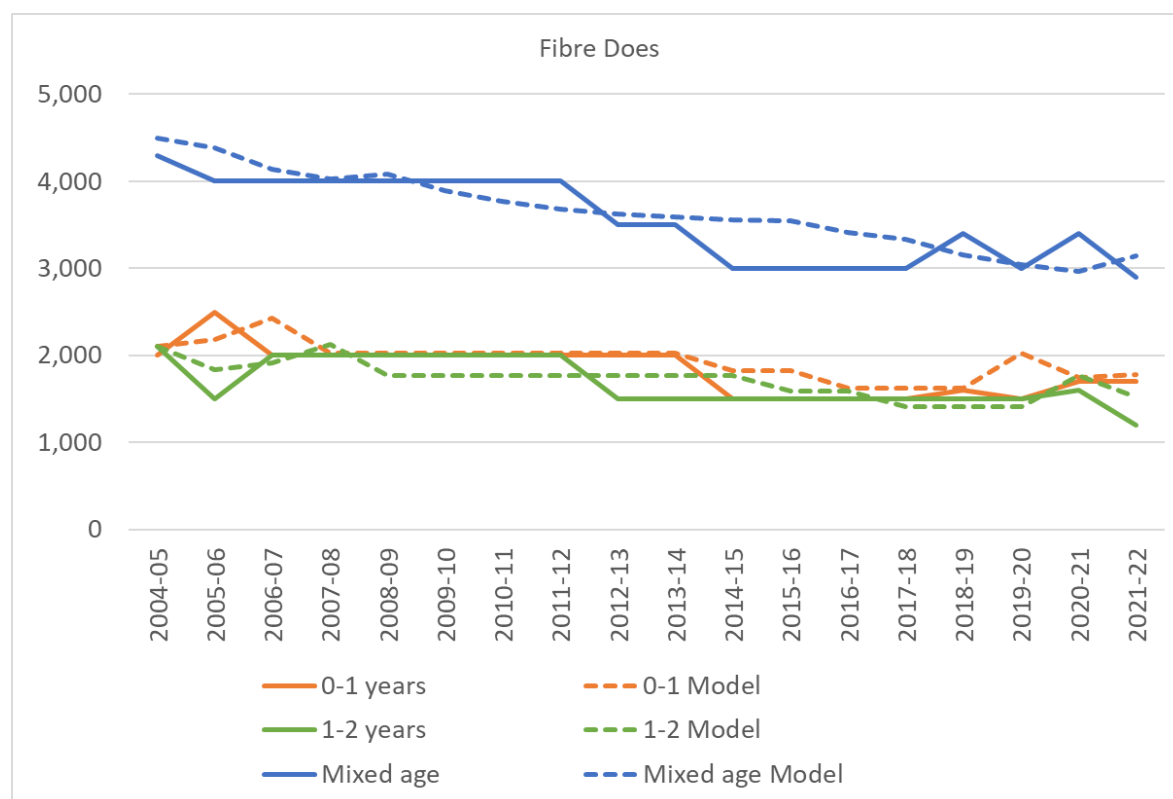


Figure 52. Comparison of modelled versus reported changes in the number of fibre (Angora) goat bucks over time.

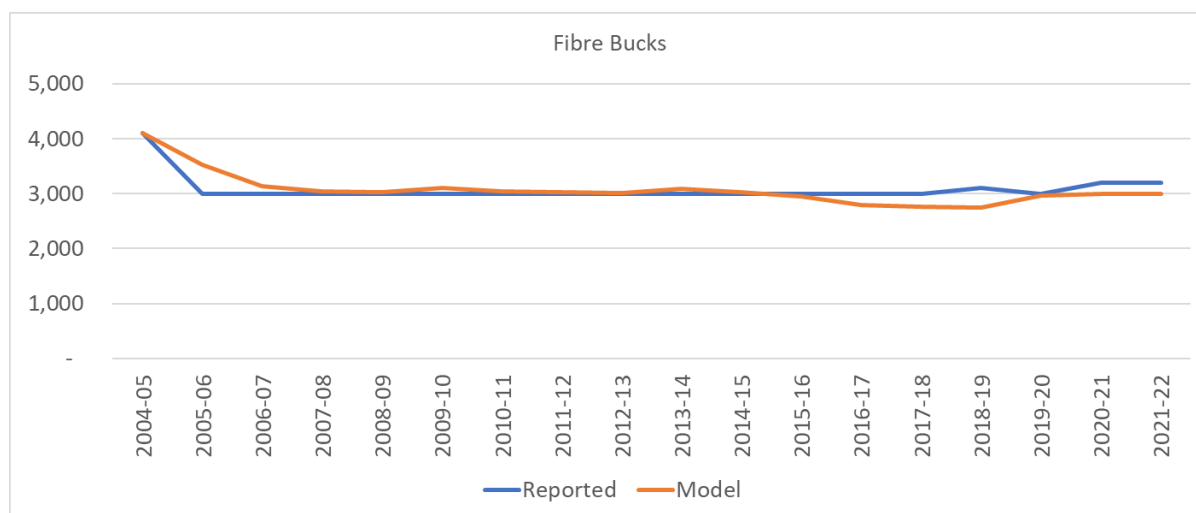
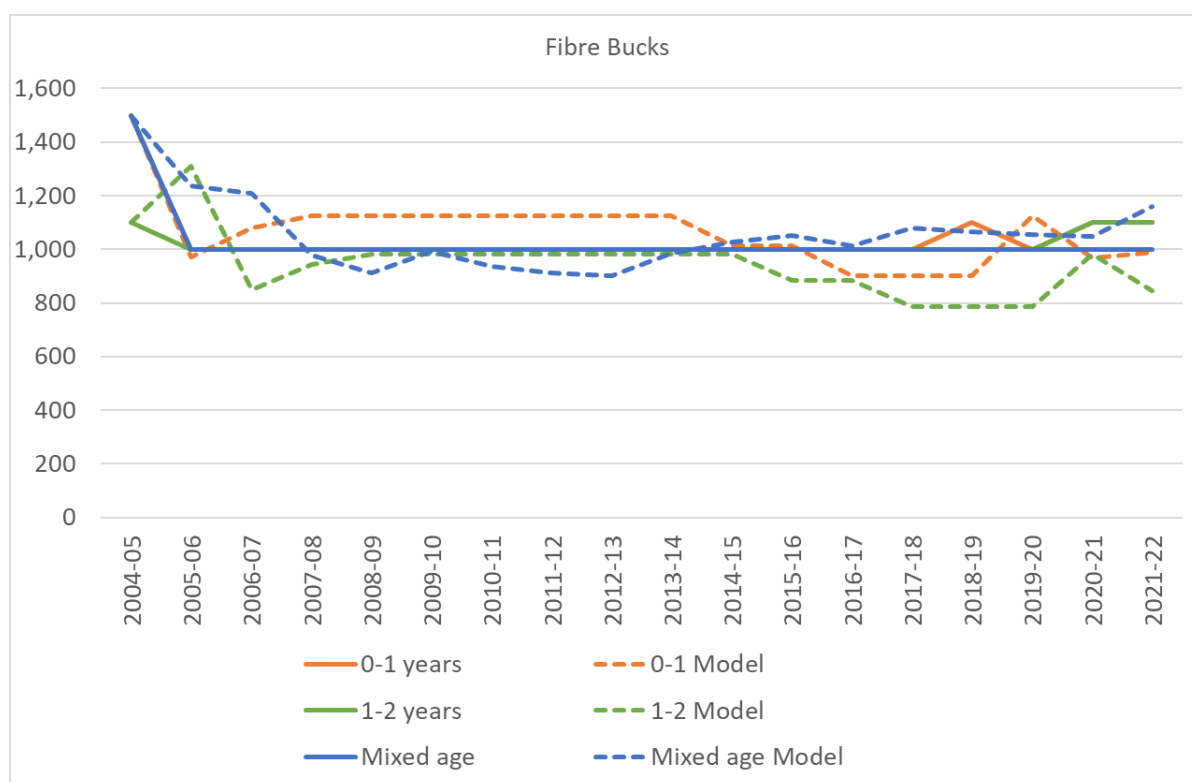


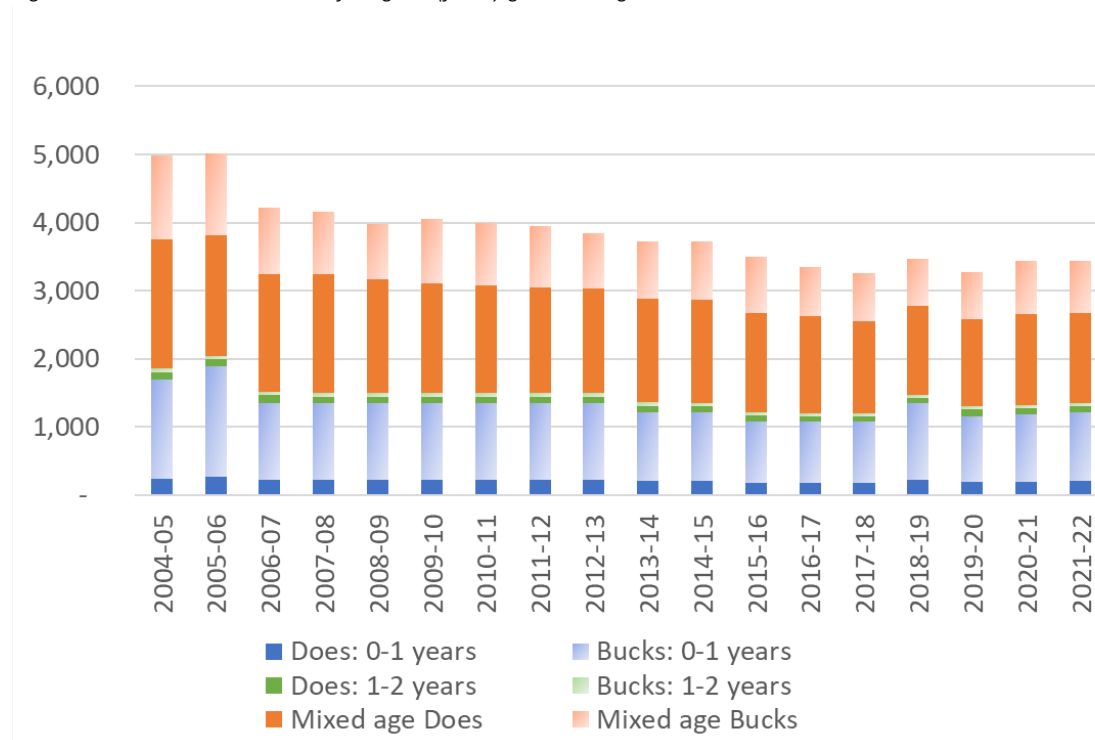
Figure 53. Comparison of modelled versus reported changes in the number of fibre (Angora) goat bucks (by stock class over time.



Fibre goat slaughter

Figure 54 shows changes in the estimated number of fibre goats slaughtered, with the pattern of slaughter remaining consistent over time.

Figure 54. Estimated number of Angora (fibre) goats slaughtered.



Subtraction model

Pastoral goat estimates

With strong alignment between reported and modelled estimates for the dairy, meat, and fibre goat sectors, the next step in the process is to do a reconciliation between total goat numbers (as reported by Statistics NZ) and modelled stock numbers for the 3 different industry sectors.

Table 15 shows a summary of total stock estimates for both bucks and does (by age) in the combined dairy, meat, and fibre sectors. Total stock numbers have then been calculated including and excluding kids, relative to stock estimates reported by Statistics New Zealand, where:

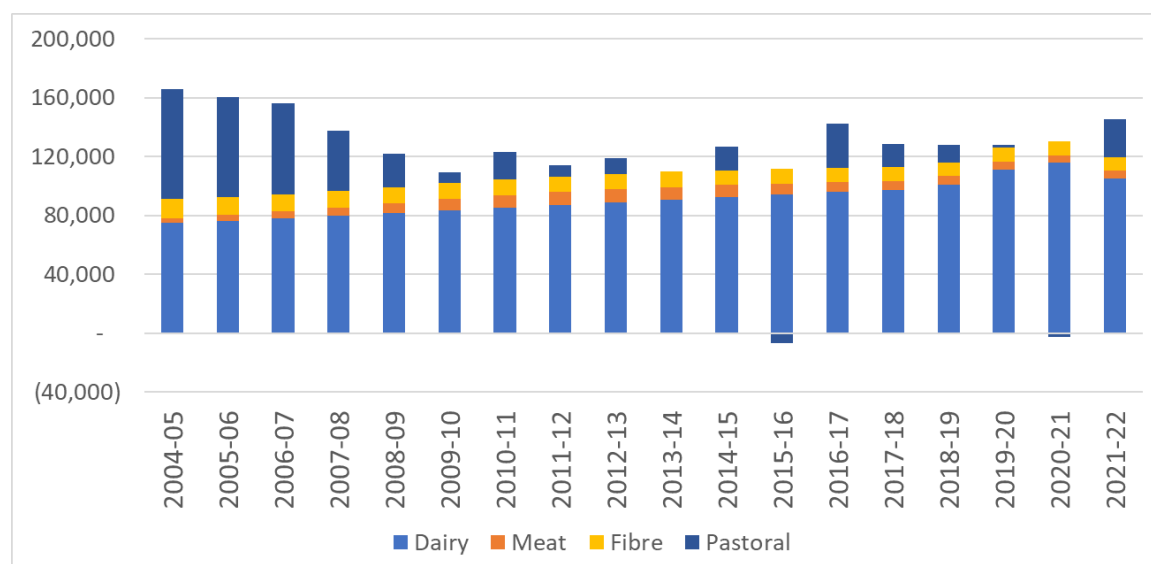
- If kids are included, modelled stock numbers are significantly higher than reported, where on average, kids account for 26% of total estimated stock numbers.
- If kids are excluded (as per the DGC dairy data), then differences between reported and estimated stock numbers are more closely aligned, with the missing stock assumed to represent the “pastoral goat” sector which includes feral goats allowed to graze on farm for the purposes of pasture management, and potentially on-farm at year end (June 30).

Table 15. Total stock estimates for the combined dairy, meat & fibre sectors, compared to reported stock numbers.

	Does				Bucks				Combined				Total		Reported (Stats NZ)	Difference	
	0-1 years	1-2 years	Mixed age	Total	0-1 years	1-2 years	Mixed age	Total	0-1 years	1-2 years	Mixed age	% kids	Incl. kids	Excl. kids		Incl. kids	Excl. kids
2004-05	21,650	15,000	46,000	82,650	2,950	2,300	3,050	8,300	24,600	17,300	49,050	27.0%	90,950	66,350	141,206	50,256	74,856
2005-06	21,805	16,298	46,283	84,386	2,594	2,454	2,857	7,905	24,399	18,752	49,140	26.4%	92,291	67,892	136,120	43,829	68,228
2006-07	22,564	16,413	47,633	86,609	2,776	2,135	2,849	7,760	25,340	18,548	50,482	26.9%	94,369	69,030	131,033	36,664	62,003
2007-08	22,760	17,013	48,851	88,624	2,940	2,252	2,741	7,932	25,700	19,264	51,592	26.6%	96,556	70,857	111,981	15,425	41,124
2008-09	23,447	17,117	50,322	90,886	2,977	2,334	2,782	8,094	26,424	19,451	53,104	26.7%	98,980	72,556	95,731	-3,249	23,175
2009-10	24,048	17,646	51,667	93,361	3,078	2,455	2,967	8,500	27,126	20,101	54,634	26.6%	101,861	74,735	82,229	-19,632	7,494
2010-11	24,811	18,105	52,808	95,724	3,003	2,537	3,079	8,619	27,815	20,642	55,887	26.7%	104,343	76,528	95,281	-9,062	18,753
2011-12	25,338	18,384	54,081	97,804	2,982	2,495	3,232	8,710	28,321	20,880	57,314	26.6%	106,514	78,193	85,970	-20,544	7,777
2012-13	25,960	18,763	55,042	99,765	2,822	2,475	3,178	8,475	28,782	21,238	58,220	26.6%	108,240	79,458	90,096	-18,144	10,638
2013-14	26,429	19,203	55,805	101,436	2,855	2,332	3,214	8,402	29,284	21,535	59,019	26.7%	109,838	80,554	79,977	-29,861	-577
2014-15	26,537	19,544	56,463	102,544	2,771	2,358	3,126	8,256	29,309	21,903	59,589	26.5%	110,800	81,491	97,370	-13,430	15,879
2015-16	26,814	19,256	57,243	103,314	2,796	2,282	3,073	8,151	29,610	21,539	60,316	26.6%	111,465	81,855	74,718	-36,747	-7,137
2016-17	27,148	19,503	57,671	104,321	2,714	2,301	2,993	8,008	29,862	21,803	60,664	26.6%	112,329	82,467	112,385	56	29,918
2017-18	26,807	19,739	58,421	104,967	2,669	2,226	2,798	7,694	29,476	21,965	61,219	26.2%	112,660	83,184	98,812	-13,848	15,628
2018-19	29,385	19,581	59,200	108,166	2,660	2,187	2,660	7,506	32,044	21,768	61,860	27.7%	115,672	83,628	96,209	-19,463	12,581
2019-20	31,052	21,497	65,541	118,089	3,111	2,179	2,560	7,850	34,163	23,675	68,101	27.1%	125,939	91,777	93,606	-32,333	1,829
2020-21	28,102	22,808	71,115	122,025	3,224	2,565	2,498	8,287	31,326	25,373	73,613	24.0%	130,311	98,986	96,416	-33,895	-2,570
2021-22	25,715	20,625	64,903	111,243	3,309	2,643	2,467	8,419	29,024	23,268	67,370	24.3%	119,662	90,638	116,666	-2,996	26,028

Figure 55 shows an overview of estimated numbers of pastoral goats (excluding kids) with pastoral goats estimated to account for 50% of total stock numbers in 2005, reducing to an average of 9% over the last 10 years. In the 2015-16 season, modelled stock numbers were 10% higher than reported, with minor differences also seen in the 2013-14 & 2020-21 seasons. These results are possibly not that unexpected (due to the transient nature of pastoral goat usage) with further commentary on feral goats provided below.

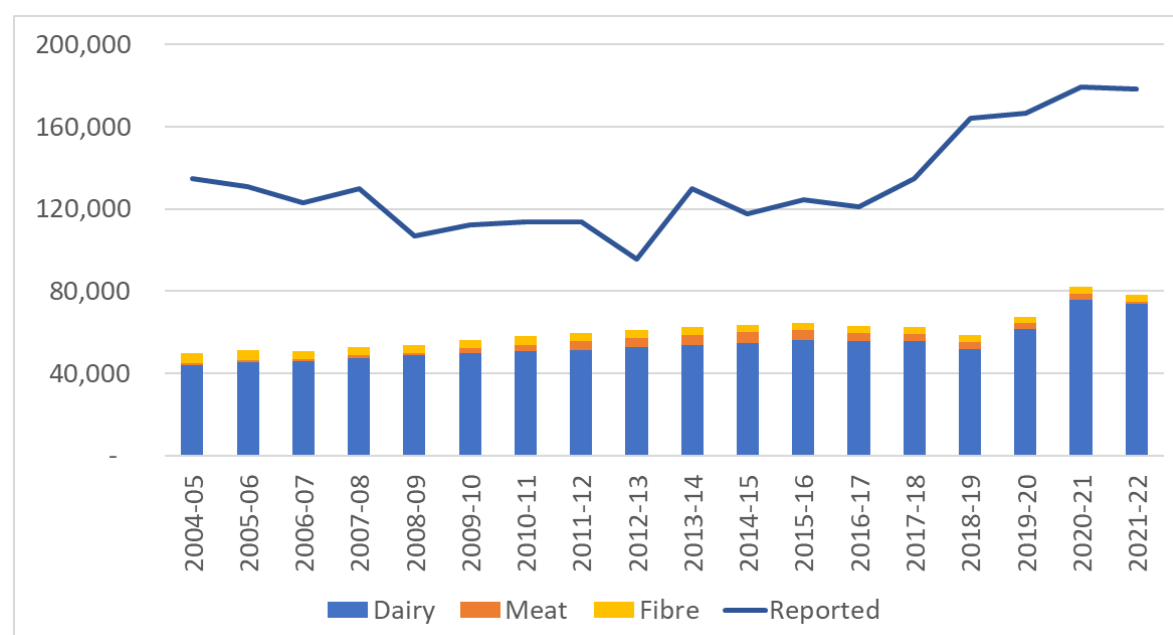
Figure 55. Estimated numbers of pastoral goat numbers (excluding kids) relative to other industry groups.



Feral goat estimates

Figure 56 shows a comparison of reported versus estimated (modelled) numbers of goats slaughtered from the dairy, meat, and fibre goat sectors, with approximately twice as many as slaughtered than expected. Once again, differences in reported versus modelled outcomes are attributed to feral goats – where usage of feral goats for pasture management is likely higher than reported, and large numbers of pastoral/feral goats captured and slaughtered pre-winter, and not present on farm at year end.

Figure 56. Comparison of reported versus estimated (modelled) numbers of stock slaughtered from the dairy, meat, and fibre goat sectors.



A simple model has therefore been developed to estimate the minimum size of the feral goat population, where:

- The kidding rate for feral goats has assumed to be low, with 0.8 kids weaned per doe (1-2 and Mixed age stock classes).
- Survival rates are lower than farmed goats and estimated at 80% for does and 90% for bucks.
- Model was calibrated using cull rates of 10% for kids, and 7%-9% of stock in the 1-2 and mixed age groups, increasing to 15% in later years.

Under these assumptions, the feral goat population is estimated at 0.4-0.6 million, with a 30% reduction since 2016 with inclusion of kids resulting in a 20% increase in total stock estimates (Figure 57). In this scenario, the number of feral/pastoral goat slaughters has increased from 55,000 in 2015 to 90,000 over the last 4 years (Figure 58), with these numbers reflecting the estimated reduction in feral goat numbers.

Increasing the cull rate to 15% across all age groups and years, resulting in a significant decline in total stock estimates (0.2M by 2021) and insufficient stock on hand to meet the estimated slaughter deficit (Figure 59).

With no certainty over either the kidding rates or survival/slaughter assumptions used within the feral goat model, modelled estimates are indicative only and should not be considered for further use.

Figure 57. Estimated feral goat numbers (including and excluding kids), assuming cull rates of 10-15%.

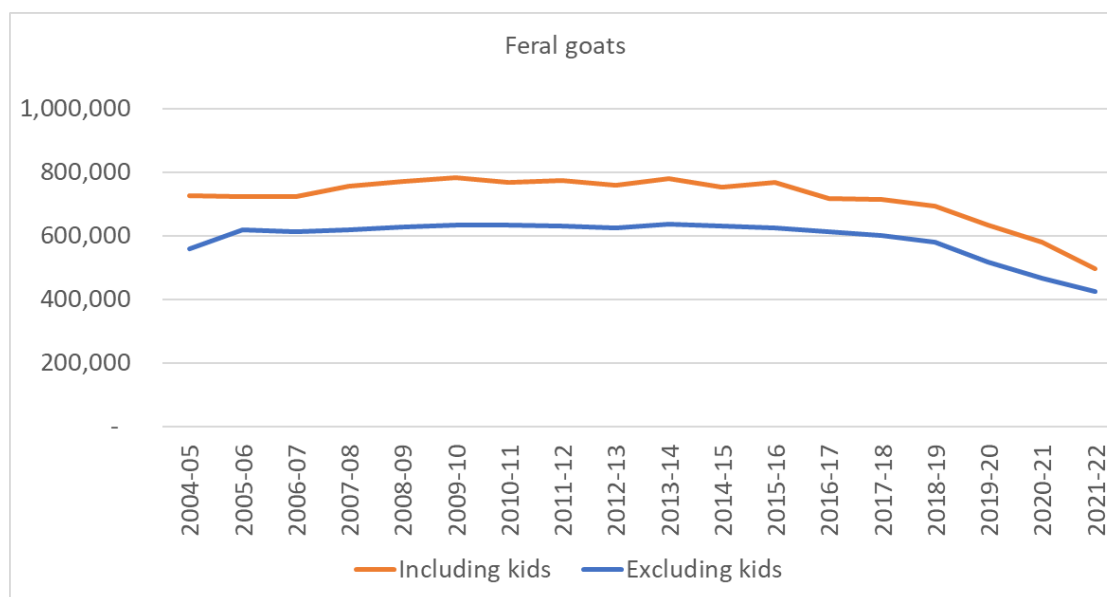


Figure 58. Modelled slaughter outcomes for the feral/pastoral goat sector based on the estimated slaughter deficit.

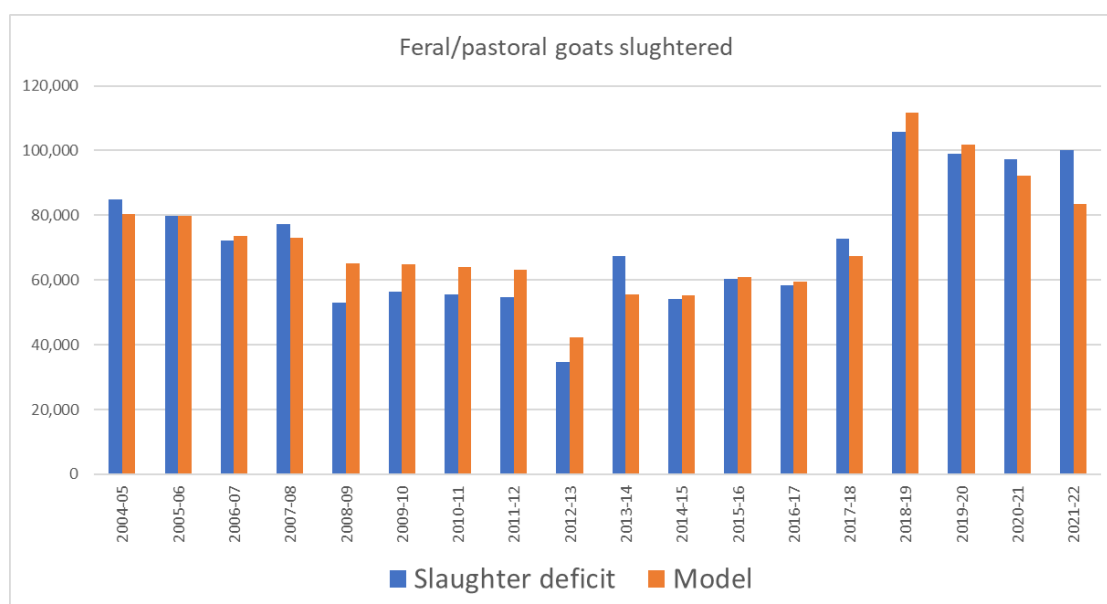


Figure 59. Impact of increasing the cull rate to 15% across all stock classes and years.



Discussion

Development of a multiyear population model has enabled a close evaluation of reported changes in the goat industry since 2005.

Whilst modelled versus reported stock numbers for the dairy goat industry (since 2015) are well aligned, failure to ascertain accurate data around the number of dairy goats farmed by non-DGC suppliers provides a level of uncertainty within the dairy goat stock estimates. Additionally, whilst there are only very small numbers of meat and fibre goats, feral goat numbers are likely very large, with provisional estimates suggesting they are likely to account for over 80% of total goats in New Zealand (Figure 60). The transitional nature of

feral goats being used for pasture management has also created anomalies within the national inventory methodologies, with feral goats not included within the inventory but estimated to account for 50-60% of goats slaughtered (Figure 61).

- It is important to note that other feral animals (including wild deer and pigs) are also excluded from the inventory. However, in the advent of these stock classes being captured and slaughtered for monetary gain (meat value), there could be an argument for inclusion of slaughter stock within the inventory methodology.

Figure 60. Estimated proportion of stock (excluding kids) within the dairy, meat, fibre, and pastoral/feral goat sectors.

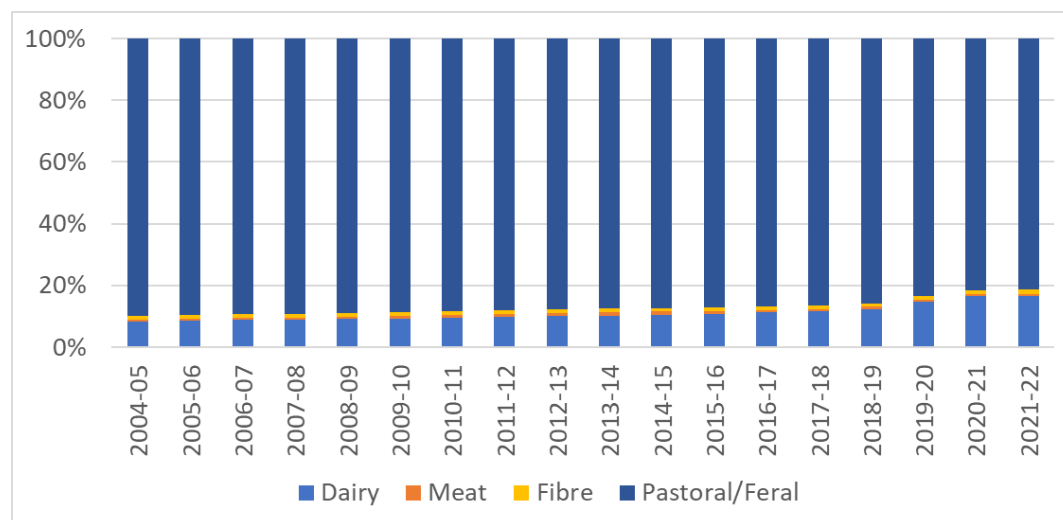
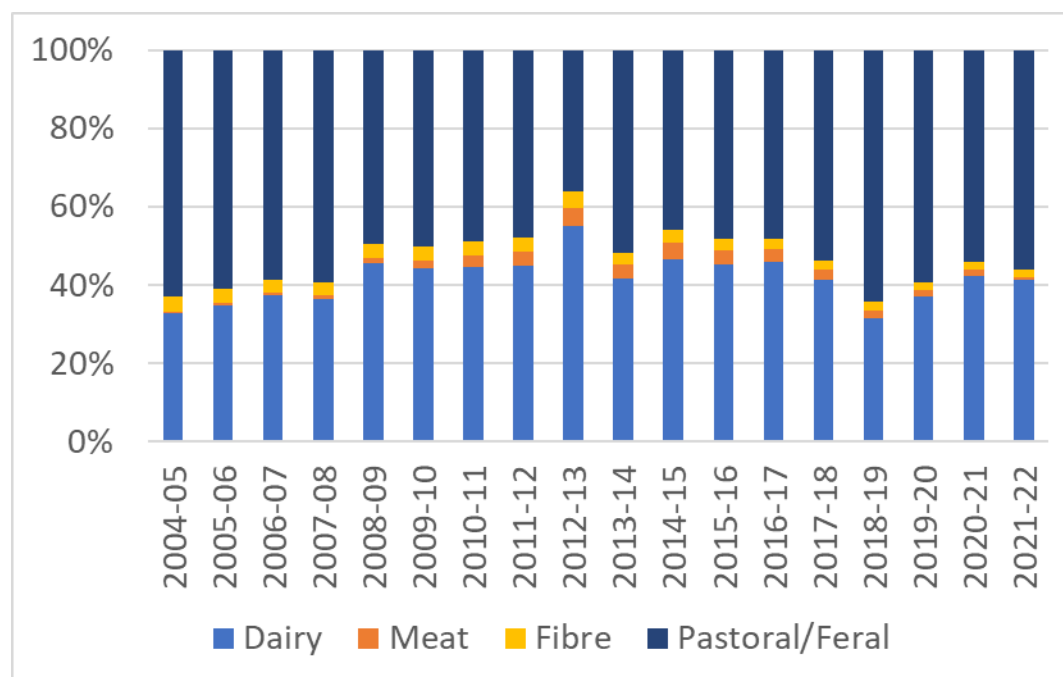


Figure 61. Origin of slaughter stock (modelled outcomes by sector).



Despite the uncertainties, 3 clear issues have been identified for consideration, with each of these factors needing to be addressed if there was a requirement to shift to a Tier 2 inventory methodology.

1. The proportion of dairy goats included within the DGC stock estimates, and the impact of differences in reproductive, survival and slaughter parameters in non-DGC herds (including lifestyle block) may have on overall dairy goat population model outcomes.
2. Exclusion of kids from stock estimates used within national inventory model calculations.
3. Impact of feral goats used for pasture management, and flow-on impacts within the national slaughter statistics.

Dairy goat model parameters

Within the current inventory model, annual enteric methane (per goat) is impacted by the proportion of milking goats³⁹ within the national goat population. With no certainty over either the historical proportions of dairy goats represented within the DGC dataset, then variations in these assumptions will impact on the total proportion of dairy goats within the national statistics and have a correspondingly small (but potentially significant) impact on estimated methane outcomes.

It will also have a flow on impact on the numbers of kids on hand at year end, and on feral/pastoral stock estimates, where if the percentage of dairy producers supplying to DGC were to be reduced- then total stock numbers would increase. This would increase stock slaughter estimates, thus resulting in a shrinking of the differences between modelled versus reported numbers of stock slaughtered.

With most dairy goats expected to be managed within commercial farming operations (as opposed to lifestyle blocks⁴⁰) solidifying the parameters associated with the proportion of stocks accounted for within the DGC dataset would provide further certainty over dairy stock numbers. This could be achieved by an in-depth analysis of changes in the Cabrito slaughter data relative to production statistics, with neither of these datasets available for use within this project.

Additional analyses could also be undertaken to look at the geographic spread of dairy goat producers, and in conjunction with feedback from the Dairy Goat breeders Society, may help further the understanding of the proportion of industry covered by NZDGC.

Exclusion of kids from the national inventory:

At an average weaning weight 19.7 kg, increasing to 48 kg by one year of age (dairy goats), inclusion of kids within a Tier 2 methodology is expected to have a small but significant impact on total goat GHG emissions. With results from this analysis suggesting that dairy account for 80-90% of farmed goats numbers (excluding pastoral/feral goats) –

³⁹ Methodology for calculation of New Zealand's agricultural greenhouse gas emissions, version 8 (April 2022): Equation 6.11

⁴⁰ See Table 2: average number of goats per farm.

consideration could be given to increasing total stock numbers by 25% (as per the dairy data).

- Within the existing Tier 1 system, these additional goats would be included within the (non-milking goat category) for the purposes of methane estimation.
- This would result in an apparent shrinking of the gap between the numbers of goats reported versus slaughtered, however does nothing to address the shortfall within the population model itself, with these stock fully accounted for within the slaughter assumptions (1-2-year and mixed age) in subsequent years.

Impact of feral goats in pasture management

With no requirement to include feral goats within the inventory, and stock estimates within this report developed for discussion purpose only, a detailed analysis of the feral goat sector has not been undertaken.

However, with feral goats likely to account for 50-60% of goats slaughtered, consideration could be given to gaining further a deeper understanding of the use of feral goats for pasture management, with a key emphasis being to understand seasonal grazing patterns, including the average amount time spent “on farm”. This could be achieved through a targeted survey of sheep and beef farmer’s, with result then used to inform decisions on inclusion of these stock (as non-milking goats) within the national inventory. However, concerns around inclusion of these stock within on-farm carbon calculators may inhibit some farmers from sharing this type of information with care required to ensure that their concerns are addressed.

Discussion / Recommendations

Development of a multiyear population model has enabled a close evaluation of reported changes in the goat industry since 2005. However, there is still considerable uncertainty over the exact composition of the national herd, and whilst shifting to a Tier 2 methodology may increase the accuracy of goat GHG emission estimates, further research is required prior to developing a detailed plan for transition.

Uncertainties within the population model are primarily centred around the composition of the national herd, and discrepancies between the numbers of goats on farm, versus goats slaughtered each year, with the following steps recommended for resolution of some of these concerns.

1. Accessioning and in-depth analysis of changes in both the Cabrito slaughter, and total dairy goat production sets with a view to solidifying estimates of the proportion of milking goats relative to total goats reported.
 - a. Engagement of the NZ Dairy goat breed Society to further understand both the geographic locations and likely inclusion as a NZDGC provider.
2. Assessment of the impact of including kids, both within the existing Tier 1 methodology, and within a draft Tier 2 methodology with a view to understanding potential increases in total goat sector emissions.

3. Targeted survey of sheep and beef farmers to gain a more in-depth understanding of the use of feral goats for pasture management, enabling decisions around inclusion of these stock within the inventory methodology.

Moving forward, solidification of the dairy goat numbers, and resolution around the potential for incorporation of both kids and feral goats (used for on-farm pasture management) within the inventory methodology, should provide a solid platform on which to make decisions around transition to a Tier 2 methodology for goats.

If this transition were to go ahead, then next steps would include:

1. Confirmation of the start year, and consideration of extending the model framework to develop historical estimates for dairy goats (back to 1990), and development of a data set containing estimated stock numbers by sector (dairy, meat, fibre), sex, and age group (0-1-years, 1-2-years, mixed age).
2. Updating of the animal production survey form to enable reporting by industry sector and stock class (sex/age). Note that within the stock class classifications, provision should be made for inclusion of wethers, with wethers estimated to account for 10-35% of stock on hand in the fibre sector⁴¹ at different stage of the year.
3. Building on the work undertaken by Burgraaf et.al (2019), confirmation of the underlying production parameters (feed quality, reproduction, growth etc) used in the GHG calculations, and assessment of the value of partitioning of the feed intake model by sector type.
4. Working with the industry to gain ongoing access to both stock estimates and production information, with this information routinely used to 'ground truth' the inventory methodology and enables updates if required.
5. Development and testing the proposed methodology within the agile inventory framework prior to implementation within the National inventory Model.
6. Development of an effective communication plan including extension material for stakeholders (which is highly pertinent if allowance is made for inclusion of feral goats used for pasture management, within the inventory methodology).

Acknowledgments

Special thanks to the Dairy Goat Cooperative, Ann Heffernan (Donkey & Mule Association of NZ), Sue Richards and Richard Farquhar (Alpaca Association), Rosemary Blunden (Kowhai Grove Ostrich farm), Manaaki Whenua andASUREQuality for the provision of data for use within this project. Thanks also to Tania Smith and Gareth Kennedy (NZDGC) for undertaking an independent review of project outcomes, and to MPI for project funding.

⁴¹ Burgraaf et.al (2019): Table 5

Appendix 1: Background information and references

Compiled by Garrick Batten (Caprinex Enterprises Ltd) in support of estimated stock numbers for the meat, fibre, pastoral, and feral goat population estimates.

BACKGROUND

The basis for calculating farmed goat numbers from 1990 was to set up a platform from herd dynamics during the 1980s. That decade saw an explosion of farmed goat numbers reflecting strong fibre markets for mohair, cashmere and cashgora, but also farmers seeking diversification from less than satisfactory returns from other livestock following the dismantling of pastoral farming subsidies from 1984. It also saw a rapid decline into the 1990's with the disappearance of cashgora goats, very few cashmere goats left, and a reduced angora flock.

Farmed goats were not important before that. For example, June 1976 Census recorded only 15 037 farmed goats. By 1979/80 there were 1629 farms with goats increasing to 9437 farms with goats in 1987/88. At the same time, goat herd structure varied with large herds building through the 1980s but collapsing again by 1990/91. The dramatic growth in the farmed goat population was driven especially by cashmere and cashgora breeding programmes. For example, cashmere goat numbers in 1984 were 5 000, 1985 - 40 000, 1986 - 160 000, 1987 - 340 000.

The background to this paper is information from the goat industry, and detailed information from Statistics Department that conducted 3 yearly goat farm surveys during this period and produced detailed annual tables for sex, production, fibre type, locality, reproduction. Meat and Wool NZ Economic Service also produced reports, and there were individual goat Breed Societies records, and an accumulation of records held by MAF.

It was assumed that goats all came from farms. However, there can be discrepancies between the definition of a farm as Statistics Department, B&LNZ and MAF can use different bases. For example, MAF definition of a farm for the greenhouse gas emissions database was stated to be 80 ha/550 stock units and that raises the complex issue of the definition of a goat stock unit that is defined differently by these various organisations. However, the 1980s figures included all goats from all sources.

There are discrepancies between the various statistical tables where goats were broken down into classes for fibre and production that are available for years up to 1990. For example, total doe numbers were listed as 675.2 or 673.0 in different tables. However, it is suggested that is not significant. A complicating factor in the Statistics reports is that male and female classifications included all ages, but mated does would have included some young animals to kid at 12 to 15 months of age.

A notable feature shown in the records during the 1970s, and especially 1980s, was annual variations within categories. For example, the percentage of does in the total national herd in the early 1980s was 75-77%, falling to 69% in 1987 and 64% in 1990. Similarly, there was a variation in does mated, for example early 1980s - 76%, 1987 - 80% and in 1990 - 71%. The calculations to produce annual tables incorporated such variability from known sources and endeavoured to try and interpret other changes. For example, a figure for weaned goats was taken as kidding minus 10% to reflect losses. Kidding rates to produce weaned goats for later mating or eventual slaughter significantly varied year to year reflecting both on-farm mating decisions, but also

significant weather losses particularly of cashmere and cashgora goats that needed to be shorn in the late winter, and of newly born kids as farmers were still learning about goat management.

Numbers for the 1980s were prepared on the basis of the nearest thousand as anything more detailed had to acknowledge unknowns and variabilities in the available information, and the inconsequential significance of refining to greater detail.

The age breakdown between young animals and adults in both sexes, needed for calculating emissions, was not calculated for the 1980s as there was no point in doing so.

By June 1990 the breed breakdown was angora 33%, cashgora 40%, cashmere 27%, with dairy goats contributing less than 0.3%. There is not really any significant difference in live weights between the fibre breeds that comprised the farmed goat population during the 1980s, and nor from the feral population that had and continued to form the base of the farmed population. Certainly, there were some between-farm differences depending on breeding policies and nutrition, but these balance out and can be ignored in an industry sense. From 1990 there is a later live weight difference when the dairy goat industry started to influence population structure and slaughter numbers and weights. As angora goats provided a more significant proportion of the farmed fibre goat population, their +25% feed intake per kg live weight will also be a factor in calculating emissions.

Percentages of males in the annual populations is significant as they are not breeding. Fibre wethers were farmed because they produced heavier fleeces than does, and there were breed variations in their male component with angora 35%, cashgora 42% and cashmere 30% sectors in the later 1980s. However, as numbers started to be reduced before the significant reduction to the national goat herd in the 1990s, the role of wethers was reduced with fading fibre markets, and their farm role, numbers and herd proportion diminished.

There was some confusion created by the discrepancy in slaughter data between Meat Producers Board slaughter and export statistics and those from Statistics Department, compounded by Statistics changing its recording date during the period, and their figures also including game meat not included in the Meat Board figures. Reconciling numbers with weights, especially in the early 80s was influenced by the numbers of animals processed through Game Meat Packing Houses. As an example, game meat was estimated in 1988/89 at 6-7% of total goat meat exports.

Annual livestock estimates used graded slaughter numbers for September years rather than June years to better reflect the on-farm situation. The annual calculations used them to balance herd breeding, sex and age dynamics, and carcase slaughter weights provided further confirmation. However, there were also influences on farmer decisions and consequently on annual tallies from fluctuating schedule prices and ability and timing for processors to slaughter goats.

Slaughter goat numbers are the balancing factor for changes between the annual opening numbers. They comprise goats from farmed flocks and herds and from the feral resource. The number of dairy goats contributing to slaughter in the 1980s was negligible, there is very good information on the fibre animals, and there were no other significant sources. At the same time, female feral does of various ages were being added to farmed fibre flocks, and a combination of these and slaughter goats contribute to the total feral goats entering the population each year. A snapshot of slaughter goat sources in 1983/4 showed angora and cashgora 10 000, dairy 2 000, cashmere 10 000, other pastoral 8 000, feral 24 000, with age breakdown of cull adult does 10%, aged wethers 15%, 8-12 months 75%.

FERAL GOATS

In calculating farmed goat numbers since 1990, it is difficult to ignore the continuing influence of feral goats. Although they are not counted in emissions estimates, the substantial population had both contributed to farmed goat numbers through capture and acted as a reservoir for farmed goats liberated following the collapse of the goat boom and the fibre goat industry in the late 1980s/early 1990s and for providing slaughter meat for local and export consumption.

A characteristic of annual goat populations during the 1980s (and subsequently) was the varying influence of feral goats. Once some feral goats were identified in the late 70s as growing some cashmere, and because cashmere and cashgora production was influenced far more by breeding than feeding, the feral herd became an important resource for building on-farm flock numbers. In fact, in one year there were no feral goats slaughtered from the North Island East Coast as all of them went to farms for fibre breeding.

The influence of feral goats being added to farm goats faded dramatically from 1990 in conjunction with collapse of the cashmere and cashgora markets in particular. In addition, angora breeders were no longer adding feral goats in their genetic upgrading programmes. The feral influence was also reversed in the early 1990s when one disposal solution to crashed goat values was some farmed goats being released back into the wild.

It is reasonable to assume that feral goats slaughtered were also coming from farms as there would be few other sources. Even before commercial goat farming started to any extent in the early 1980s, the feral goat herd has always been a significant component of goat slaughter and goat meat exports. For example, slaughter numbers in the 1970s ranged from 71-10 8000 with annual average estimated at about 80 000. Consequently, feral goat input onto farms can be calculated for each year. Feral goat musters and therefore numbers were on a casual basis for slaughter often reflecting opportunities of locality and/or staff availability.

Before the so-called goat boom started in the early 1980s, and continued for that decade, there had always been a significant number of goats in New Zealand, even if not on farms. They were declared a noxious animal in 1956 for ecological damage on Crown land and to the environment. So, the feral goat herd has always been a significant component of goat slaughter and goat meat exports.

Unfortunately, slaughter goat numbers from two different data sources have 50-100% differences and confusion between years of record, and relationships between slaughtering and exports. Despite that, and using an informed interpretation, analysis of annual slaughter numbers during the 1970s shows a range from 50-150 000 head and annual average about 80 000. A typical year would have been 1975-76 when 80 300 was slaughtered and 32 000 shot, leading to a NZ Forest Service feral goat population estimate of 400 000 at that time.

Slaughter numbers are confused by Game Meat Packing House processors who were licenced for export in 1964, but not all were exporting although their numbers could appear in the slaughter data sets. In 1975 there was a change in meat processing and export licencing standards that later put the GMPH out of export business, and the 1980 Meat Act reduced GMPH exports to nil by the mid-80s.

However, slaughter weights ranged widely between the years from 8.5 to 17.9 kg where heavier weights were no doubt influenced by more adult goats through Game Meat Packing House processors handling 30 to 60% of the annual kill until the later 1970s. The average carcase weight during this period of 10 kg perhaps suggests that younger animals comprised the majority of the kill.

Combining the available skewed and limited information indicates a feral population more like 450 000 than the above estimate of 400 000 at the start of the 1980s goat boom.

Even although there can be difficulty reconciling different data sources such as Statistics NZ, Meat and Wool Board and MAF, and recognising variability even within those sources, information from live goat numbers and their performance and slaughter goat data can also be formed to create a reasonable basis for estimating the national feral herd. Using the Census return for 1975/76 of 15 037 farmed goats as an example, although the base farm was not defined, it would be reasonable to assume that the farmed goat population then was stable. Total annual kidding rate would be influenced by some does being milked for several years without being mated, and surplus goats for home kill.

Feral goats were studied by various scientists during the 1960s and 1970s in the King Country, Hunua Ranges, Arapawa Island, Marlborough, and East Coast with various unpublished theses. However, that and other published information on which to base population parameters of size, growth rate and reproductive rate is limited by the very small samples of individual animals studied such as Arapawa 6, Hunua 4, Marlborough 5, Taranaki 10, Hawkes Bay 13 goats. Nevertheless, Rudge and Smit (1978) suggested an annual population increase of 0.375, with some confirmation of an earlier study by Rudge (1969) of one small self-contained herd at about 0.4. That was balanced by off-take through slaughter and culling. Another confirmation of herd dynamics was described by Riney and Caughey (1959), who showed that an unmolested feral goat herd occupied a reasonably close territory area, enabling some confirmation of the above figures.

That study is also relevant to the role of feral goats on farm boundaries and their relationship to goat stock tallies in the annual herd projections on which to base GHG emissions; the relationship of goats and sheep did not affect the goat population on the boundaries of their zones.

Slaughter weight ranges with dressing-out percentages for males 44.6% and females 42.6% tend to confirm feral live weights. Carcase weight range spread showed 6 kg: < 5%, 6-9 kg: 12%, 9-14 kg: 40%, 14-18 kg: 36%, >18 kg: 5%. However, it should be noted that numbers killed influence total output weight.

A much better picture of the feral herd on which to base likely goat performance and productivity can be obtained from an internal MAF report of a 1978-85 study of a significant farmed feral herd at Delaware Bay, North Nelson. This herd was loosely managed on an extensive basis on low fertility hill country at a light stocking rate in conjunction with sheep and cattle. There was some management input such as attempted controlled mating, twice-a-year internal parasite control, male kid castration at 6 months, slaughter of low-quality or unproductive animals, and all male goats at 30 kg live weight. Growth rates were influenced by feed conditions, internal parasites, lice, and foot problems that highlighted goats' ability to gain and lose weight, but particularly with males required to spend more time controlling scrub weeds.

However, the records from this annual herd with a size of about 160 females and 110 males over this period have enabled reasonable estimates of live weights, growth rates, reproductive rates, and losses. Together with other data, that can be used as a basis for calculating a national feral herd structure of 150k adult does 50k 1-2 year does, 30k female kids and 200k mixed age males That tends to indicate a national feral herd estimate of 430 000, and in conjunction with other estimates above, confirms a figure of about 440 000.

A notable feature of this Delaware Bay study was light weights of feral goats at the start of the 1980s decade. Adult does took four years to grow to more than 25 kg live weight and males took 3 years to

grow to the target slaughter weight of 30 kg. Average yearling weights were less than 20 kg. These feral liveweight figures have some confirmation from other studies, such as from a 1978 Ballantrae Grassland Division trial with average adults 26 kg, a 1979-80 MAF/Land&Survey study of over 100 Arapawa adult goats 22.8 to 29.4 kg, a 1979 MAF Sherry River goat weed control trial with adult goats 20.62 - 27.9 kg, and a 1977 Whitianga farmed goat trial with mixed age adult does 20.5 kg.

This production data for feral goats is relevant to all Fibre and Pastoral goat sectors in later analyses as they formed the foundation and basic goat structure for them.

THE 1980s FARMED GOATS

Before the so-called goat boom started in the early 1980s, and continued for that decade, there had always been a significant number of goats in New Zealand even if not on farms. They were declared a noxious animal in 1956 for ecological damage on Crown land and to the environment. Those feral goats were studied by various scientists during the 1960s and 1970s with various unpublished theses in the King Country, Hunua Ranges, Arapawa Island, Marlborough, and East Coast.

Information from live goat numbers and their performance and slaughter goat data can be formed to create a reasonable basis for estimating the national feral herd. Even although there can be difficulty reconciling different data sources such as Statistics NZ, Meat and Wool Board and MAF, and recognising variability even within those sources.

Slaughter goat numbers from two different data sources have 50-100% differences and confusion between years of record, and relationships between slaughtering and exports. Analysis of slaughter numbers during the 1970s shows a range from 50-150 000 head and annual average about 80 000, but before 1975 annual export slaughter carcase numbers were 50 -100 000. A typical year would have been 1975-76 when 80 300 was slaughtered and 32 000 shot leading to a NZ Forest Service feral goat population estimate of 400 000.

Census return for that year was 15037 farmed goats, although the base farm was not defined. It would be reasonable to assume that the farmed goat population was stable, as total annual kidding rate would be influenced by some does being milked for several years without being mated, and surplus goats for home kill.

Although New Zealand had exported goat meat for many years based on the feral herd providing, on average, about 50 000 goats annually, the 1980s were a critical part of the evolution of commercial goat farming in New Zealand. What had been basically a hobby and lifestyle-based sector with small dairy goat herds kept for liquid milk, cheese and show exhibit reasons was quickly transformed. The main drivers for change were the then economic and taxation situations that encouraged urban and other investment into livestock, a booming share market, and the coincidental opportunity to enter world goat fibre markets.

In the 1980s decade, the farmed goat population grew from about 50 000 to 1.3 million based on capture of feral goats for farming and farmed herd expansion at the maximum biological rate given the constraints of management limitations affecting reproductive rate and growth rates, but the ameliorating influence of farming non-breeding wether goats that produced more fibre and were consequently more profitable.

The dairy goat sector showed little change during this period, while the initial boost came from developing a mohair supply from a minuscule angora herd by cross breeding with feral goats to meet then encouraging World prices. One consequence of earlier upgrading was production of a

fibre that was labelled cashgora, “The Pearl of the Pacific”, and a fortunate export contract that encouraged producers to farm crossbred angora goats specifically to produce this new fibre. At the same time, the discovery of cashmere on feral goats attracted international buyers whose traditional Chinese supply was currently limited. An additional attraction of cashmere was that it was influenced more by genetics than nutrition, so farmers could rapidly increase potential economic returns.

The net result of the opportunities for producing 3 different fibres encouraged the development of a national fibre warehouse and marketing producer cooperative that provided valuable production information on goats and their fibres with specific studies and associated reports. At the same time there were parallel activities with economic studies into the production of these fibres by the Ministry of Agriculture and Universities, and associated and also separate research projects that were reported in various publications, and in other unpublished documentation. The then MAF Advisory Service rapidly evolved with various publications and activities to support farmers learning about farming this new animal.

The impetus for these farming ventures involving a new animal, new products and new non-traditional export markets encouraged producers to form their own organisations, being Mohair Producers of New Zealand MOPANZ, Cashmere Producers of New Zealand CAPRONZ, and Cashgora Farmers of New Zealand CFNZ. Their enthusiasm and self-funded activities continued to produce studies and reports both from these individual organisations and in conjunction with research organisations and activities. These were disseminated to members and the wider farming industry in various ways, but the fibre industry growth impetus and constant changes with increased knowledge at times produced confusing information and contradictory statements. Some authorities had difficulty in interpreting this information using terms, structures, and measurements that they were familiar with and able to use but did not necessarily apply to this new animal and its products.

DAIRY GOATS

During the 1980s, dairy goat enthusiasts formed several small cooperatives to manufacture various milk products evolving into general agreement amongst themselves to produce milk powder for export. The number of commercial milking goats grew from about 2000 to about 11000 with total production heading towards 200 tons (that would later prove unsaleable in the market by 1992). However, prior producer management issues on-farm, personal producer conflicts and marketing concerns had already led to stabilising growth in the national herd.

ANGORA GOATS

At this time the only way to increase the angora flock was through cross breeding to feral goats, and continual upgrading to eventually produce mohair suitable for marketing to buyers’ requirements. Mohair prices are influenced by the degree of coarse hair in the fleece, and fibre fineness that increases with age. Fibre produced during the earlier upgrading generations did not meet mohair standards but could be sold as cashgora. Later generations in the upgrading process produced fleeces that could be downgraded from mohair to cashgora. Consequently, goats identified as angora were of mixed parentage and those identified as angora were possibly mis-categorised.

Mohair markets have traditionally fluctuated in price that has affected farmer enthusiasm, and breeding and expansion decisions, and these have been evident since the early 1980s until today. However, most angora breeders ran small non-commercial flocks, so marketing decisions were often ignored or overrun by enthusiasm, and the angora flock continued to expand to 27% of the national fibre flock by 1989.

Enthusiasm also influenced some information produced by MOPANZ and individual producers that was sometimes reproduced in publications.

CASHGORA GOATS

The fortunate appearance of a market for the crossbred mohair fibre that was labelled as cashgora with a firm contract price encouraged more farmers to farm goats specifically for this product. These goats were easier to farm than angoras, wether goats that were easier to manage produced more fibre than female goats, and fibre grading and prices were less demanding. The various results in fibre qualities produced during angora upgrading and specific cashgora breeding were able to be accommodated within the contract.

The classification of goats as cashgora had the same potential for mis-categorisation as angoras, and there was also some confusion with any cashmere goats that produced fleeces that were not saleable as cashmere but could be included in cashgora grades. Consequently, classifying 44% of the national fibre flock as cashgora in 1989 could be questioned for accuracy.

CASHMERE GOATS

Cashmere goat numbers grew more slowly than angora and its cashgora derivative in the earlier 1980s despite firm contracts, support, and investment from buyers. This sector was based on feral goats growing small amounts of variable quality cashmere fibre and consequent financial return but driven by the potential for very high prices from suitable fibre that could be relatively quickly developed by breeding. The limited initial breeding base, significantly improved by imported Australian cashmere genetic material, quickly built to a substantial flock of nearly one-third of the national fibre flock, although limited to some extent by non-breeding wethers that were easier to manage and produced more fibre than female goats.

There are questions about the accuracy of Census numbers for this sector as well as the other fibre sectors, particularly as a feral goat growing some cashmere could be classed as a cashmere goat, or as a pastoral goat by a non-fibre producer. Additionally, some cashmere goats were not shorn for various management reasons and may not have been categorised as cashmere goats.

PASTORAL GOATS

The pastoral goat sector was classified under the “Other” category in Census returns. It included goats run on farms for weed control reasons, to produce meat, or feral goats that happened to be on the farm at the time of the census. It also included animals from fibre flocks that were either incorrectly or deliberately misnamed. They formed nearly one quarter of the total farmed goat population by 1989.

THE EARLY 1990s FARMED GOATS

The 1980s so-called goat boom eventually collapsed in 1990-91. It had been threatened by changes in livestock taxation rules that influenced investment decisions, and the 1987 share market crash. However, the final events that started a rapid goat depopulation on farms was driven by the Fibre sector with a combination of the failure of the cashgora and then cashmere contracts, one of the occasional downturns in mohair prices, a significant lack of producer confidence in their industry, withdrawal of support for their cooperative warehouse company, all leading to no markets for fibre and virtually no facilities for selling it anyway. Fibre goat producers either slaughtered their goats or just liberated them back into the bush.

The decline of 6% of the national fibre herd to 1990 was followed by annual reductions of 13%, 25%, 33%, 34% and 25%. By 1995 when the national herd was less than 22% of the peak, the cashgora sector had completely disappeared, a rapidly shrinking cashmere residue continued but eventually almost disappeared, and the angora flock, initially bolstered by better fibre prices but gradually reduced.

The unique characteristics of each of the separate goat population dynamics continued to influence changes in the national herd into the 1990's as it had during the 1980s. However, the fibre markets discussed above were the dominant influence that produced the overall Fibre sector decline.

The angora flocks that were generally small were able to provide better animal care, kidding percentages and survivability, but angora goats were more difficult to manage on a commercial scale, particularly in weather conditions affecting foot problems. Angora goats also needed to be better fed than other goats to produce their twice-annually shorn fleeces.

Angora and Boer goat embryos were imported by Landcorp from South Africa and released from quarantine in 1994, with most interest and influence from the latter. They particularly excited American buyers to pay substantial sums for bucks and does and for Landcorp to establish a Canadian subsidiary. Consequently, numbers for export were built rapidly through MOET techniques, and the local population took some time to develop.

Boer goats were initially seen as a superior meat breed, and also appealed visually to livestock block farmers who similarly bid up prices to encourage breeding numbers to increase. However, the breed proved unsuitable for most NZ commercial farmed conditions, and its significance and numbers gradually continued to decline.

Cashgora farmers, whose management and consequent flock composition varied depending on flock size and fleece selection criteria, had always produced variable kidding and survival rates; wether goats that produced greater fleece weights were also being used for weed control resulting in reductions in overall survival.

Cashmere goat survival rates were often influenced by variable weather conditions as these goats required annual shearing during the winter. Although wether goats with greater fleece weights were included in flocks, management policies encouraged breeding females to make genetic progress that were particularly vulnerable at winter shearing in late pregnancy that reduced survivability and kidding rates.

Dairy goat farmers who were generally able to produce relatively high kidding percentages continued to euthanize buck kids at birth. The ambitious commercial Dairy goat sector collapsed with a marketing issue in the early 1990s but realised its problems and started to rebuild.

The Pastoral goat sector whose kidding percentage ranged between 60 to 100% at weaning, continued challenging their animals with weed control work that reduced survivability. Slaughter rates were sometimes influenced by processing availability.

FERAL GOATS (now)

Feral goats are mainly still found on approximately one-third of New Zealand that is public conservation land, as well as moving on and off adjoining private farmland. They are subject to occasional destruction by shooting and poisoning on that land by the Department of Conservation, and recreational and commercial harvesters. Feral goats also move on and off neighbouring

farmland where they are sometimes included in farmed goat statistics depending on occurrence and inclinations of the landowner.

Official feral goat numbers are not available, but the Department of Conservation has monitored ungulate occurrence that basically includes deer species and feral goats on its land since 2012. (Moloney, P.D., et al). Occupancy and relative abundances of introduced ungulates on New Zealand's public conservation land 2012-2018. New Zealand Journal of Ecology 45. Unfortunately, the monitoring method does not in itself distinguish goats' presence. The method assesses 1400 evenly spread sites on its land throughout the country, with 280 of those sites measured each September- May. Occupancy and abundance varied across sites, being generally lower in National Parks.

While it is not possible to accurately differentiate animal species at each survey date, one base study using DNA analysis indicated that feral goats comprised about one-third of the ungulate population in the North Island and about one fifth in the South Island in the period 2012 to 2018. Statistical analysis and bio-economic modelling indicate that overall ungulate occupancy rates increased by 34% and 21% annually in the North and South Island respectively during that period. A 2021 follow-up study showed that occupancy in 2012 of 70% had increased to 82% in 2021. It is suggested that recovery was spread evenly between the deer and goat species, given the known reduction in commercial deer recovery and government-funded control, and goat population dynamics. There is sound research to conclude that goat numbers will increase without human influences, and that individual populations can become at least self-supporting.

Despite several requests, the Department of Conservation has been unable to provide any estimate of feral goat numbers. At the start of the 1990s, the numbers of goats calculated for disposal from declining farmed fibre flocks compared with slaughter numbers clearly shows the opportunity for the feral herd to rebuild rapidly. Given known and calculated reproductive rates and natural losses, and the numbers added to farmed animals in the annual slaughter statistics, it can be postulated from that and from Doc studies during this century that the base feral herd has re-established at the previous level of about 400000.

GOAT INDUSTRY REFERENCES

Listed under decades

1950

1. Riney T & Caughley G 1959 NZJSci 2 157-170 Feral goat population studies

1960

2. Asher GW Ecological and genetic heterogeneity within and between feral goat (*Capra hircus* L) populations in New Zealand 1967 MSc thesis Victoria University
3. The role of pasture and silage in supporting milk production of goats in New Zealand. King W et al 1968 NZSAP 28 111-115
4. Rudge MR 1969 Reproduction of feral goats (*Capra hircus* L) near Wellington NZJS 12(4) 817-827

1970

5. Rudge MR & Smit TJ 1970. Expected rate of increase of hunted populations of feral goats (*Capra hircus* L) in New Zealand NZJSc 13(2) 256-259
6. Kirton AH 1970 NZJAgRes 13 167-181 Feral goat meat studies
7. Rudge MR & Joblin RJ 1976. Comparison of some methods of capturing and marking feral goats (*Capra hircus* L) NZJZool. 3 51-55
8. Live weights of farmed feral goats (*Capra hircus* L). Kirton AH, Patterson DJ 1977 NZJExpAg 5 7-10
9. Clark JM & Asher GW 1977 Biological and ecological values of Arapawa Scenic Reserve Eds PR 64-65
10. Controlling scrub weeds with goats. Batten GJ NZ Weed & Pest control Confr.1979

1980

11. Meat&WoolNZ Internal report 1978-85 Averages of returns for goat meat
12. MAF AgLINKS - Various goat topics published in the 1980s
13. Agricultural Statistics - Goats by Statistical Area 1982, 1983, 1987
14. Use of goats for coarse weed control on hill country. Lambert et al Ruakura Farmers Confr 1981
15. MAF internal report 1982. Seven years of monitoring production parameters in a farmed mixed-age, mixed-sex feral goat herd at Delaware Bay, North Nelson
16. MAF 1983 report to Department of Lands and Survey on a 2-year study of Arapawa goats removed to a study area in Nelson 1979 to 1981
17. The effects of pre and postnatal nutrition on the milk production of Australian feral goats 1984 Norton BW et al. Animal production in Australia Vol 15. 726
18. MAF Internal report March 1985 The previous 6 years of goat kill through GMPH, export and abattoirs
19. MAF Internal report 1986. The New Zealand dairy goat industry
20. Pasture feeding of goats. McCall DG & Lambert MG Chap 8 in NZAPS Occ PUBL #10 1986 LIVESTOCK FEEDING ON PASTURE 105-110
21. Goat industry livestock production and returns information 1987 NZ Meat&Wool Boards Ec Service
22. A new meat goat breed. Paper to Third Intl Goat Confr 1987 G J Batten
23. Live weight and reproductive performance in goats. Parry A & MacLean K. MAFTech Gisborne June 1988 Fibre News
24. Mohair Producers Assn of NZ National Conference Proceedings 1988

25. Poppi et al 1988 Sheep and goat have similar digestion.
26. Comparative aspects of digestive physiology and nutrition in goats and sheep. Devendra C 1989 Symposium on ruminant physiology and nutrition in Asia Japan

1990

27. Internal MAF 1990 Reports. Summary of goat slaughter numbers based on breed and sources
28. Goat industry livestock production and returns information. Meat&Wool Boards Econ.Service 1990, 1992, 1994, 1995 ,1997, 1998, 1999
29. Agricultural statistics - Goats by Statistical Area 1990
30. The New Zealand goat fibre industry Harvey WRA 1991 MBA thesis
31. New Zealand Cashmere industry - an industry development strategy Frizzell A 1992
32. Comparison of performance of Boer and Spanish goats in two US locations. Blackburn HD JAnimSci Jan 1995 73:1 302-309
33. Waldon DF et al 1995 Growth rate, feed consumption and carcass measurements of Spanish and Spanish-Boer goats. JAnSci 73 Suppl 1.2153
34. 1996 MAFRes Internal report Boer Cashmere goat crossbreeding trial
35. Texas A&M research report 1997

2000

36. Relationships between live weight and herd-test traits in a Saanen goat herd in New Zealand. NZJAgRes 2001 54(4) 315-320
37. Goat Industry Review. Meat&Wool Boards Econ Service 2000, 2001, 2002, 2005, 2006, 2007, 2009
38. Quality and composition of milk produced by suckled Boer goat does. Tambajong D et al 7th international conference on goats France May 2000
39. Cameron MR et al. Growth and slaughter traits of Spanish goats 2001 JAnSc 79 1423-1430
40. Prediction of metabolizable energy requirements for maintenance and gain of pre-weaning, growing and mature goats. Luo J et al JSmRumRes 2004 53:3 231-252

2010

41. Methane emissions and nitrogen excretion rates for New Zealand goats. Lassey K 2011
42. Jayanegara, A.; Leiber, F.; Kreuzer, M. Meta-analysis of the relationship between dietary tannin level and methane formation in ruminants from in vivo and in vitro experiments. J. Anim. Physiol. Anim. Nutr. 2012, 96, 365–375.
43. [Small ruminant greenhouse gas emissions, with broaden focus on Italian sheep and goats](#)
44. [Atzori](#) AS et al Large Animal Review, 2014
45. [Carbon footprint of dairy goat milk production in New Zealand](#). Robertson K et al.Journal of Dairy Science 2015
46. [Climate change: Production performance, health issues, greenhouse gas emissions and mitigation strategies in sheep and goat farming](#). Marino R et al. Small Ruminant Res 2016
47. Massey University Report on the New Zealand goat industry to Federated Farmers 2016
48. Rate of passage of digesta in ruminants - are goats different? Moyo & Nsahali GOAT SCIENCE Chap 3 2017
49. [The advantages of goats for future adaptation to Climate Change: A conceptual overview](#)
50. [NK Darcan, N Silanikove](#) - Small Ruminant Research, 2018
51. A review of greenhouse gas emissions inventory methodology for farmed goats in New Zealand. NZ MPI Tech paper 2018/...Burggraaff V et al 2019
52. [Current status of global dairy goat production: An overview](#). Miller BAS et al. Asian-Australasian Journal of Animal Sciences, 2019

2020

53. Federated Farmers goat industry report 2021 King C: International goat conference 2022 Extracts - GHGe. Goats and their role in climate change. Kaluman N
54. Occupancy and relative abundances of introduced ungulates on New Zealand's public conservation land 2012-2018.
55. Moloney, P.D., Forsyth, D.M., Ramsey, D.S., Perry, M., McKay, M., Gormley, A.M., Kappers, B., Wright, E.F., 2021. New Zealand Journal of Ecology 45.
56. Effect of age on the performance of Kiko goats raised on cool-season pastures. Chaudry S et al Tuskegee University 2022
57. D Hutchings Meat industry pers.comm
58. P Loughhead Boer goats pers.comm
59. S Averill dairy goats pers.comm
60. W Arnold goats pers.comm
61. D Burgess Meat goats pers.comm
62. M Woodward MOPANZ pers.comm
63. M Perry DoC pers.comm
64. B Ressieux DoC pers.comm

Appendix 2: Meat and fibre goat population estimates.

Table 16 show stock estimates for the Boer goat population, with stock numbers classified according to the numbers of does and bucks that survived to mating, and still present at year end (post culling). Estimates for the number of kids born are also provided, with all estimates shown in terms of thousands of goats⁴². Results for fibre goats including (Angora, Cashgra and Cashmere) are shown in Table 17, with these estimates to be combined to represent a single “fibre goat group” within the goat population model.

Table 16. Boer goat population estimates (000's of goats) developed by Garrick Batten May 2023.

	Does						Bucks						Kids	
	Survived to mating			Survived post culling			Survived to mating			Survived post culling			Born	
YEAR	Mixed age	1-2	O-1	Mixed age	1-2	O-1	Mixed age	1-2	O-1	Mixed age	1-2	O-1	Does	Bucks
1992/93	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0	0.1	0.1	0.2	0.2
1993/94	0.2	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.2	0.2	0.2
1994/95	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1995/96	0.4	0.2	0.4	0.3	0.2	0.4	0.4	0.3	0.3	0.3	0.2	0.3	0.4	0.4
1996/97	0.5	0.4	0.3	0.3	0.3	0.3	0.5	0.3	0.2	0.3	0.2	0.2	0.3	0.3
1997/98	0.6	0.3	0.3	0.5	0.3	0.3	0.5	0.2	0.3	0.3	0.2	0.2	0.3	0.4
1998/99	0.8	0.3	0.4	0.7	0.3	0.3	0.5	0.2	0.4	0.2	0.2	0.2	0.4	0.4
1999/20	1	0.3	0.5	0.8	0.3	0.4	0.4	0.2	0.5	0.2	0.2	0.1	0.5	0.5
2000/01	1.1	0.4	0.5	1	0.3	0.3	0.4	0.1	0.6	0.3	0.1	0.2	0.5	0.6
2001/02	1.3	0.3	0.6	1	0.3	0.5	0.3	0.2	0.7	0.2	0.2	0.2	0.6	0.7
2002/03	1.3	0.5	0.7	1.1	0.4	0.5	0.4	0.2	0.6	0.3	0.2	0.1	0.7	0.6
2003/04	1.5	0.5	0.7	1.2	0.4	0.5	0.5	0.1	0.7	0.4	0.1	0.2	0.7	0.7
2004/05	1.6	0.5	0.8	1.5	0.4	0.4	0.5	0.2	0.8	0.3	0.2	0.2	0.8	0.8
2005/06	1.9	0.4	0.9	1.8	0.4	0.9	0.5	0.2	0.9	0.4	0.2	0.3	0.9	0.9
2006/07	2.2	0.9	1	2	0.8	0.9	0.6	0.3	1	0.5	0.3	0.5	1.1	1.1

⁴² Converted to whole numbers for use in the model (e.g., 0.1 mixed age goats survived to mating in 1992/93 =100 goats).

	Does						Bucks						Kids	
	Survived to mating			Survived post culling			Survived to mating			Survived post culling			Born	
YEAR	Mixed age	1-2	O-1	Mixed age	1-2	O-1	Mixed age	1-2	O-1	Mixed age	1-2	O-1	Does	Bucks
2007/08	2.8	0.9	1.4	2.7	0.7	1.3	0.8	0.5	1.4	0.5	0.3	0.5	1.4	1.4
2008/09	3.2	1.3	1.6	2.8	1.4	1.4	0.8	0.4	1.6	0.6	0.3	0.5	1.6	1.6
2009/10	4.2	1.4	2	3.6	1.1	1.6	0.9	0.5	2	0.2	0.4	0.6	2.1	2.1
2010/11	4.7	1.6	2.2	4	1.3	1.8	1.1	0.6	2.2	0.9	0.5	0.5	2.3	2.4
2011/12	5.3	1.8	2.4	4.3	1.2	1.8	1.4	0.5	2.5	1	0.4	0.3	2.6	2.6
2012/13	5.5	1.8	2.4	4.3	1.2	1.8	1.4	0.5	2.5	1	0.4	0.3	2.6	2.7
2013/14	5.5	1.8	2.4	4.3	1.2	1.7	1.4	0.3	2.4	0.9	0.3	0.2	2.7	2.6
2014/15	5.5	1.8	2.4	4.3	1.2	1.7	1.4	0.3	2.4	0.9	0.3	0.2	2.6	2.6
2015/16	5.2	1.6	2.3	4	0.8	1.1	1	0.2	2.3	0.7	0.2	0.2	2.5	2.5
2016/17	4.8	1.1	1.8	3.2	0.8	1	0.9	0.2	1.8	0.6	0.2	0.2	2	2
2017/18	4	1	1.8	3	0.6	1	0.8	0.2	1.8	0.5	0.2	0.2	1.9	1.9
2018/19	3.6	1	1.6	2.8	0.5	0.8	0.7	0.2	1.6	0.4	0.2	0.3	1.7	1.8
2019/20	3.3	0.8	1.5	2.8	0.5	0.7	0.6	0.3	1.5	0.4	0.3	0.3	1.6	1.6
2020/21	3.3	0.8	1.5	2.8	0.5	0.7	0.6	0.3	1.5	0.4	0.3	0.3	1.6	1.6
2021/22	3.3	0.8	1.5	2.8	0.5	0.7	0.6	0.3	1.5	0.4	0.3	0.3	1.6	1.6

Table 17. Fibre goat population estimates (000's of goats) developed by Garrick Batten May 2023.

		Does						Bucks					
		Survived to mating			Survived Post Culling			Survived to mating			Survived Post Culling		
Year	Age	0-1	1-2	MA	0-1	1-2	MA	0-1	1-2	MA	0-1	1-2	MA
1995/96	ANGORA	28,000	17,000	46,000	23,000	14,000	15,000	29,000	7,000	4,000	3,000	2,000	3,000
	CASHGRA	12,000	9,000	33,000	8,000	6,000	15,000	13,000	2,000	3,000	2,000	2,000	2,000
	CASHMRE	7,000	2,000	15,000	2,000	1,000	10,000	7,000	1,000	2,000	1,000	1,000	2,000
	Total	47,000	28,000	94,000	33,000	21,000	40,000	49,000	10,000	9,000	6,000	5,000	7,000
1996/97	ANGORA	12,000	21,000	27,000	8,000	7,000	17,000	12,000	3,000	4,000	3,000	2,000	3,000
	CASHGRA	5,000	5,000	15,000	0	0	0	6,000	2,000	3,000	0	0	0
	CASHMRE	3,000	1,000	8,000	2,000	500	6,000	2,000	1,000	2,000	500	1,000	1,000
	Total	20,000	27,000	50,000	10,000	7,500	23,000	20,000	6,000	9,000	3,500	3,000	4,000
1997/98	ANGORA	9,000	7,000	22,000	6,000	4,000	14,000	10,000	2,000	4,000	2,000	1,000	3,000
	CASHGRA	0	0	0	0	0	0	0	0	0	0	0	0
	CASHMRE	2,000	1,500	5,000	1,000	1,000	3,000	500	500	500	500	500	0
	Total	11,000	8,500	27,000	7,000	5,000	17,000	10,500	2,500	4,500	2,500	1,500	3,000
1998/99	ANGORA	12,000	5,500	17,000	5,000	5,000	6,500	12,000	2,000	3,500	2,000	1,500	3,000
	CASHGRA	0	0	0	0	0	0	0	0	0	0	0	0
	CASHMRE	1,200	900	3,000	700	600	2,800	1,000	200	500	400	100	400
	Total	13,200	6,400	20,000	5,700	5,600	9,300	13,000	2,200	4,000	2,400	1,600	3,400
1999/00	ANGORA	5,000	4,000	11,000	4,000	2,000	5,000	5,000	2,000	4,000	2,000	1,000	3,000
	CASHGRA	0	0	0	0	0	0	0	0	0	0	0	0
	CASHMRE	1,100	500	3,000	100	300	1,700	1,100	300	400	200	100	200
	Total	6,100	4,500	14,000	4,100	2,300	6,700	6,100	2,300	4,400	2,200	1,100	3,200
2000/01	ANGORA	3,500	4,000	5,500	3,000	3,000	3,000	4,500	2,000	2,000	2,000	1,000	1,000
	CASHGRA	0	0	0	0	0	0	0	0	0	0	0	0
	CASHMRE	1,200	100	1,900	100	100	900	1,200	100	200	100	100	100
	Total	4,700	4,100	7,400	3,100	3,100	3,900	5,700	2,100	2,200	2,100	1,100	1,100
2001/02	ANGORA	2,500	3,000	5,500	2,000	2,500	4,500	2,500	1,500	1,500	1,500	1,500	1,500

		Does						Bucks					
		Survived to mating			Survived Post Culling			Survived to mating			Survived Post Culling		
Year	Age	0-1	1-2	MA	0-1	1-2	MA	0-1	1-2	MA	0-1	1-2	MA
	CASHGRA	0	0	0	0	0	0	0	0	0	0	0	0
	CASHMRE	500	100	1,200	100	100	600	400	100	100	200	100	0
	Total	3,000	3,100	6,700	2,100	2,600	5,100	2,900	1,600	1,600	1,700	1,600	1,500
2002/03	ANGORA	2,500	2,000	6,500	2,000	2,000	5,000	2,000	1,500	2,500	1,500	1,000	1,500
	CASHGRA	0	0	0	0	0	0	0	0	0	0	0	0
	CASHMRE	300	200	700	100	100	400	200	400	0	100	100	0
	Total	2,800	2,200	7,200	2,100	2,100	5,400	2,200	1,900	2,500	1,600	1,100	1,500
2003/04	ANGORA	3,000	2,000	6,500	2,000	2,000	4,000	3,000	1,500	2,500	1,500	1,000	1,500
	CASHGRA	0	0	0	0	0	0	0	0	0	0	0	0
	CASHMRE	200	100	500	100	100	300	0	100	0	0	100	0
	Total	3,200	2,100	7,000	2,100	2,100	4,300	3,000	1,600	2,500	1,500	1,100	1,500
2004/05	ANGORA	3,000	2,000	6,000	2,000	2,000	4,000	2,500	1,500	2,500	1,500	1,000	1,500
	CASHGRA	0	0	0	0	0	0	0	0	0	0	0	0
	CASHMRE	100	100	400	0	100	300	0	100	0	0	100	0
	Total	3,100	2,100	6,400	2,000	2,100	4,300	2,500	1,600	2,500	1,500	1,100	1,500
2005/06	ANGORA	3,000	2,000	6,000	2,500	1,500	4,000	2,500	1,500	1,500	1,000	1,000	1,000
	CASHGRA	0	0	0	0	0	0	0	0	0	0	0	0
	CASHMRE	0	0	0	0	0	0	0	0	0	0	0	0
	Total	3,000	2,000	6,000	2,500	1,500	4,000	2,500	1,500	1,500	1,000	1,000	1,000
2006/07	ANGORA	2,500	2,500	5,500	2,000	2,000	4,000	1,000	1,000	1,000	1,000	1,000	1,000
	CASHGRA	0	0	0	0	0	0	0	0	0	0	0	0
	CASHMRE	0	0	0	0	0	0	0	0	0	0	0	0
	Total	2,500	2,500	5,500	2,000	2,000	4,000	1,000	1,000	1,000	1,000	1,000	1,000
2007/08	ANGORA	2,500	2,000	5,500	2,000	2,000	4,000	1,000	1,000	1,000	1,000	1,000	1,000
	CASHGRA	0	0	0	0	0	0	0	0	0	0	0	0
	CASHMRE	0	0	0	0	0	0	0	0	0	0	0	0
	Total	2,500	2,000	5,500	2,000	2,000	4,000	1,000	1,000	1,000	1,000	1,000	1,000

		Does						Bucks					
		Survived to mating			Survived Post Culling			Survived to mating			Survived Post Culling		
Year	Age	0-1	1-2	MA	0-1	1-2	MA	0-1	1-2	MA	0-1	1-2	MA
2008/09	ANGORA	2,500	2,000	5,500	2,000	2,000	4,000	1,000	1,000	1,000	1,000	1,000	1,000
	CASHGRA	0	0	0	0	0	0	0	0	0	0	0	0
	CASHMRE	0	0	0	0	0	0	0	0	0	0	0	0
	Total	2,500	2,000	5,500	2,000	2,000	4,000	1,000	1,000	1,000	1,000	1,000	1,000
2009/10	ANGORA	2,500	2,000	5,500	2,000	2,000	4,000	1,000	1,000	1,000	1,000	1,000	1,000
	CASHGRA	0	0	0	0	0	0	0	0	0	0	0	0
	CASHMRE	0	0	0	0	0	0	0	0	0	0	0	0
	Total	2,500	2,000	5,500	2,000	2,000	4,000	1,000	1,000	1,000	1,000	1,000	1,000
2010/11	ANGORA	2,500	2,000	5,500	2,000	2,000	4,000	1,000	1,000	1,000	1,000	1,000	1,000
	CASHGRA	0	0	0	0	0	0	0	0	0	0	0	0
	CASHMRE	0	0	0	0	0	0	0	0	0	0	0	0
	Total	2,500	2,000	5,500	2,000	2,000	4,000	1,000	1,000	1,000	1,000	1,000	1,000
2011/12	ANGORA	2,500	2,000	5,500	2,000	2,000	4,000	1,000	1,000	1,000	1,000	1,000	1,000
	CASHGRA	0	0	0	0	0	0	0	0	0	0	0	0
	CASHMRE	0	0	0	0	0	0	0	0	0	0	0	0
	Total	2,500	2,000	5,500	2,000	2,000	4,000	1,000	1,000	1,000	1,000	1,000	1,000
2012/13	ANGORA	2,500	2,000	5,500	2,000	1,500	3,500	1,000	1,000	1,000	1,000	1,000	1,000
	CASHGRA	0	0	0	0	0	0	0	0	0	0	0	0
	CASHMRE	0	0	0	0	0	0	0	0	0	0	0	0
	Total	2,500	2,000	5,500	2,000	1,500	3,500	1,000	1,000	1,000	1,000	1,000	1,000
2013/14	ANGORA	2,000	2,000	5,000	2,000	1,500	3,500	1,000	1,000	1,000	1,000	1,000	1,000
	CASHGRA	0	0	0	0	0	0	0	0	0	0	0	0
	CASHMRE	0	0	0	0	0	0	0	0	0	0	0	0
	Total	2,000	2,000	5,000	2,000	1,500	3,500	1,000	1,000	1,000	1,000	1,000	1,000
2014/15	ANGORA	2,500	2,000	5,000	1,500	1,500	3,000	1,000	1,000	1,000	1,000	1,000	1,000
	CASHGRA	0	0	0	0	0	0	0	0	0	0	0	0
	CASHMRE	0	0	0	0	0	0	0	0	0	0	0	0

		Does						Bucks					
		Survived to mating			Survived Post Culling			Survived to mating			Survived Post Culling		
Year	Age	0-1	1-2	MA	0-1	1-2	MA	0-1	1-2	MA	0-1	1-2	MA
	Total	2,500	2,000	5,000	1,500	1,500	3,000	1,000	1,000	1,000	1,000	1,000	1,000
2015/16	ANGORA	2,000	1,500	4,500	1,500	1,500	3,000	1,000	1,000	1,000	1,000	1,000	1,000
	CASHGRA	0	0	0	0	0	0	0	0	0	0	0	0
	CASHMRE	0	0	0	0	0	0	0	0	0	0	0	0
	Total	2,000	1,500	4,500	1,500	1,500	3,000	1,000	1,000	1,000	1,000	1,000	1,000
2016/17	ANGORA	2,000	1,500	4,500	1,500	1,500	3,000	1,000	1,000	1,000	1,000	1,000	1,000
	CASHGRA	0	0	0	0	0	0	0	0	0	0	0	0
	CASHMRE	0	0	0	0	0	0	0	0	0	0	0	0
	Total	2,000	1,500	4,500	1,500	1,500	3,000	1,000	1,000	1,000	1,000	1,000	1,000
2017/18	ANGORA	2,000	1,500	4,500	1,500	1,500	3,000	1,000	1,000	1,000	1,000	1,000	1,000
	CASHGRA	0	0	0	0	0	0	0	0	0	0	0	0
	CASHMRE	0	0	0	0	0	0	0	0	0	0	0	0
	Total	2,000	1,500	4,500	1,500	1,500	3,000	1,000	1,000	1,000	1,000	1,000	1,000
2018/19	ANGORA	2,000	1,500	4,500	1,500	1,500	3,000	1,000	1,000	1,000	1,000	1,000	1,000
	CASHGRA	0	0	0	0	0	0	0	0	0	0	0	0
	CASHMRE	2,500	0	500	100	0	400	100	0	0	100	0	0
	Total	4,500	1,500	5,000	1,600	1,500	3,400	1,100	1,000	1,000	1,100	1,000	1,000
2019/20	ANGORA	2,000	1,500	4,500	1,500	1,500	3,000	1,000	1,000	1,000	1,000	1,000	1,000
	CASHGRA	0	0	0	0	0	0	0	0	0	0	0	0
	CASHMRE	0	0	0	0	0	0	0	0	0	0	0	0
	Total	2,000	1,500	4,500	1,500	1,500	3,000	1,000	1,000	1,000	1,000	1,000	1,000
2020/21	ANGORA	2,000	1,500	4,500	1,500	1,500	3,000	1,000	1,000	1,000	1,000	1,000	1,000
	CASHGRA	0	0	0	0	0	0	0	0	0	0	0	0
	CASHMRE	200	100	400	200	100	400	200	100	0	100	100	0
	Total	2,200	1,600	4,900	1,700	1,600	3,400	1,200	1,100	1,000	1,100	1,100	1,000
2021/22	ANGORA	2,000	1,500	4,500	1,500	1,000	2,500	1,000	1,000	1,000	1,000	1,000	1,000
	CASHGRA	0	0	0	0	0	0	0	0	0	0	0	0

		Does						Bucks					
		Survived to mating			Survived Post Culling			Survived to mating			Survived Post Culling		
Year	Age	0-1	1-2	MA	0-1	1-2	MA	0-1	1-2	MA	0-1	1-2	MA
	CASHMRE	200	200	500	200	200	400	100	100	100	100	100	0
	Total	2,200	1,700	5,000	1,700	1,200	2,900	1,100	1,100	1,100	1,100	1,100	1,000