Department of Primary Industries and Regional Development

GOVERNMENT OF WESTERN AUSTRALIA

LIVECORP THE AUSTRALIAN LIVESTOCK EXPORT CORPORATION

MEAT & LIVESTOCK AUSTRALIA

final report

National livestock export industry sheep, cattle and goat transport performance report 2018

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Executive summary

The objective of this project was to summarise the performance of the Australian livestock export industry in terms of mortality levels of sheep, cattle and goats exported by sea and air from Australia during 2018.

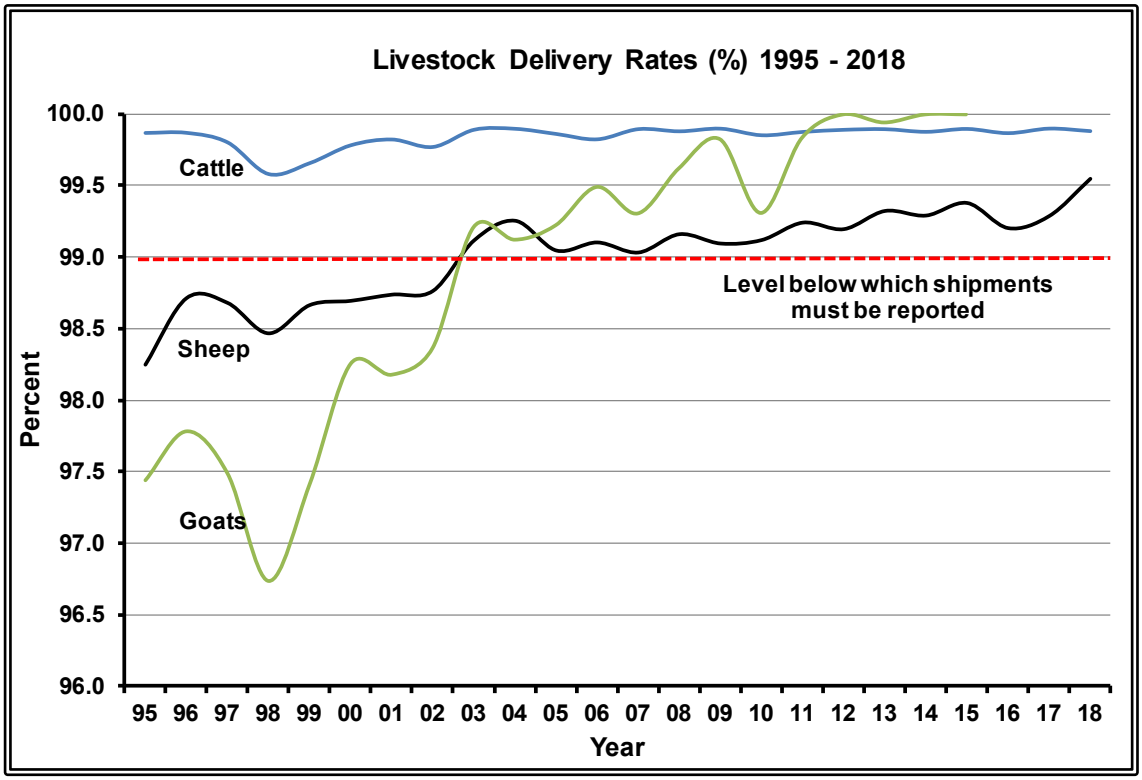
Industry stakeholders, government, animal welfare groups and the general public have a keen interest in monitoring performance in different sectors of the livestock export trade. This summary report provides the only comprehensive breakdown by species, time of year, ships, load ports and major destinations over the calendar year, along with summary analyses of trends over time.

The overall mortality rate for sheep during sea transport to all destinations during 2018 was 0.46% (5,202 mortalities in 1.14 million sheep exported). This was a 36% fall compared to the mortality rate of 0.71% observed in 2017. The main port of loading was Fremantle, which exported 939,000 sheep with a mortality rate of 0.41% (3,888 mortalities), followed by Adelaide exporting 201,000 sheep with a mortality rate of 0.63% (1,268 mortalities) and Portland which exported 3,700 sheep with a mortality rate of 1.24% (46 mortalities).

The overall mortality rate for cattle during sea transport to all destinations during 2018 was 0.12% (1,327 mortalities in 1.12 million cattle exported). This was an 18% increase compared to the mortality rate of 0.10% observed in 2017. The overall mortality rates on voyages to the Middle East/North Africa, and South-East Europe destinations were 0.14% (91 mortalities in 70,000 cattle exported) and 0.24% (148 mortalities in 60,000 cattle) respectively. The highest overall mortality rate on a regional basis was 0.24%, for exports to North-East Asia (364 mortalities in 0.15 million cattle exported), while the lowest overall mortality rate was 0.09% for exports to South-East Asia (724 mortalities in 0.84 million cattle exported).

No goats were exported by sea from Australia in 2018.

Percentages of sheep, cattle and goats successfully delivered by sea since 1995 are shown below.



Summary information regarding the 31,834 sheep, 11,646 cattle and 22,644 goats exported by air during 2018 has also been included in this report. These experienced overall mortality rates of 0.01% (4 mortalities), 0.00% (nil mortalities) and 0.05% (12 mortalities) respectively.

Contents

Background
The live export of sheep, cattle and goats makes a significant contribution to the Australian economy, valued at around $1,750 million in 2018, and provides employment in the many services that support this industry. The livestock export trade provides important support for the sheep, cattle and goat industries of Australia and is the only market outlet for producers in some areas of the country.

This report summarises information about mortalities in sheep, cattle and goats during sea and air transport from Australia. It allows industry, government and others interested parties to monitor mortality trends in these sectors. The report also lists relevant published studies and current research related to the industry.

The Australian Government Department of Agriculture (DA) also presents mortality data, though in a different format, under "Reports to Parliament' at their website: http://www.agriculture.gov.au/export/controlled-goods/live-animals/live-animal-export-statistics/reports-to-parliament.

It should be noted that the DA mortality figures refer only to voyages for which data was *received* during the calendar year, in contrast to this current report which refers to the complete set of data for all voyages which *departed* during the calendar year.

1 Project objectives

The project objectives were to:

a) Produce a report which summarises the mortality of sheep, cattle and goats exported from Australia for the 2018 calendar year and provide an informed analysis of mortality trends in the livestock export industry;
b) Maintain data and expertise to provide analysis and informed comment.

2 Methodology

The information in this report was obtained from ship Master's Reports (which record livestock mortalities and other information about each voyage), other tailored shipboard records and from "Yellow Books", which record more-detailed information about numbers of livestock mortalities (ports of loading and discharge, and daily mortality by type-age-sex categories over the loading, voyage and discharge phases) than is available from the Master's Report.

This current report is for all voyages and flights which departed Australia during the calendar year 2018. Information on the number of sheep exported to various destination countries from ports in Australia was compiled from records supplied by ships and Livestock Export Companies. Information for livestock exported by air was provided by the Department of Agriculture.

In recent years the significant rise in livestock exports to Turkey and the Black Sea caused an imbalance in the Miscellaneous exports category. A new destination region, South-East Europe, was introduced in 2012 to allow a more meaningful examination of exports to this region. South-East Europe includes ports in Turkey and the Black Sea

From 2012 onward, graphs and tables presenting long-term overviews have been restricted to a rolling ten-year basis. It is considered that the older data does not reflect the current state of the trade in terms of standards required of industry, ships participating and markets serviced.

Readers should be aware that additional mortality information for a particular year may be received after publication of that year's summary report. Such information will be added to the database and used in subsequent analyses. Therefore, statistics for a particular year may vary slightly in subsequent reports from those originally published.

High-mortality voyages have always been included in relevant summary figures in this series of publications. It should be noted that in some areas of presentation, inclusion of such voyages, usually resulting from exceptional circumstances (such as extreme environmental conditions, mechanical failure or trade dispute, and therefore not representing usual trade conditions), would distort consideration of long-term trends. Where such voyages have been excluded from analysis of trends, explanatory text or footnotes indicate the exclusion.

Beginning in the 2013 publication of this series, references are made to Federal Department of Agriculture and Water Resources investigations into exceptional voyages and flights mentioned in the report text. It should be noted that these Department of Agriculture reports have been available to the public for a number of years and that parties with an interest in the live export industry have been aware of this availability.

Further information regarding exceptional voyages can be found at 6.2 Appendix 2. Any external links provided are current up to the date of publication of this report.

In order to maintain confidentiality, individual ships are identified by codes in this report.

Summary information was produced using Statistix 10.0 (Analytical Software, 2015, Tallahassee, Florida USA).

2.1 Voyage

The majority of voyages by sea involve loading at one port and discharge at one port. But each year a number of voyages involve loading at multiple Australian ports (split-load voyages), and discharge at multiple destination ports, often in different countries. Where analyses involved split-load voyages, the consignments of livestock from each load port were considered as separate “voyages”, so that the definition of a “voyage” came to be “consignment from load port to discharge region”.

More recently shipboard reporting has become so comprehensive that in most cases it allows tracking of consignments from individual load ports to individual discharge ports. This is a great credit to the diligence of ships’ officers.

To take advantage of this comprehensive reporting, where it has been possible, all voyages have been split into separate “voyages” based on loading and discharge ports. This breakdown better reflects the actual conditions that occurred for the livestock consigned to those destinations.

It can be seen that a comprehensively reported voyage involving one or more load ports and an extended discharge phase over a number of ports, has the potential to generate numerous “voyages”. So, a ship might load at three ports and discharge at two ports, effectively generating six “voyages” if livestock were sent to each discharge port from each load port. In most cases the current high quality of the information supplied allows this close description of the actual conditions experienced.

So, the definition of “voyage” has almost completely shifted from “consignment from load port to discharge region”, to “consignment from load port to discharge port”. While this widens the scope for voyage analyses and related research work, results in this series of publications will continue to be reported on the basis of discharge regions for the foreseeable future.

2.1.1 Load, Voyage and Discharge phases

The shipboard part of the export process is divided into three distinct phases; Load; Voyage and Discharge. These phases are precisely demarcated by dates and times.

Date and time for the end of loading marks the end of the Load phase and the beginning of the Voyage phase. Date and time for the beginning of discharging marks the end of the Voyage phase and the beginning of the Discharge phase.

In the few cases where a ship delivers livestock to more than one discharge port without providing comprehensive information, all the mortalities after the beginning of discharge at the first port through to the end of discharge at the last port have been combined into an overall Discharge phase.

3 Results and discussion

3.1 Sheep

3.1.1 Performance trend

Figures 1 and 2 show the number of sheep exported and the percentage of mortalities during sea transport from all ports in Australia to all destinations over the last decade as well as the trend line (linear regression) across those years. The 1.14 million sheep exported in 2018 was the lowest number exported since recording began in 1985. The number of sheep exported annually since 2009 has varied between 3.5 and 1.14 million, and the annual mortality has varied between 0.91% and 0.46%. The trend for numbers of sheep exported and annual mortality continues downward.

Figure 1 Number of sheep exported by sea from Australia to all destinations since 2009

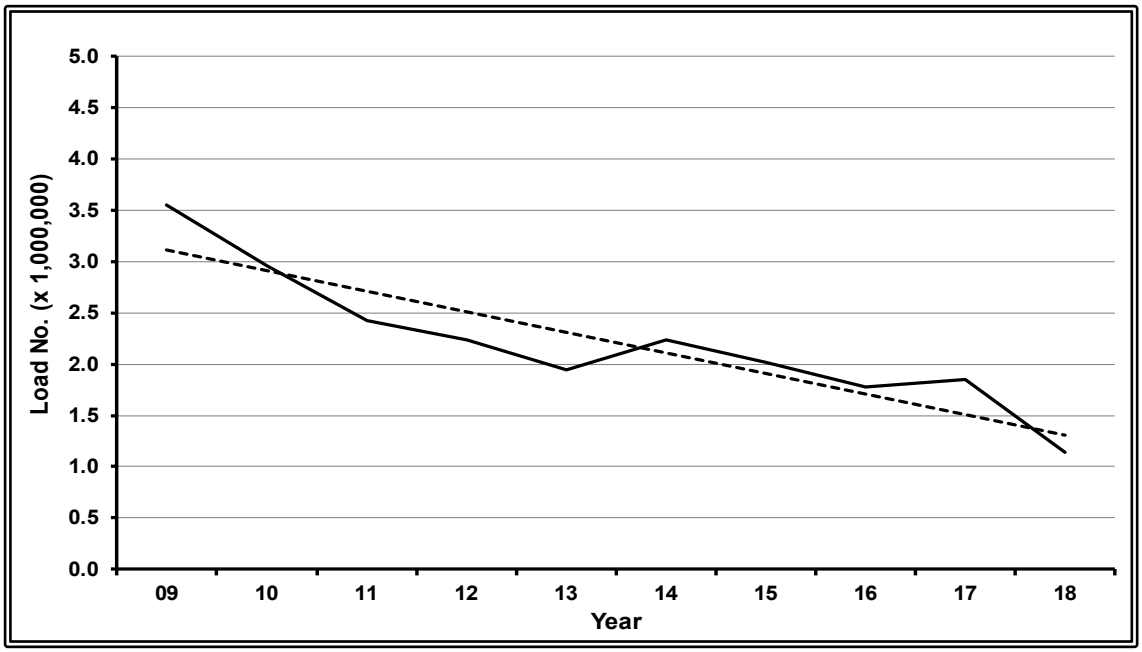
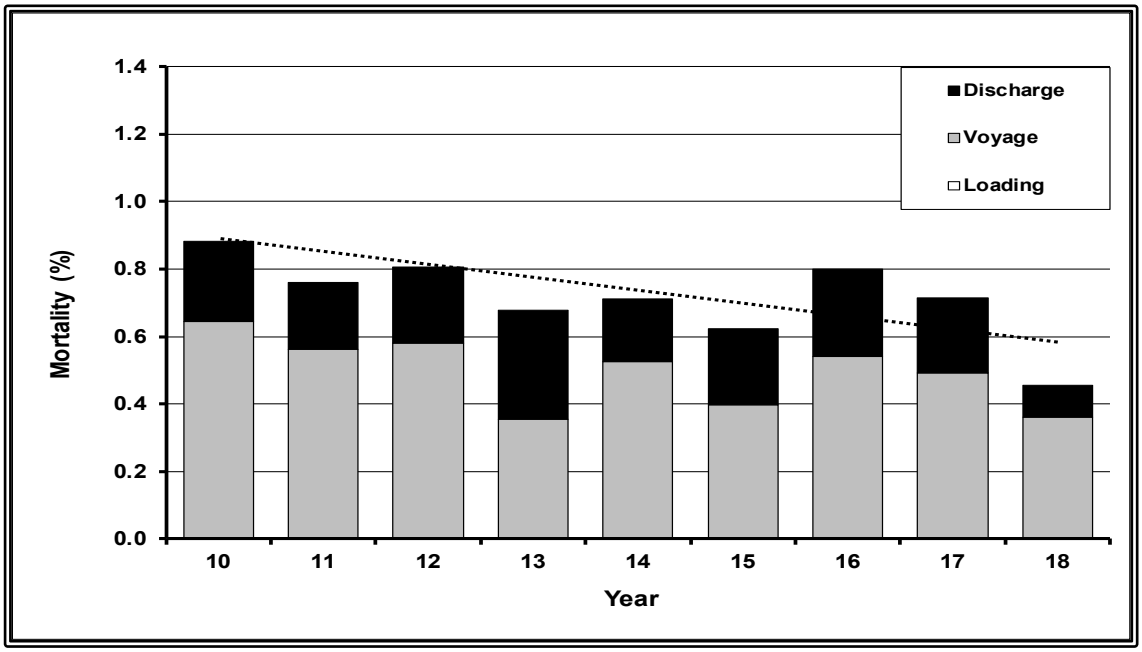


Figure 2 Annual mortality of sheep exported by sea from Australia to all destinations since 2009



3.1.2 Overview

All sheep exported live by sea from Australia in 2018 were loaded either at Fremantle (82.1%), Adelaide (17.6%), or Portland (0.3%). The overall average voyage and discharge lengths were 18.00 and 4.04 days respectively (Table 1, below).

The shipboard part of the export process is divided into three phases: loading (load); voyage to the first port of unloading (voyage); and discharge. The discharge phase usually includes all mortalities after arrival at the first port. Consequently if a ship called at more than one discharge port, all the mortalities after arrival at the first port were included in the discharge phase. See the Methodology (3.1 Voyage) section of this report for a more detailed explanation of the voyage phases and instances of split-loading and split-discharging.

There were 6 voyages to the Middle East/North Africa and South-East Europe in 2018 for which sheep were loaded at more than one port in Australia (split-load voyages). Mortalities for split-load voyages were attributed to the port of loading for all voyages in 2018. Where analysis involves split-load voyages, the consignments of sheep from each load port have been considered as separate “voyages”.

Using the above definition of voyage, there were 32 "voyages" of sheep to the Middle East/North Africa and South-East Europe during 2018. This involved 25 ship journeys, six of which were split-loaded, and one of which was split for discharge.

903,149 sheep were exported to the Middle East/North Africa (79.0% of all sheep exported) and the average voyage length (voyage to first discharge port) for exports to this region was 17.13 days with 4.15 days for discharge. Most voyages had multiple discharge ports, but the recent fall in discharge days indicates the extent to which reporting has moved to individual consignments tracked from load port to discharge port. The overall mortality for these sheep was 0.45%.

230,818 sheep were exported to South-East Europe (20.2% of all sheep exported) and the average voyage length (voyage to first discharge port) for exports to this region was 23.99 days with 4.43 days for discharge. The overall mortality for these sheep was 0.48%.

9,470 sheep were exported on two voyages from Fremantle to South-East Asia (0.8% of all sheep exported). The average voyage length (voyage to first discharge port) for exports to this region was 8.02 days with 1.20 days for discharge, and the overall mortality was 0.31%. These sheep will not be examined further in this report.

Table 1 Mortality rates, number of voyages, voyage and discharge days, and number of sheep exported for voyages to major destination regions during 2018

Parameter	ME/N Africa	SE Asia	SE Europe	Total
Voyages (No.)	25	2	7	34
Sheep (No.)	903,149	9,470	230,818	1,143,437
Mortality rate overall (%)	0.45	0.31	0.48	0.46
Mortality rate range (%)	0.13 – 1.96	0.08 – 0.56	0.25 – 1.24	0.08 – 1.96
Voyage days (Ave.)	17.13	8.02	23.99	18.00
Discharge days (Ave.)	4.15	1.20	4.43	4.04

3.1.3 Destination country

Countries that imported Australian sheep in 2018 are shown in Table 2. As in 2017, the main importing countries were Qatar (28% of all Australian sheep exports), followed by Kuwait (24%) and Turkey (18%).

Overall export numbers fell by 37.7% compared to 2017. Disruption to the trade and new legislation restricting exports during the Middle-Eastern summer was the main contributor to this fall. Countries mainly affected include Oman (-74%), Kuwait (-53%), Qatar (-47%) and UAE (-42%). Exports to Jordan rose by 116%.

Table 2 Destination countries for sheep exported from Australia during 2018

Country	Fremantle	Adelaide	Portland	Other	Total
Israel	62,622				62,622
Jordan	92,848	23,278			116,126
Kuwait	238,267	44,846			283,113
Oman	36,114	6,000			42,114
Qatar	270,944	54,056			325,000
Russia	12,282		3,721	2	16,005
Turkey	154,539	60,276			214,815
U.A.E.	61,511	12,663		212	74,386
S.E. Asia	9,470			31,368	40,838
N.E. Asia				1,529	1,529
Other				170	170
Total	938,597	201,119	3,721	33,281	1,176,718

Note: figures include exports by air.

3.1.4 Middle East/North Africa

The number of sheep exported to the Middle East/North Africa in 2018 was 903,149 (79.0% of all sheep exported) and the average voyage length (voyage to first discharge port) for exports to this region was 17.13 days with 4.15 days for discharge (Table 3). The overall mortality for these sheep was 0.45%.

Table 3 Mortality rates, number of voyages, average voyage and discharge length, and number of sheep exported from various ports to Middle East/North Africa for 2018

Port	Voyages (No.)	Sheep (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days
Fremantle	22	762,306	0.41	0.13 – 1.96*	16.49	3.70
Adelaide	3	140,843	0.70	0.31 – 0.99	21.81	7.48

* Note – this result was incurred prior to legislated changes lowering reportable limit to 1.00%

One high-mortality voyage for 2013 may not be included in some of the following analyses as the mortality was incurred under exceptional circumstances, and would distort the meaningful representation of long-term trends.

Class numbers and mortalities were not able to be determined for one split-loaded voyage during 2018. This voyage has also been excluded from some analyses.

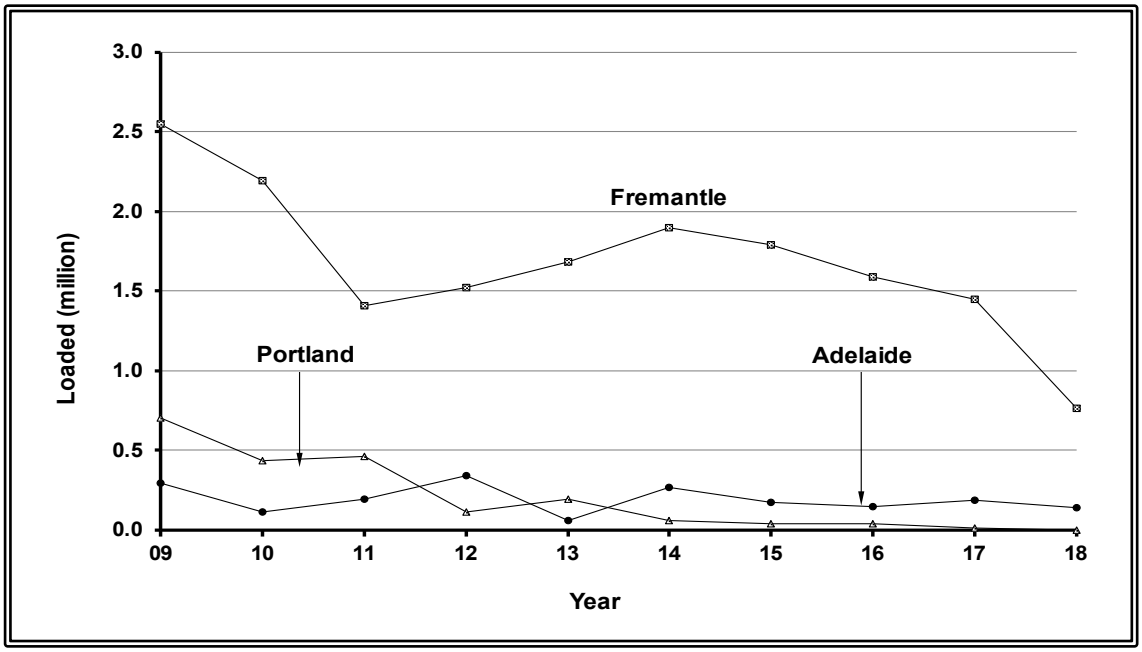
Where exclusions apply within sections 4.1.5.2 through to 4.1.6.3, text, tables and figures are appropriately annotated.

Federal Department of Agriculture investigation summaries regarding high-mortality voyages are referred to in 6.2 Appendix 2.

3.1.4.1 Port of loading

All sheep exported by sea from Australia to the Middle East/North Africa during 2018 were loaded at Fremantle (84.4%, Figure 3) and Adelaide (15.6%). No sheep were exported to the region from Portland during 2018, the first time this has occurred since recording began in 1985.

Figure 3 Number of sheep exported by sea to the Middle East/North Africa from Fremantle (Western Australia), Portland (Victoria) and Adelaide (South Australia) since 2009



The number and class of sheep exported by sea to the Middle East/North Africa from Fremantle and Adelaide during 2018 are shown in Table 4. Overall numbers exported to the region in 2018 fell by 45.2% compared to 2017, with exports from Fremantle and Adelaide falling by 50.1% and 36.8% respectively. As noted above, the main contributor to this fall has been new legislation restricting exports during the Middle-Eastern summer.

Class comparisons between 2018 and 2017 are not valid due to the exclusion of one 2018 split-loaded voyage of 62,668 sheep for which class details were not available.

Table 4 The numbers and classes of sheep exported by sea to the Middle East/North Africa from Fremantle, Adelaide and Portland during 2018

Livestock		Fremantle	Adelaide	Total
Wethers	adults	240,500	99,278	339,778
	hoggets	140,372	12,125	152,497
	lambs	278,946	5,469	284,415
Rams	adults	20,785	594	21,397
	hoggets	280		280
	lambs	13,583		13,583
Ewes	adults	23,347		23,347
	hoggets			
	lambs	5,103	99	5,202
Total	sheep	722,916*	117,565*	840,481

* One voyage excluded – shipment not detailed by class

3.1.4.2 Mortality rates

The total mortality rate for all sheep exported to all destination regions during 2018 was 0.46% (Table 5 and figure 4).

For sheep exported to the Middle East/North Africa during 2018, the Fremantle total mortality rate fell to 0.41% while that of Adelaide rose to 0.70%. No sheep were exported to the region from Portland.

While the 2018 total of 0.46% represents a substantial fall from the 0.71% of 2017, the years are not comparable because of the legislated restrictions on 2018 exports to the Middle East/North Africa region over the Middle-Eastern summer.

An adjusted total is also provided in Table 4, which excludes Middle East/North African voyages for the months June to August over the years 2014 to 2018 (see Section 4.1.6 - Middle-East summer Live Sheep Export ban). It should be noted that these figures cannot account for differences caused by the new load-density restrictions imposed during 2018.

Table 5 Annual shipboard mortality rates for all sheep exported from Fremantle, Adelaide and Portland to the Middle East/North Africa, and Total and Adjusted Total mortality rates for all sheep exported to all destinations

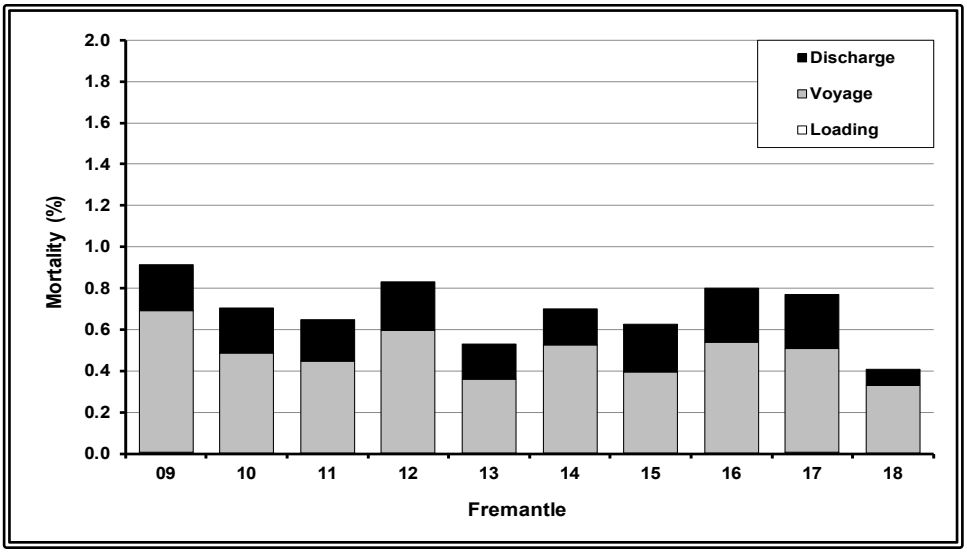
		Mortality rate (%)			
	Year	Load	Voyage	Discharge	Total
Fremantle*	2014	0.00	0.53	0.17	0.71
	2015	0.00	0.39	0.23	0.63
	2016	0.01	0.53	0.26	0.80
	2017	0.00	0.50	0.26	0.77
	2018	0.00	0.33	0.08	0.41
Adelaide*	2014	0.00	0.53	0.26	0.78
	2015	0.00	0.44	0.16	0.60
	2016	0.00	0.51	0.21	0.72
	2017	0.00	0.44	0.13	0.57
	2018	0.00	0.45	0.25	0.70
Portland*	2014	0.00	0.41	0.32	0.72
	2015	0.00	0.39	0.22	0.61
	2016	0.00	0.70	0.19	0.88
	2017	0.00	0.19	0.09	0.28
	2018	n/a	n/a	n/a	n/a
Total**	2014	0.00	0.53	0.18	0.71
	2015	0.00	0.40	0.23	0.62
	2016	0.01	0.54	0.26	0.80
	2017	0.00	0.49	0.22	0.71
	2018	0.00	0.36	0.09	0.46
Adjusted	2014	0.00	0.50	0.15	0.65
Total***	2015	0.00	0.39	0.16	0.55
	2016	0.00	0.43	0.19	0.62
	2017	0.00	0.41	0.14	0.55
	2018	0.00	0.36	0.09	0.45

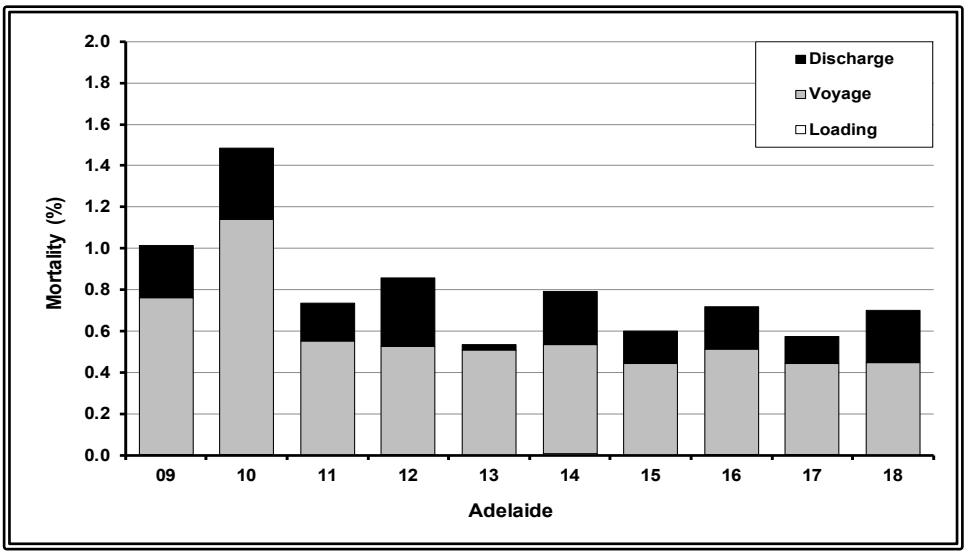
* Middle East/North Africa only

** Total includes all sheep exported by sea from Australia to all destinations

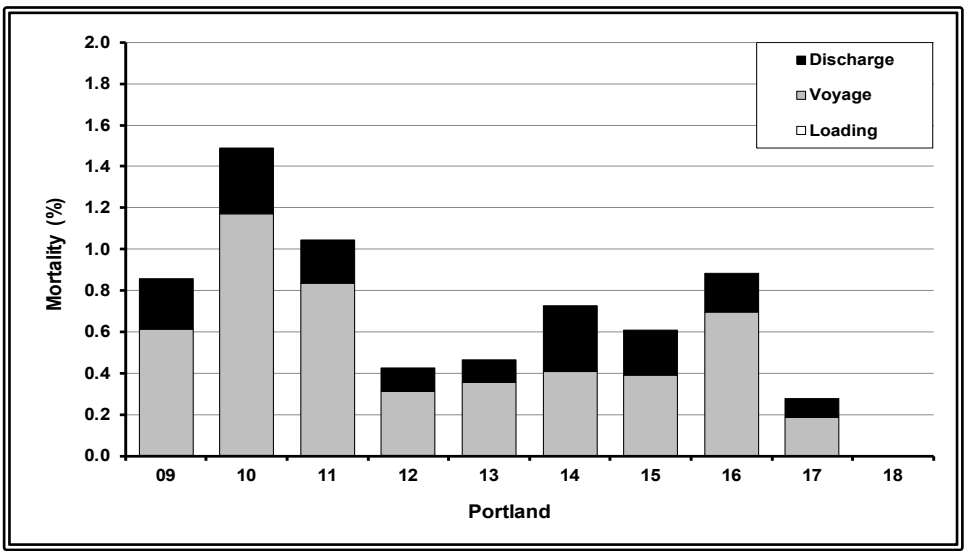
*** Adjusted Total includes all sheep exported by sea from Australia to all destinations excluding Voyages to the Middle East/North Africa over the months June to August

Figure 4 Annual mortality for sheep exported from Fremantle, Adelaide and Portland to the Middle East/North Africa from 2009 to 2018.





Note – one exceptional voyage excluded for 2013. If included, the overall 2013 mortality would have been 5.79%



3.1.4.3 Class of sheep

The mortality rates of various classes of sheep exported from Australia to the Middle East/North Africa are shown in Table 6 and Figure 5. The highest total mortality rates by class for 2018 were in all ram classes (0.71%, 1.07% and 0.80% for adult, hogget and lamb rams respectively), followed by lamb and adult wethers with 0.52% and 0.46% respectively (refer to Table 3 for numbers loaded).

Along with adult ewes, the ram classes have consistently been high over the last decade, their contribution to overall mortality being limited by their numbers exported.

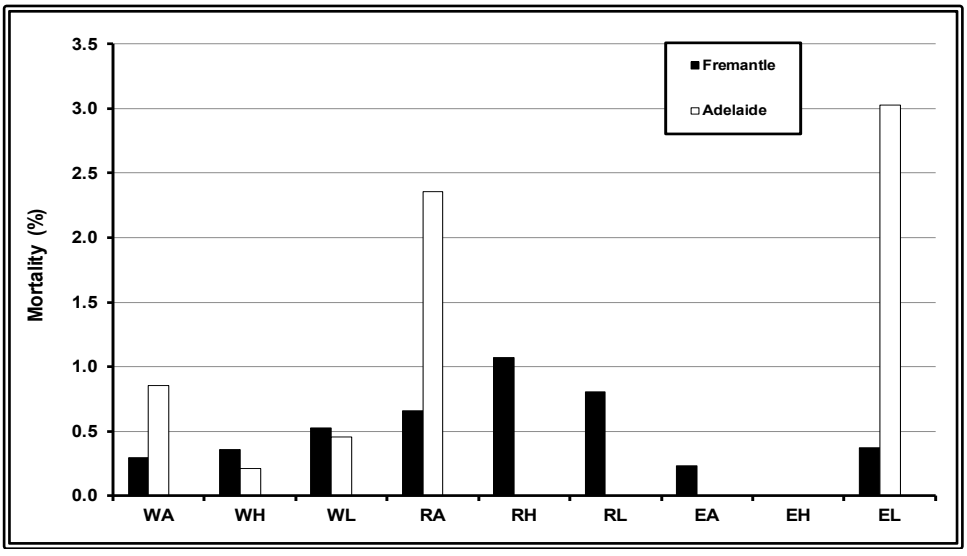
Table 6 Overall mortality (%) for classes of sheep exported from Fremantle and Adelaide to the Middle East/North Africa in 2018

Class of sheep		Fremantle	Adelaide	Total
Wethers	adult	0.30	0.85	0.46
	hogget	0.35	0.21	0.34
	lamb	0.52	0.46	0.52
Rams	adult	0.66	2.36*	0.71
	hogget	1.07	n/a	1.07
	lamb	0.80	n/a	0.80
Ewes	adult	0.23	n/a	0.23
	hogget	n/a	n/a	n/a
	lamb	0.37	3.03*	0.42

n/a - not applicable (no sheep of this class were loaded)
* both figures involve one small shipment with only a few mortalities

Figure 5 Overall mortality (%) for classes of sheep exported from Fremantle and Adelaide to the Middle East/North Africa in 2018

WA = wether adults WH = wether hoggets WL = wether lambs
RA = ram adults RH = ram hoggets RL = ram lambs
EA = ewe adults EH = ewe hoggets EL = ewe lambs

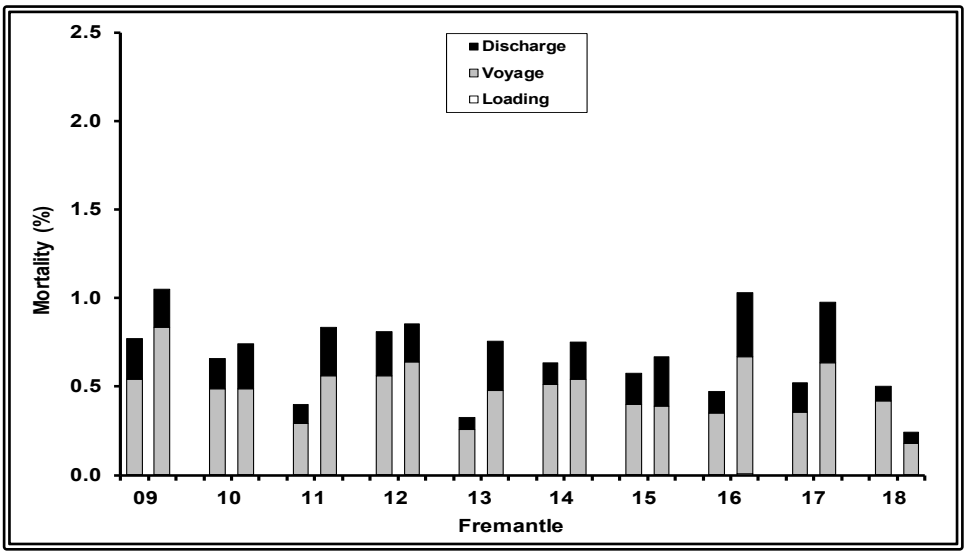


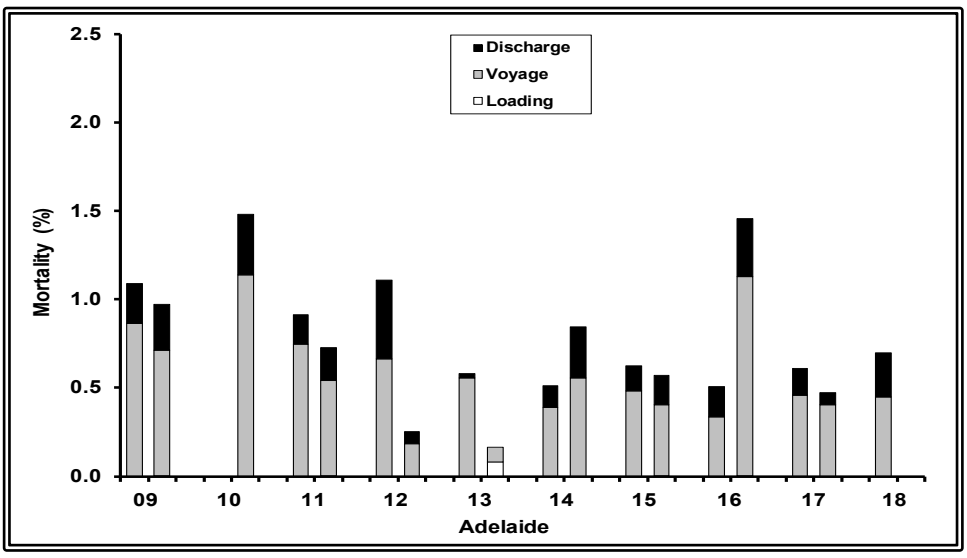
3.1.4.4 Time of year

Overall half-yearly mortality rates for sheep exported to the region were higher in the first half of the year when compared with the second, but the comparison is not valid due to legislated restrictions on the trade, which included an export ban during the Middle-Eastern summer and reduced stocking rates thereafter. Results are shown for Fremantle, Adelaide and Portland (Fig. 6), but Portland did not export sheep to the region in 2018, and Adelaide did not export sheep in the second half of the year.

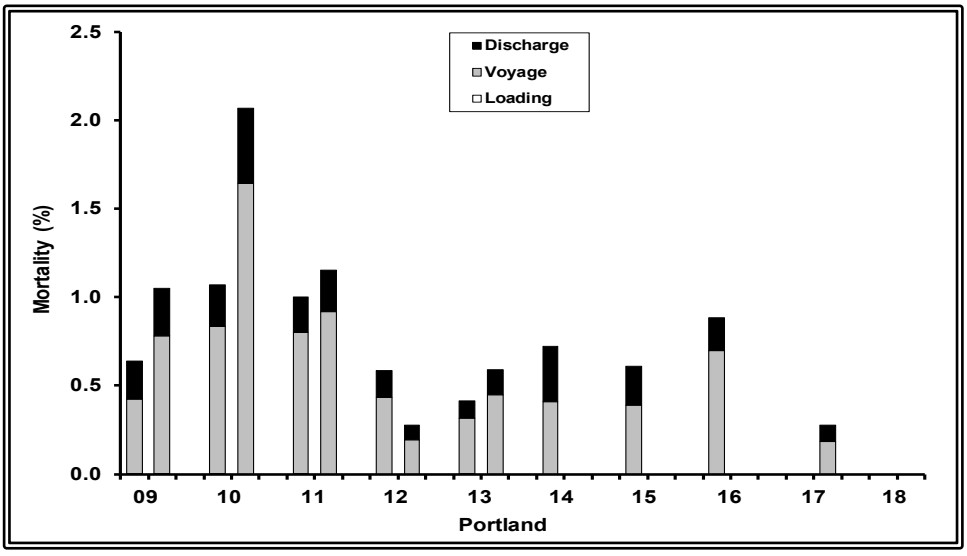
With the imposed restrictions, this half-yearly comparison will no longer be valid in the future.

Figure 6 Mortality (%) for sheep exported by sea from Fremantle, Adelaide and Portland to the Middle East/North Africa for the first and second half of each year from 2009 to 2018





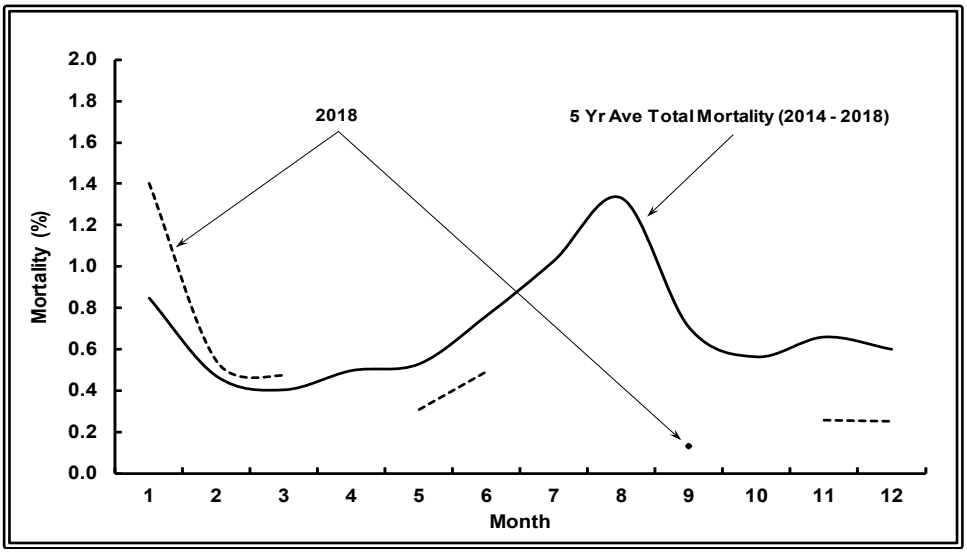
Note – one exceptional voyage excluded for 2013. If included, the 2013 second-half mortality would have been 7.09%



In 2018, monthly mortality rates (total mortality as a proportion of total loaded for each month) in sheep exported from Fremantle were at or below the 5-year average profile, apart from being substantially higher in January (Figure 7).

It should be noted that the 5-year average profile encompasses the partial 2018 year, making the profile somewhat distorted when compared to previous full-year presentations. This annual versus 5-year average profile presentation will no longer be valid in the future.

Figure 7 Monthly mortality rates for shipments from Fremantle to the Middle East/North Africa in 2018 and the 5-year monthly averages for the period 2014 to 2018



3.1.4.5 Time of year and age of sheep

Previous reports in this series show clearly that there are indisputable patterns of seasonal difference in mortality rates for all classes of sheep when examined by sex and age. The only exception is for ewe hoggets, which are not exported in sufficient numbers to allow reliable conclusions to be drawn.

These established patterns include:

- A significantly lower mortality rate in the first half of the year compared to the second half
- An annual pattern of monthly mortality rate with lower mortalities over the months February to May and higher mortalities over the months June to September.
- A higher mortality rate seen in adults compared to the younger hoggets or lambs – though this distinction has become blurred in recent years, as less sheep, and particularly less wethers, have been exported (see Figure 7)

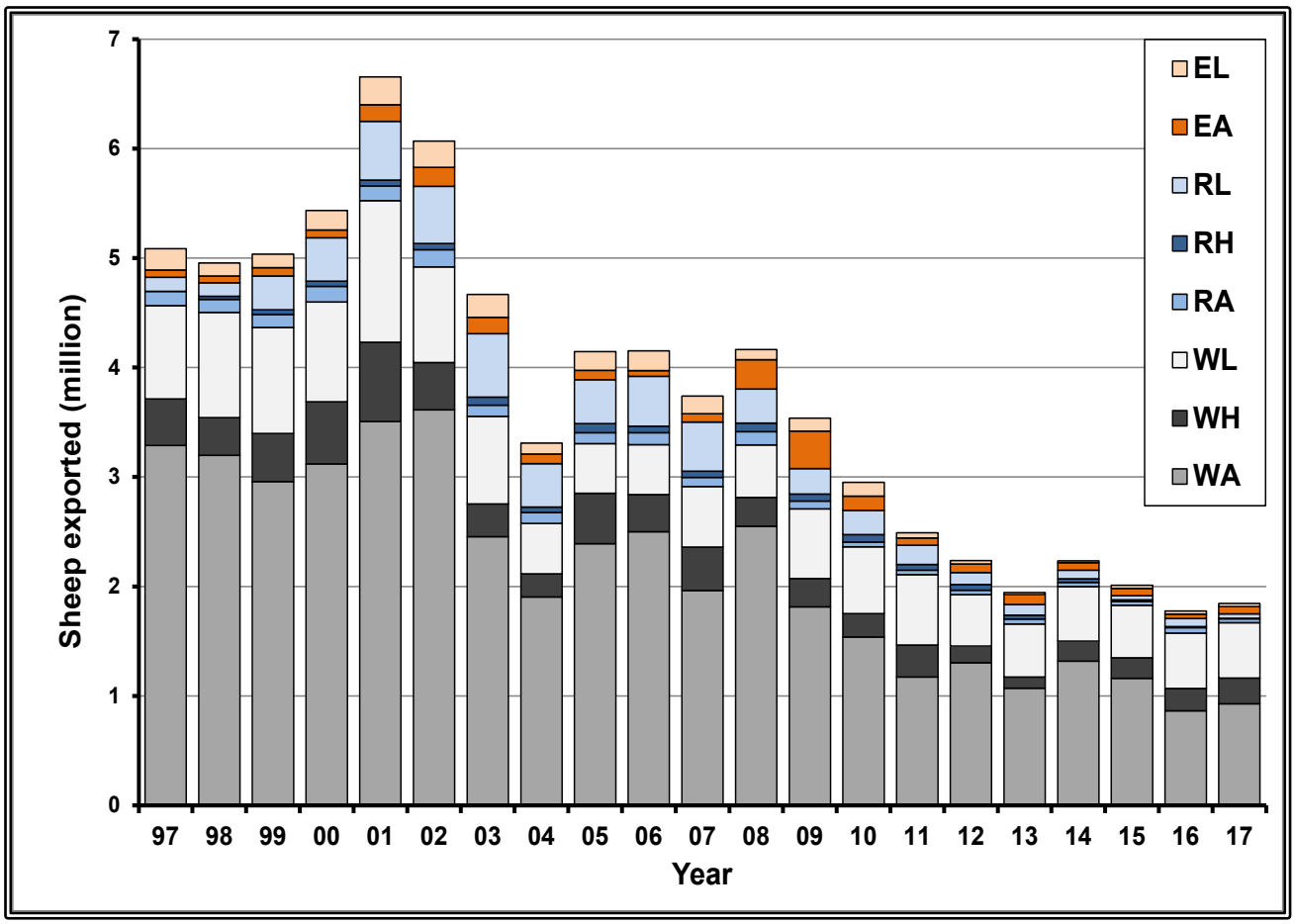
With the restrictions placed on the trade, data for this section will be invalid in the future. Much of the examination for time-of-year has involved cumulative data, but this will no longer be possible with partial-year data going forward.

3.1.4.6 Class numbers and mortality rates over time

Adult wethers are the mainstay of the live sheep export trade, and, by sheer weight of numbers, the largest component of mortalities. This can be easily demonstrated by comparing class numbers exported over time and their corresponding mortality rates.

It can be seen that Wether Adults (WA) stand out as the main class exported, followed by Wether Lambs (WL), with Wether Hoggets (WH) and Ram Lambs (RL) sharing third position (Figures 8).

Figure 8 Numbers by class of sheep exported from Australia, 1997 to 2017



Note – incomplete year of 2018 excluded

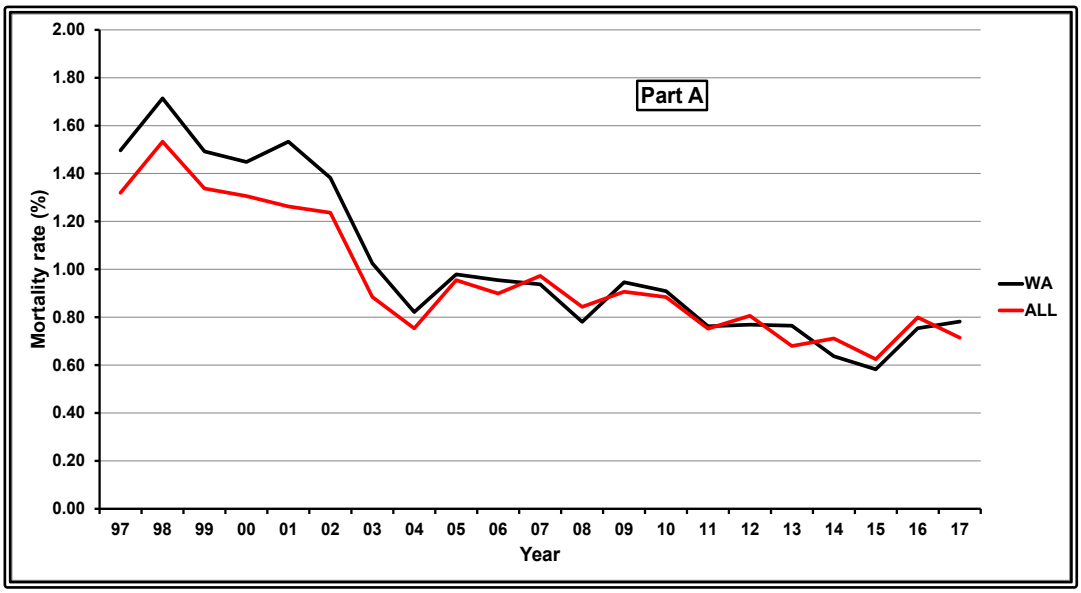
Figure 9, below, shows that the overall mortality rate is closely linked to the Adult Wether mortality (part A). It can also be seen that ram classes have had consistently high mortality rates over time, with Ram Adults (RA) nearly always at or near highest (Part B).

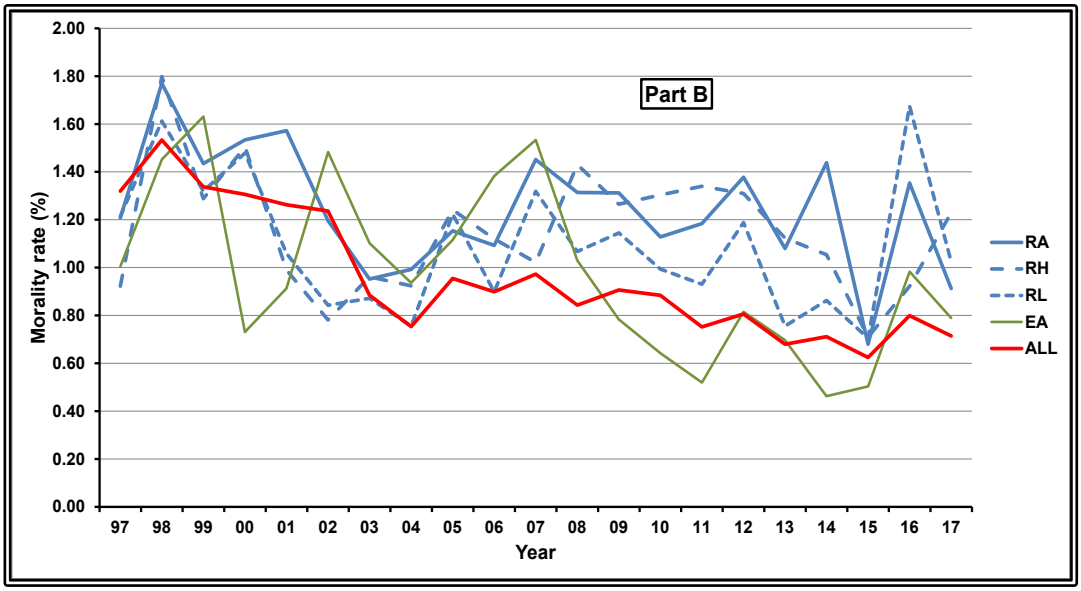
The Ewe Adults (EA) mortality rate has varied quite widely over the time, but the three ram classes have remained the highest from 2008 onward, except in the case of Ewe Adults rising slightly over Ram Lambs in 2016.

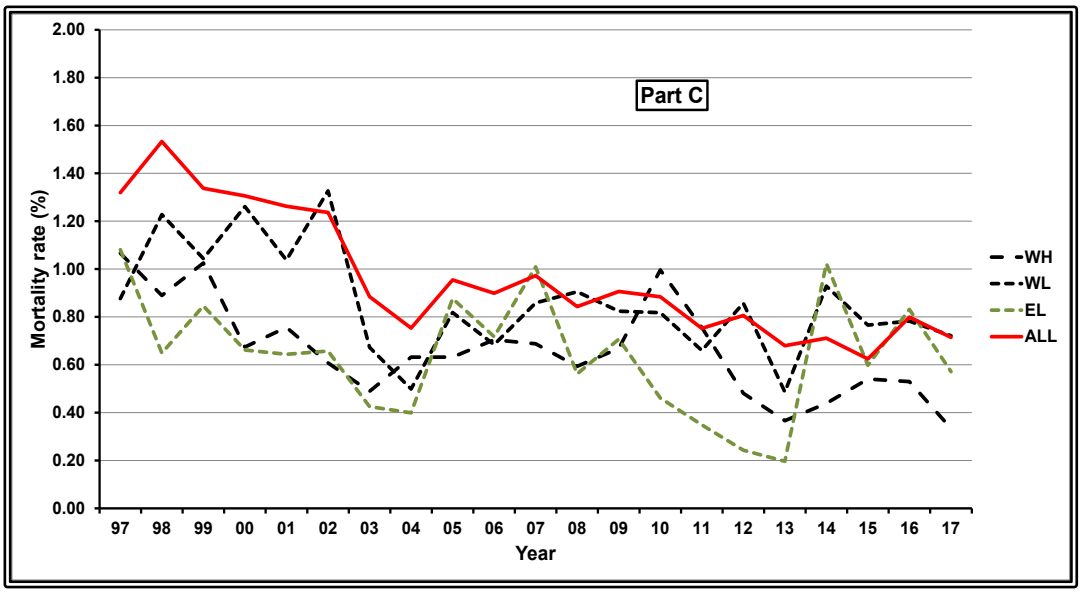
Wether Hoggets (WH) and Lambs (WL), and Ewe Lambs (EL) have usually been lower than the overall average (Figure 8 Part C).

2018 data has been excluded from this section of the report due to the trade disruption caused by the previously mentioned legislated restrictions, but the similarity to the long-term pattern can be noted in Tables 4 and 6 above.

Figure 9 Mortality rate (%) by class of sheep exported from Australia, 1997 to 2017







3.1.4.7 Long-term seasonal mortality patterns

Seasonal differences in mortality can be demonstrated for all classes of sheep studied in this series of reports except for ewe hoggets, which are not exported in sufficient numbers to bring reliable conclusions.

It is useful to compare the long-term mortality profiles of Adult Wethers, the main component of overall mortality rate, and Adult Rams, the class with the highest mortality rate.

Figures 10 and 11 show monthly mortality rates (total mortality as a proportion of total loaded for each month) over three periods, 1997-2003, 2004-2010 and 2011-2017, for Adult Wethers and Adult rams respectively. While the overall pattern for Adult Wethers has reduced more noticeably over time, these periods demonstrate the enduring stability of the seasonal difference.

Figure 10 Average monthly mortality rate (%) for Adult Wethers for three periods

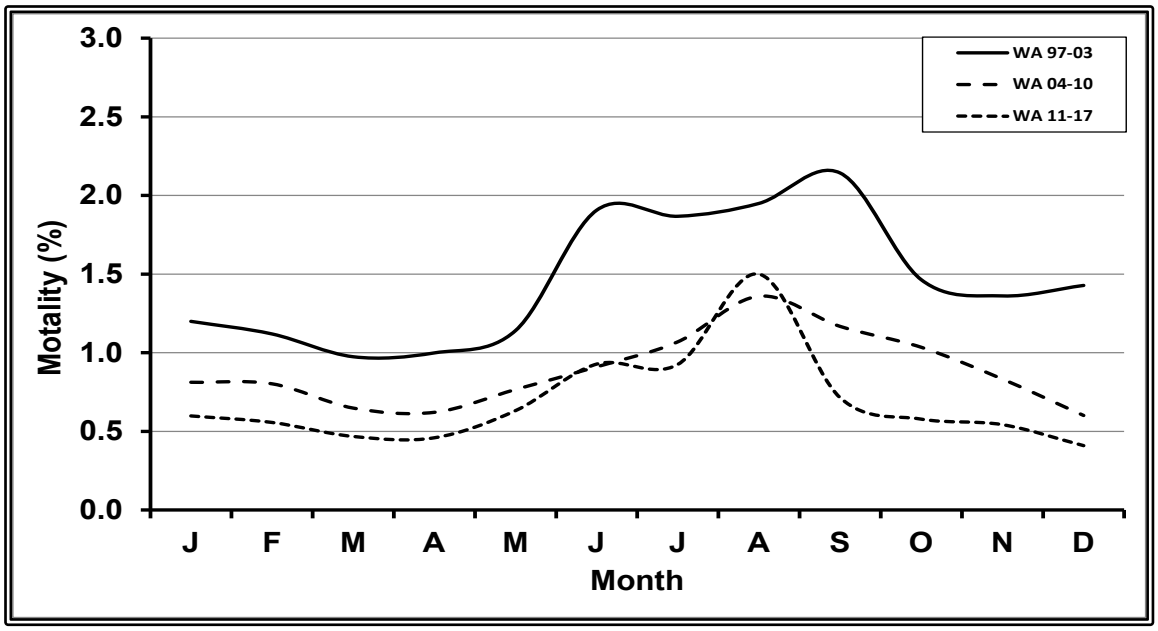
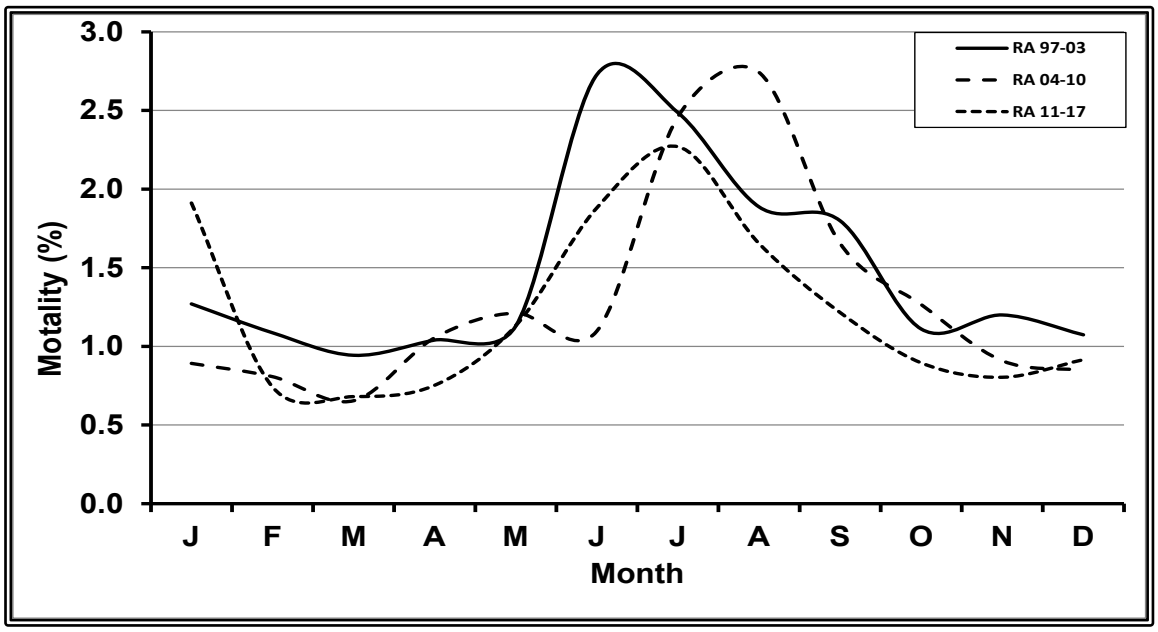


Figure 11 Average monthly mortality rate (%) for Adult Rams for three periods



There is no doubt that there is a consistent seasonal difference, with the lowest mortality rates occurring in sheep loaded from February to May, and the highest occurring in those loaded from June through to September. Therefore, annual mortality rates would be expected to increase if more sheep, and particularly more of the higher mortality classes, are exported between June and September.

Nevertheless, the legislated changes restricting exports during the Middle-Eastern summer will also restrict further research into this area of seasonal differences in mortality rates. The Middle-Eastern summer restriction is expected to bring a welcome reduction in annual mortality rates (see Section 4.1.6 – Middle-East summer Live Sheep Export ban), but for the foreseeable future it will also restrict the usefulness of data that might be used to examine long-term mortality patterns.

The historical reduction in the overall mortality pattern in the live sheep export trade is undoubtedly associated with improvements in ship design and livestock management, but the tendency towards exporting younger wethers to meet the changing market requirements over the mid-80's to mid-90's is probably the greatest factor in this reduction.

3.1.4.8 Ship

The voyages of each ship were classified into low (mortality rate up to 1.0%), medium (mortality rate from 1.0 to 2.0%) and high (mortality rate greater than 2.0%) mortality categories for sheep exported to the Middle East/North Africa from Fremantle (Table 7a), and Adelaide (Table 7b).

There were no voyages carrying sheep to the region from Portland during 2018.

There were no voyages in the "high" category during 2018. Approximately 91% of voyages from Fremantle, and 100% of voyages from Adelaide were in the "low" category.

Table 7a Number of voyages in low, medium and high mortality categories for ships loaded at Fremantle in 2018

	Mortality rate			
Ship (code)	Low <1.0%	Medium 1.0 – 2.0%	High >2.0%	Total
32	4	0	0	4
33	1	0	0	1
34	5	0	0	5
35	3	0	0	3
43	2	0	0	2
131	0	1	0	1
138	1	0	0	1
139	3	1	0	4
140	1	0	0	1
Total	20	2	0	22

Table 7b Number of voyages in low, medium and high mortality categories for ships loaded at Adelaide in 2018

	Mortality rate			
Ship (code)	Low <1.0%	Medium 1.0 – 2.0%	High >2.0%	Total
33	1	0	0	1
34	2	0	0	2
Total	3	0	0	3

3.1.5 South-East Europe

Sheep have been exported live by sea to South-East Europe since 2010. After a four year hiatus, from 2013 to 2016, exports to the region resumed in 2017.

The number of sheep exported to South-East Europe during 2018 was 230,818 (20.2% of all sheep exported) and the average voyage length (voyage to first discharge port) for exports to this region was 23.99 days with 4.43 days for discharge. The overall mortality for these sheep was 0.48%.

The numbers of sheep exported to South-East Europe since the inception of the trade are shown in Table 8. Over the time, the mortality rate has progressively fallen from 1.16% to 0.48%.

Table 8 Mortality rates, number of voyages, average voyage and discharge length, and number of sheep exported to South-East Europe from 2010 to 2018

Year	Voyages (No.)	Sheep (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days
2010	4	215,038	1.16	0.74 – 1.47	23.10	8.05
2011	10	351,722	0.85	0.47 – 1.07	25.72	5.35
2012	7	249,602	0.78	0.34 – 1.35	26.94	3.41
2017	5	198,303	0.50	0.41 – 0.62	26.48	3.99
2018	7	230,818	0.48	0.25 – 1.24*	23.99	4.43

* Note – this result was incurred prior to legislated changes lowering reportable limit to 1.00%

3.1.5.1 Port of loading

Sheep exported to South-East Europe in 2018 departed from Fremantle (73%), Adelaide (26%) and Portland (2% - Table 9). Destination countries for sheep exported to the region were Turkey (93%) and Russia (7%).

The voyages from each port were classified into various mortality categories as shown in Table 10. During 2018 71% of voyages were in the low category.

Table 9 Mortality rates, number of voyages, average voyage and discharge length, and number of sheep exported from various ports to South-East Europe for 2018

Port	Voyages (No.)	Sheep (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days
Fremantle	4	166,821	0.46	0.25 – 1.08	21.60	4.16
Adelaide	2	60,276	0.47	0.39 – 0.60	25.86	4.02
Portland	1	3,721	1.24*	n/a	29.82	6.32

* Note – this result was incurred prior to legislated changes lowering reportable limit to 1.00%

Table 10 Number of voyages in the low, medium and high mortality categories for shipments from various ports to South-East Europe during 2018

Port	Mortality rate			Total
	Low <1.0%	Medium 1.0 – 2.0%	High >2.0%	
Fremantle	3	1	0	4
Adelaide	2	0	0	2
Portland	0	1	0	1
Total	5	2	0	7

3.1.5.2 Ship

The voyages of each ship taking sheep from Australia to South-East Europe were classified into various mortality categories as shown in Table 11.

During 2018 there were only two ships that carried sheep to the region, with 71% of voyages in the low category.

Table 11 Number of voyages in the low, medium and high mortality categories for shipments from various ports to South-East Europe during 2018

Ship (code)	Mortality rate			Total
	Low <1.0%	Medium 1.0 – 2.0%	High >2.0%	
35	5	0	0	5
50	0	2	0	2
Total	5	2	0	7

3.1.5.3 Class of sheep

Mortality rates for classes of sheep exported to South-East Europe during 2018 are presented in Table 12.

During 2018 the South-East Europe sheep trade comprised mainly wether lambs and adults exported to Turkey (63% and 17% respectively) followed by adult ewes exported to Russia (7%).

The highest mortality rates occurred in adult ewes (1.14%) followed by adult wethers (0.56%). The lowest mortality rates were in ram and wether lambs with 0.47% and 0.48% respectively.

Table 12 Mortality rate, number of voyages and number of sheep in the classes exported to South-East Europe in 2018

Class		Voyages (No.)	Sheep (No.)	Mortality rate overall (%)	Mortality rate range (%)
Wethers	adults	4	39,647	0.56	0.42 – 0.70
	hoggets	3	13,186	0.41	0.30 – 0.52
	lambs	4	144,682	0.39	0.22 – 0.59
Rams	adults	5	5,258	0.48	0.00 – 1.49
	lambs	3	12,692	0.47	0.07 – 0.57
Ewe	adults	2	15,353	1.14	1.12 – 1.22

3.1.6 Middle-East Summer Live Sheep Export ban

In December 2018 The Australian Livestock Exporters' Council announced a voluntary three-month moratorium on live sheep exports to the Middle-East over the months June to August. The Australian Government signed the proposal into law early in 2019, with new loading restrictions placed on the Trade for the further months of the Middle-East summer.

These restrictions have created an incongruity in the annual data, where data prior to 2018 can be compared in whole years, while data from 2018 onwards may only be compared in partial "moratorium" years of nine months; January to May and September to December.

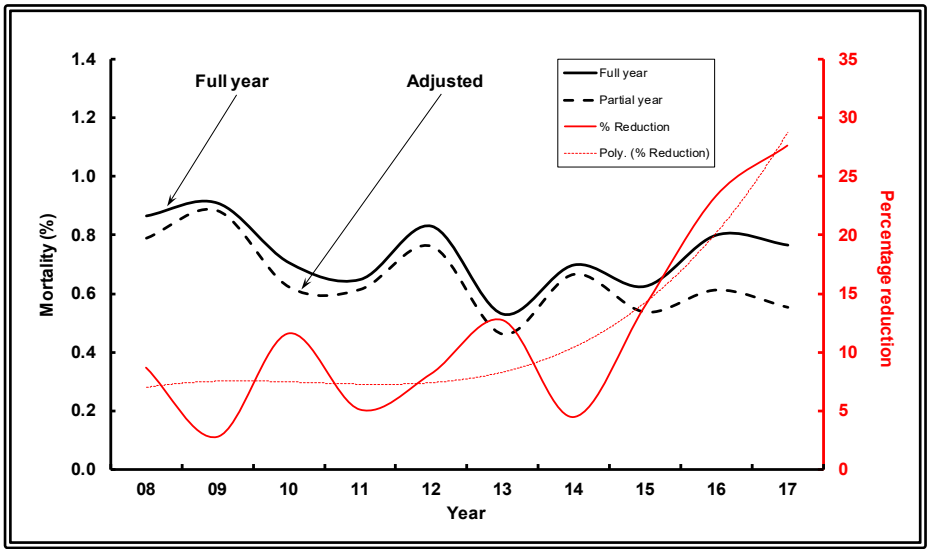
Having said that, the years prior to 2018 can also be made to reflect the partial "moratorium" years simply by removing all data for the months of June to August.

It is of immediate interest to examine what the impact on annual mortality would have been if the same June to August restriction had previously been applied. Since we have whole years of data up to 2017, previous figures for each full and partial year can be compared.

The following comparison of years has been made for Fremantle, as the major contributor of sheep for the Middle-East/North African market.

Figure 12 shows total mortality percentage for voyages from Fremantle to the Middle East/North Africa for the full years 2008 to 2017, as well as adjusted results if voyages for the months of June to August had been removed. The percentage reduction in mortality between full and partial years is also shown.

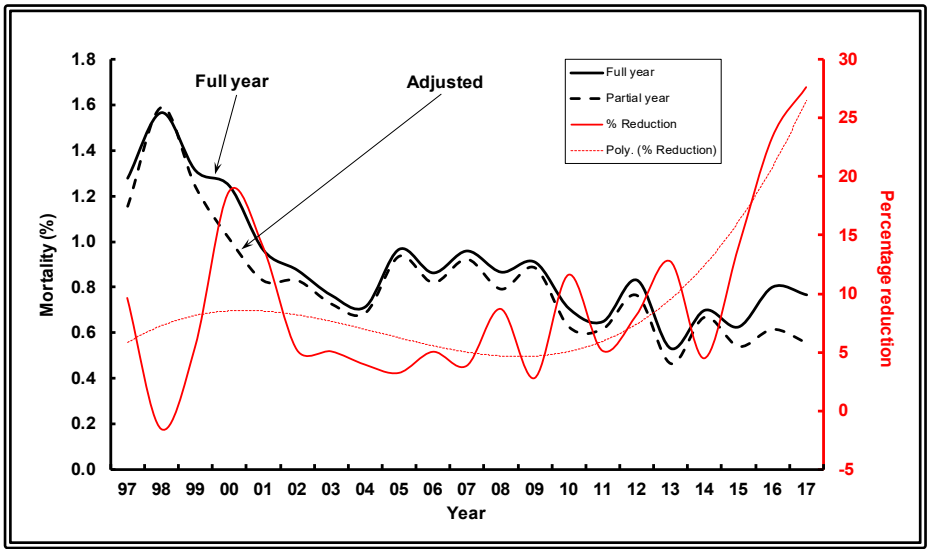
Figure 12 Total mortality (%) for sheep exported by sea from Fremantle to the Middle East/North Africa for the full years 2008 to 2017, partial years (excluding June to August), and the resulting percentage reduction



The reduction in percentage mortality fluctuates about 7.5% over 2008 to 2014, but then rises steadily over 2015 to 2017, with a continued rising trend. This appears to justify the ongoing adjustment of the export year to exclude the months of June to August. However, looking at wider historical data in the same terms brings a different perspective.

Figure 13 shows total mortality percentage for voyages from Fremantle to the Middle East/North Africa for the full years 1997 to 2017, as well as the partial years with the months of June to August removed. Again, the mortality reduction percentage between full and partial years is also shown.

Figure 13 Total mortality (%) for sheep exported by sea from Fremantle to the Middle East/North Africa for the full years 1997 to 2017, partial years (excluding June to August), and the resulting percentage reduction



While the recent rising trend is still evident, the longer-term view shows that over the majority of the period 1997 to 2017, the mortality rate for partial years has actually remained quite close to the mortality rate for full years.

If an “expected” figure can be placed on the reduction, the combined difference between full year and partial year mortality rates is only 7.5%. This equates to a long-term reduction in the annual mortality rate, under current full export years (~0.70%, Table 4), of approximately 0.05%. That is, a reduction from 0.70% to 0.65%.

A long-term reduction of 7.5% in the annual mortality rate may not be the magnitude of benefit expected from reducing the export year to exclude the months of June to August.

3.2 Cattle

3.2.1 Performance trend

The number of cattle shipped from all ports in Australia to all destinations since 2009 as well as the trend line (linear regression) across those years is shown in Figure 14. Figure 15 shows the number of cattle mortalities during sea transport since 2009. The number of cattle exported annually has varied from approximately 620,000 to 1,310,000, and the annual mortality has varied between 0.10 and 0.15%. The overall trend for numbers of cattle exported is upwards while the trend for annual mortality has returned to slightly downward.

Figure 14 Number of cattle exported by sea from Australia to all destinations since 2009

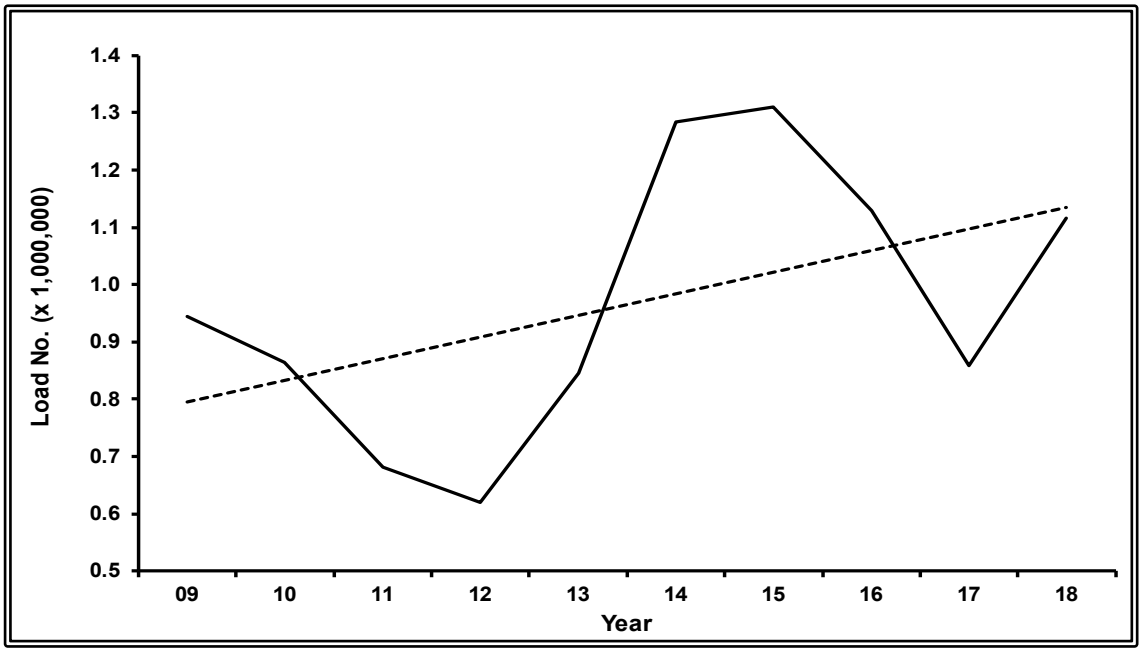
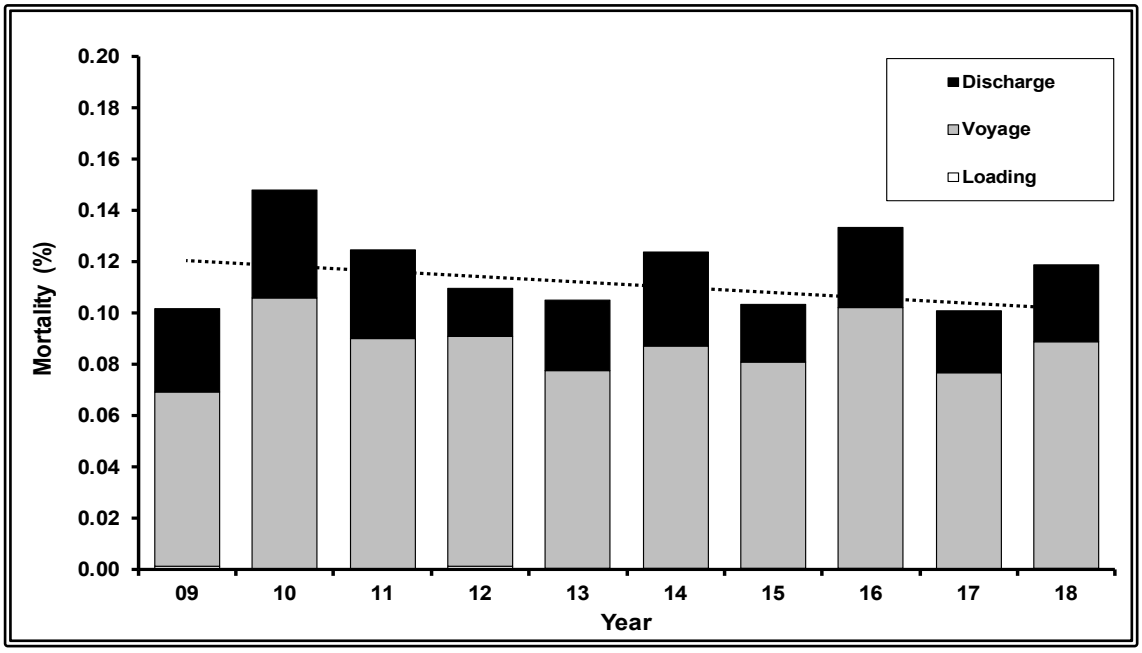


Figure 15 Annual mortality of cattle exported by sea from Australia to all destinations since 2009



3.2.2 Overview

The live cattle trade from Australia in 2018 was characterised by the large number of loading ports in Australia and the widely distributed ports to which the animals were shipped. This differs from the live sheep trade which had only three ports of loading, with the majority of sheep being shipped to the Middle East/North Africa.

There were 356 cattle "voyages" during 2018. This involved 323 ship journeys, which was a 22% increase when compared to 2017. There were 28 ship journeys which were split for loading or discharge, and these generated a further 61 “voyages” as a result.

Where analysis involving split-load/discharge voyages has been performed, cattle consignments from each load port to each discharge port have been considered as separate “voyages’. See the Methodology (3.1 Voyage) section of this report for a more detailed explanation of the voyage phases and the involvement of split-loading and split-discharging.

The overall number of cattle exported from Australia in 2018 rose by 30% compared to 2017, to 1.12 million (Table 13, below). This figure comprised an extra 0.13 million cattle exported to South-East Asia, as well as the doubling and tripling of southern exports to China and South-East Europe respectively. The overall mortality rate in 2017 was 0.12%, a rise of 18% on the figure of 0.10% observed in 2017. 23% of all cattle voyages returned a nil mortality rate during 2018.

The highest overall mortality rate on a regional basis was for exports to North-East Asia (0.24%), while the lowest overall mortality rate was for exports to South-East Asia (0.09%). There were no exports to either Mexico or Miscellaneous destinations in 2018

The number of cattle exported to the Middle East/North Africa in 2018 rose by 62% compared to 2017, with the number of voyages also rising by 8%. The mortality rate to the region fell by 22%.

Exports to South-East Asia rose by 19% in 2018 compared to 2017. This made up over half of the overall rise in live cattle exports for 2018. The number of voyages rose by 16%, from 231 in 2017 to 269 in 2018. Trade to South-East Asia accounted for 75% of all cattle exported in 2018.

Exports to South-East Asia involve a mix of smaller ships performing short single-load/single-discharge voyages, and larger ships that load and/or discharge at more than one port. In 2018, these larger vessels accounted for 40% of the cattle exported and 21% of the voyages made to South-East Asia.

Exports to North-East Asia in 2018 rose by 70% compared to 2017, much of the rise being made up of a doubling of exports to China. The mortality rate for the region also doubled, from 0.11% in 2017 to 0.24% in 2018.

Exports to South-East Europe in 2018 tripled those of 2017, while the mortality rose from 0.21% to 0.24%.

Table 13 Mortality rates, number of voyages, voyage and discharge days, and number of cattle exported for voyages to major destination regions during 2018

Parameter	ME/N Africa	SE Asia	NE Asia	SE Europe	Total
Voyages (No.)	28	269	49	10	356
Cattle (No.)	67,006	838,238	148,943	61,657	1,115,844
Mortality rate o/all (%)	0.14	0.09	0.24	0.24	0.12
Mortality rate range (%)	0.00 – 0.60	0.00 – 1.85*	0.00 – 1.51*	0.00 – 0.47	0.00 – 1.85
Voyage days (Ave.)	18.04	8.13	16.96	24.80	10.60
Discharge days (Ave.)	3.47	1.25	0.80	4.68	1.46
Voyages with nil mortalities (No.)	10	65	5	3	83

* exceptional voyages; see Sections 4.2.3 and 4.2.4

3.2.3 Middle East/North Africa

The number of live cattle exported to the Middle East/North Africa during 2018 rose by 62% compared to 2017 (Table 14), and the number of voyages rose by 8%.

Overall mortality rates have remained below 0.5% over the last decade. In 2018 the mortality rate was 0.14%, which is the lowest rate achieved since comprehensive recording began in 1995.

Table 14 Mortality rates, number of voyages, average voyage and discharge length, and number of cattle exported to the Middle East/North Africa from 2009 to 2018

Year	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days	Nil mortality voyages (No.)
2009	41	98,183	0.33	0.00 – 1.78*	15.37	4.62	13
2010	37	163,869	0.40	0.00 – 1.62*	17.57	3.75	14
2011	28	80,180	0.17	0.00 – 0.67	17.91	3.14	10
2012	31	98,236	0.16	0.00 – 0.86	18.53	2.74	11
2013	33	121.780	0.17	0.00 – 0.44	19.28	3.99	12
2014	25	106.065	0.36	0.00 – 2.75*	19.21	4.72	11
2015	31	99,558	0.26	0.00 – 0.78	19.10	3.21	12
2016	28	72,721	0.30	0.00 – 0.72	17.77	4.33	14
2017	26	41,384	0.17	0.00 – 1.00	17.14	4.13	15
2018	28	67,006	0.14	0.00 – 0.60	18.04	3.47	10

* exceptional voyages; see 6.2 Appendix 2

3.2.3.1 Port of loading

There were four ports of loading for voyages to the Middle East/North Africa in 2018, with 88% of cattle being exported from Fremantle (Table 15). The port with the highest mortality rate in 2018 was Geelong.

The voyages from each port were classified into various mortality categories as shown in Table 16. There was one voyage in the medium or high categories, loaded in Geelong.

All voyages for Adelaide and Portland were in the nil or low categories.

Table 15 Mortality rates, number of voyages, average voyage and discharge length, and number of cattle exported from various ports to the Middle East/North Africa for 2018

Port	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days
Fremantle	22	58,881	0.11	0.00 – 0.40	16.96	3.25
Geelong	1	3,343	0.60	n/a	22.71	1.07
Portland	2	3,069	0.16	0.13 – 0.18	21.92	1.03
Adelaide	3	1,713	0.23	0.00 – 0.28	21.81	7.48

Table 16 Number of voyages in nil, low, medium and high mortality categories for shipments from various ports to the Middle East/North Africa for 2018

Port	Mortality rate				Total
	Nil 0.0%	Low >0.0 – 0.5%	Medium >0.5 – 1.0%	High >1.0%	
Fremantle	8	14	0	0	22
Adelaide	2	1	0	0	3
Portland	0	2	0	0	2
Geelong	0	0	1	0	1
Total	10	17	1	0	28

3.2.3.2 Time of year

Cattle exported to the Middle East/North Africa were affected by the legislated restrictions imposed on the Live Sheep Trade. These restrictions prevented the movement of sheep and cattle ships to that region. As a result, the comparison between the five-year and 2018 monthly mortality profiles could not be drawn.

3.2.3.3 Ship

The voyages of each ship carrying cattle from Australia to the Middle East/North Africa were classified into four mortality categories: nil (no mortalities); low (mortality rate up to 0.5%); medium (from 0.5 to 1.0%); and high (greater than 1.0%). Note that for this comparison, “voyage” equates to consignment from a port. If a ship loaded at two ports, then two “voyages” are shown, one for each port.

Table 17 shows the number of voyages in the various mortality categories for each ship. There was one voyage in the medium or high categories, involving ship 43. Ninety six percent of voyages were in the nil or low categories.

Table 17 Number of voyages in nil, low, medium and high mortality categories for shipments to the Middle East/North Africa for 2018

Ship (code)	Mortality rate				Total
	Nil 0.0%	Low >0.0 – 0.5%	Medium >0.5 – 1.0%	High >1.0%	
32	3	1	0	0	4
33	0	2	0	0	2
34	6	0	0	0	6
35	0	2	0	0	2
43	1	1	1	0	3
131	0	2	0	0	2
139	0	6	0	0	6
140	0	3	0	0	3
Total	10	17	1	0	28

3.2.3.4 Class of cattle

In 2018, there was two shipment of cattle totalling 5,799 for which mortality could not be attributed to class, and these have been excluded from this section of the report.

The highest overall class mortality rate occurred in adult steers (0.22%; Table 18). Bull classes made up 86% of all cattle shipped to Middle East/North Africa in 2018.

Table 18 Mortality rates, number of voyages and number of cattle in various classes exported to the Middle East/North Africa in 2018

Class	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)
Bull adults*	18	35,775	0.13	0.00 – 0.60
Bull weaners	6	11,296	0.10	0.00 – 0.16
Heifers beef	10	6,393	0.03	0.00 – 0.79
Steer adults*	18	4,025	0.22	0.00 – 6.67†
Heifers dairy	3	3,718	0.16	0.13 – 0.18

* may include young as well as mature animals (i.e. animals not separately classified as "weaner")
† a small consignment with a few deaths, which did not attract a Federal Department of Agriculture investigation.

3.2.4 South-East Asia

The number of cattle exported to South-East Asia in 2018 rose by 62% compared to 2017 and the number of voyages rose by 17% (Table 19). The mortality rate has remained under 0.1% over the last decade, at an average of 0.07%.

The mortality rate for voyages to the region during 2018 has remained at 0.09%. A nil mortality rate was reported on 23% of the voyages to the region.

Table 19 Mortality rates, number of voyages, average voyage and discharge length, and number of cattle exported to South-East Asia from 2009 to 2018

Year	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days	Nil mortality voyages (No.)
2009	288	795,465	0.08	0.00 – 0.83	6.27	0.99	130
2010	202	551,761	0.04	0.00 – 0.44	6.47	0.86	105
2011	113	446,708	0.04	0.00 – 0.79	6.95	1.72	55
2012	127	361,383	0.04	0.00 – 0.80	6.71	1.32	63
2013	177	594,457	0.08	0.00 – 0.73	7.27	1.92	71
2014	266	995,138	0.08	0.00 – 3.52*	7.66	1.55	96
2015	310	1,066,664	0.08	0.00 – 3.68*	8.34	1.52	102
2016	272	863,960	0.09	0.00 – 1.42*	7.96	1.47	86
2017	231	704,683	0.09	0.00 – 10.05*	7.46	1.44	83
2018	269	838,238	0.09	0.00 – 1.85*	8.13	1.25	65

* exceptional voyages; see 6.2 Appendix 2

3.2.4.1 Port of loading

Most cattle exported to South-East Asia in 2018 were loaded at Darwin (50%) followed by Townsville (30%) and Broome (10%, Table 20). The mortality rate was highest for cattle exported from Fremantle (0.15%) followed by Townsville (0.12%), then Broome and Geraldton (0.08%).

The voyages from each port were classified into various mortality categories as shown in Table 21. 98% of voyages were in the nil or low categories in 2018. There were four voyages in the medium and one in the high category involving the ports of Broome, Darwin, and Townsville. These three ports also accounted for 87% of voyages to the region.

Table 20 Mortality rates, number of voyages, average voyage and discharge length, and number of cattle exported from various ports to South-East Asia in 2018

Port	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days
Darwin	150	416,457	0.06	0.00 – 1.85*	7.28	1.11
Townsville	60	254,057	0.12	0.00 – 0.73	10.46	1.76
Broome	25	84,358	0.08	0.00 – 0.63	6.79	1.25
Fremantle	16	44,393	0.15	0.03 – 0.37	10.03	1.14
Wyndham	5	14,915	0.03	0.00 – 0.08	4.55	1.05
Karumba	7	10,849	0.03	0.00 – 0.06	9.62	0.44
Geraldton	5	10,495	0.08	0.09 – 0.24	8.73	0.89
Port Hedland	1	2,714	0.04	n/a	3.95	0.36

* exceptional voyage; see 6.2 Appendix 2

Table 21 Number of voyages in nil, low, medium and high mortality categories for shipments from various ports to South-East Asia for 2018

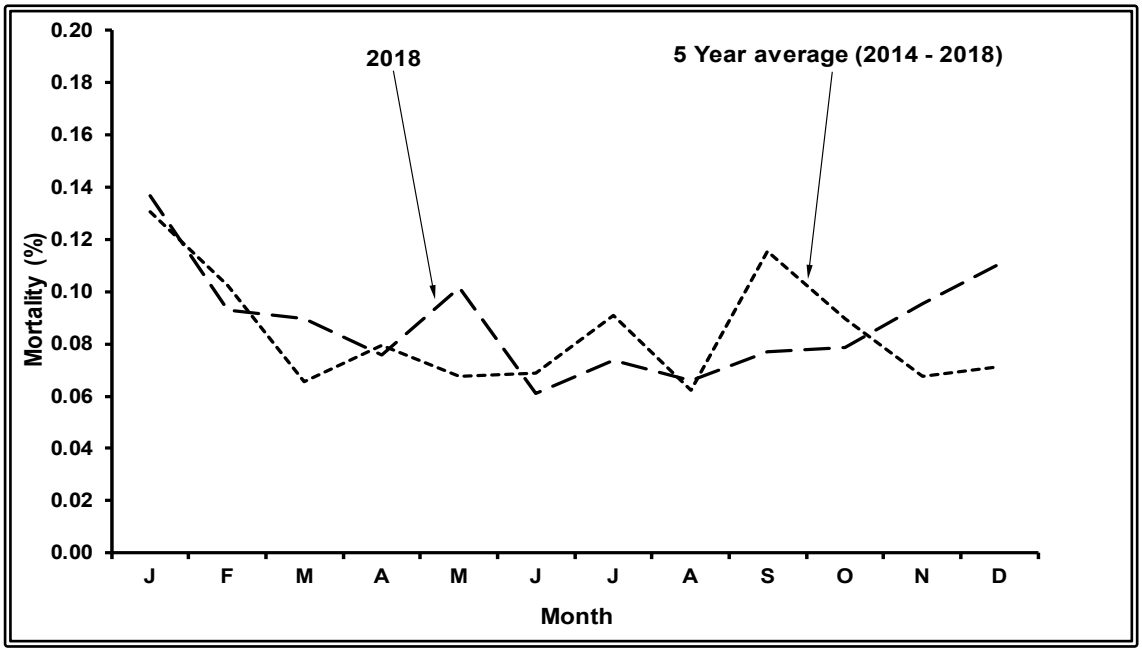
Port	Mortality rate				Total
	Nil 0.0%	Low >0.0 – 0.5%	Medium >0.5 – 1.0%	High >1.0%	
Darwin	47	101	1	1	150
Townsville	3	55	2	0	60
Broome	6	18	1	0	25
Fremantle	0	16	0	0	16
Wyndham	3	2	0	0	5
Karumba	4	3	0	0	7
Geraldton	2	3	0	0	5
Port Hedland	0	1	0	0	1
Total	65	199	4	1	269

3.2.4.2 Time of year

Monthly mortality rates (total mortality as a proportion of total loaded for each month) for voyages to South-East Asia in 2018 were at or below 0.10% for the year except for the months of January and December (Figure 16).

The monthly mortality rate profile for 2018 approximated that of the 5-year average.

Figure 16 Monthly mortality rates of cattle on voyages from all ports to South-East Asia for 2018 and the 5-year average monthly rates for the period 2014 to 2018



3.2.4.3 Ship

Voyages for each ship from Australia to South-East Asia were classified into various mortality categories as shown in Table 22. Ninety eight percent of voyages were in the nil or low categories. There were four voyages in the medium and one in the high category.

The number of voyages to the region rose from 231 in 2017 to 269 in 2018, an increase of 17%.

Ships with a carrying capacity of 6,000 or more head accounted for 21% of voyages to South-East Asia in 2018. They also accounted for 40% of cattle exported, 35% of mortality, 20% of voyage days and 40% of discharge days.

It should be noted that the larger ships often undergo more complex loading and discharging schedules which generate more "voyages", as discussed in "Voyage", Section 3.1 of the Methodology.

Table 22 Number of voyages in nil, low, medium and high mortality categories for shipments to South East Asia for 2018

	Mortality rate				
Ship (code)	Nil 0.0%	Low >0.0 – 0.5%	Medium >0.5 – 1.0%	High >1.0%	Total
43	0	3	0	0	3
44	2	6	0	0	8
47	0	11	1	0	12
49	2	13	0	0	15
50	1	9	0	0	10
59	1	10	0	0	11
77	2	7	1	0	10
95	3	9	0	0	12
120	6	15	0	0	21
122	1	6	0	0	7
124	7	13	0	0	20
125	2	13	0	0	15
126	2	8	0	0	10
127	4	9	0	0	13
128	0	1	0	0	1
129	7	13	0	0	20
130	2	1	0	0	3
131	1	5	0	0	6
132	3	3	1	0	7
133	0	16	0	0	16
134	0	2	0	0	2
135	4	6	0	0	10
136	8	10	0	0	18
138	1	2	1	0	4
140	4	5	0	0	9
-	2	3	0	1	6
Total					

Note – one ship code excluded for 2018. The ship performed 2, 3, 0 and 1 voyages in the Nil, Low, Medium and High categories respectively

3.2.4.4 Class of cattle

In 2018, 97.80% of cattle exported to South-East Asia were able to be identified by class. The 18,463 cattle that could not be identified to class were exported on three voyages, incurring a total mortality of 0.09%. These cattle will not be examined further in this section.

Adult steers and beef heifers comprised 48% and 18% respectively of all classes exported to the region in 2018 (Table 23).

The highest mortality rates occurred in beef cows (0.37%) followed by adult bulls (0.17%).

Note that high values for mortality rate ranges not included in voyage investigations mentioned at 6.2 Appendix 2, involved only a few deaths in small numbers loaded.

Table 23 Mortality rates, number of voyages and number of cattle in various classes exported to the South-East Asia in 2018

Class	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)
Steer adults*	243	402,578	0.08	0.00 – 1.16†
Heifers beef	165	152,208	0.05	0.00 – 2.50†
Steer weaners	43	118,059	0.05	0.00 – 0.40
Bull adults*	165	109,796	0.17	0.00 – 5.41††
Bull weaners	34	19,256	0.04	0.00 – 0.33
Cows beef	48	17,677	0.37	0.00 – 2.09††
Heifers dairy	1	192	0.00	n/a

* may include young as well as mature animals (i.e. animals not separately classified as "weaner")
† small consignment with a few deaths, which did not attract a Federal Department of Agriculture investigation
†† exceptional voyage; see 6.2 Appendix 2

3.2.5 North-East Asia

The number of cattle exported to North-East Asia in 2018 rose by 70% compared to 2017, with the number of voyages rising by 58% (Table 24).

The mortality rate for voyages to the region during 2018 was 0.24%, the first time it has risen above 0.20% since 1999. Prior to 2018, the mortality rate has remained under 0.2% over the last decade, at an average of 0.12%. A nil mortality rate was reported on 10% of voyages to the region.

The North-East Asia cattle trade has been characterised by steers exported to Japan and heifers sent to China, but much of the 2018 increase in exports to the region has come from slaughter cattle sent to China.

Table 24 Mortality rates, number of voyages, average voyage and discharge length, and number of cattle exported to North-East Asia from 2009 to 2018

Year	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days	Nil mortality voyages (No.)
2009	23	48,116	0.07	0.00 – 0.22	16.91	0.70	5
2010	34	69,638	0.08	0.00 – 0.33	18.25	0.62	10
2011	31	68,773	0.15	0.00 – 0.46	18.08	0.87	5
2012	30	74,941	0.17	0.00 – 0.70	17.55	0.76	7
2013	31	81,521	0.15	0.00 – 1.18*	17.63	0.68	5
2014	39	123,583	0.14	0.00 – 2.04*	17.47	0.76	10
2015	32	98,213	0.08	0.00 – 0.56	17.35	0.66	7
2016	35	102,487	0.14	0.00 – 0.64	17.28	0.75	8
2017	31	87,877	0.11	0.00 – 0.52	17.18	0.81	4
2018	49	148,943	0.24	0.00 – 1.51*	16.96	0.80	5

* exceptional voyage; see 6.2 Appendix 2

3.2.5.1 Port of loading

The majority of cattle exported to North-East Asia in 2017 departed from Portland (73%), followed by Fremantle (12%) and Brisbane (9% - Table 25). All cattle loaded at Brisbane were exported to Japan while those loaded at other ports were exported to China.

The voyages from each port were classified into various mortality categories as shown in Table 26. During 2018 there was one voyage in the medium mortality category, while 86% of all voyages were in the nil or low categories.

Table 25 Mortality rates, number of voyages, average voyage and discharge length, and number of cattle exported from various ports to North-East Asia for 2018

Port	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days
Portland	27	108,824	0.24	0.00 – 1.51*	17.50	0.96
Fremantle	9	18,044	0.48	0.05 – 1.45*	16.65	0.80
Brisbane	9	12,716	0.06	0.00 – 0.20	16.75	0.32
Geelong	2	5,554	0.04	0.03 – 0.05	16.57	0.70
Port Alma	1	2,199	0.23	n/a	13.23	1.15
Townsville	1	1,606	0.13	n/a	11.43	0.80

* exceptional voyage; see 6.2 Appendix 2

Table 26 Number of voyages in nil, low, medium and high mortality categories for shipments from various ports to North-East Asia for 2018

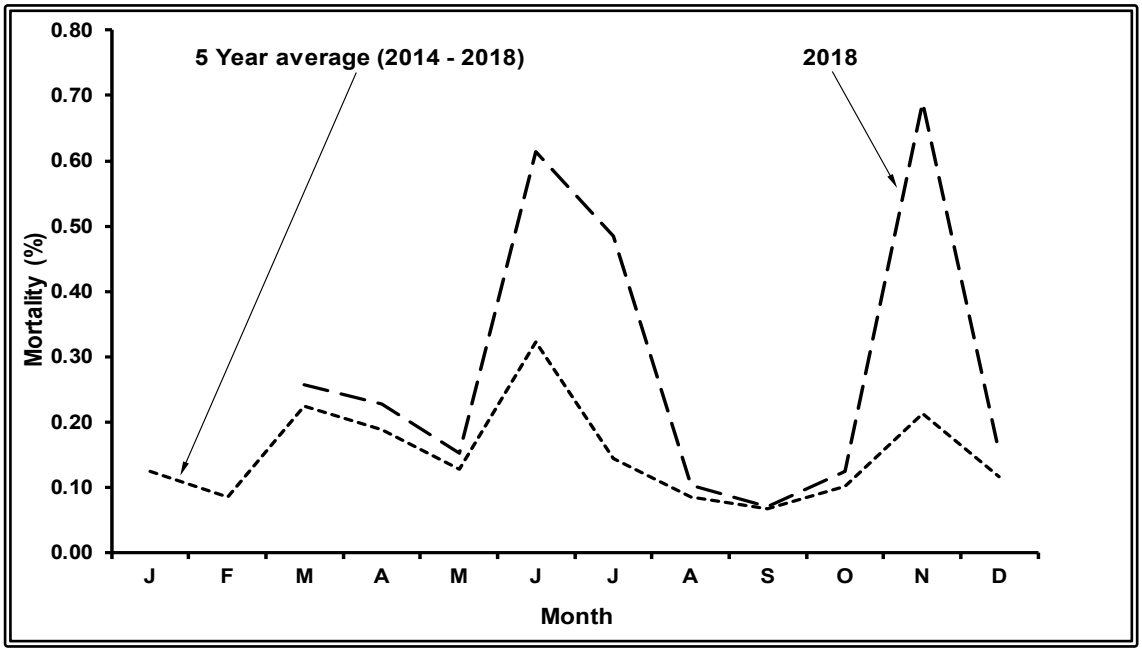
Port	Mortality rate				Total
	Nil 0.0%	Low >0.0 – 0.5%	Medium >0.5 – 1.0%	High >1.0%	
Portland	1	22	3	1	27
Fremantle	0	6	2	1	9
Brisbane	4	5	0	0	9
Geelong	0	2	0	0	2
Port Alma	0	1	0	0	1
Townsville	0	1	0	0	1
Total	5	37	5	2	49

3.2.5.2 Time of year

Monthly mortality rates (total mortality as a proportion of total loaded for each month) for voyages to North-East Asia in 2018 were below 0.25% throughout the year except for the months of June, July and November (Figure 17).

The monthly mortality rate profile for 2018 approximated the 5-year average except for the months mentioned.

Figure 17 Monthly mortality rates of cattle on voyages from all ports to North-East Asia for 2018 and the 5-year average monthly rates for the period 2014 to 2018



3.2.5.3 Ship

In 2018, 95.72% of cattle exported to North-East Asia were able to be identified by class. One shipment of 6,376 cattle (total mortality 0.09%) could not be identified to class, and these cattle will not be examined further in this section.

The voyages of each ship taking cattle from Australia to North-East Asia were classified into various mortality categories as shown in Table 27. During 2018 there were five voyages in the medium and two in the high mortality categories. 86% of voyages were in the nil or low categories.

Table 27 Number of voyages in nil, low, medium and high mortality categories for shipments to North-East Asia for 2018

Ship (code)	Mortality rate				Total
	Nil 0.0%	Low >0.0 – 0.5%	Medium >0.5 – 1.0%	High >1.0%	
44	0	2	0	0	2
49	0	0	1	0	1
59	0	2	1	0	3
77	1	2	0	0	3
95	0	2	0	0	2
120	0	1	0	0	1
122	3	2	0	0	5
123	0	1	0	0	1
126	1	2	0	0	3
127	0	2	0	0	2
128	0	1	0	0	1
130	0	2	0	0	2
131	0	4	0	0	4
132	0	4	2	0	6
134	0	1	0	0	1
135	0	4	0	0	4
138	0	3	1	0	4
-	0	2	0	2	4
Total	5	37	5	2	49

Note – two ship codes excluded for 2018. These ships performed 0, 2, 0 and 2 voyages in the Nil, Low, Medium and High categories respectively

3.2.5.4 Class of cattle

Mortality rates for classes of cattle exported to North-East Asia during 2018 are presented in Table 28. The North-East Asian cattle trade comprised mainly steers exported to Japan and China (27%) and heifer classes exported to China (63%).

The highest mortality rates occurred in weaner steers (0.93%) followed by adult steers (0.37%).

Table 28 Mortality rate, number of voyages and number of cattle in the classes exported to North-East Asia in 2018

Class	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)
Heifers dairy	18	62,699	0.21	0.00 – 0.84
Steer adults*	25	40,005	0.37	0.00 – 1.69††
Heifers beef	20	30,880	0.18	0.00 – 5.13†
Cows dairy	2	4,963	0.18	0.06 – 0.25
Bull adults*	8	3,367	0.24	0.00 – 0.50
Steer weaners	1	537	0.93	n/a
Cows beef	2	116	0.00	n/a

* may include young as well as mature animals (i.e. animals not separately classified as "weaner")
† small consignment with a few deaths, which did not attract a Federal Department of Agriculture Investigation
†† exceptional voyage; see 6.2 Appendix 2

3.2.6 South-East Europe

The significant rise in livestock exports to Turkey and the Black Sea over the last decade initially had the effect of excessively boosting numbers of cattle exported to the Miscellaneous region. In 2012 a new destination region, South-East Europe, was introduced to allow a more meaningful examination of exports to this area. The mortality rate in cattle exported to South-East Europe was 0.24% in 2018.

The number of cattle exported to South-East Europe has increased significantly since 2009 while mortality rates have remained near 0.5% or less over the last decade, at an average of 0.33% (Table 29).

Numbers of voyages and cattle exported to the region tripled during 2018 compared to 2017.

Table 29 Mortality rates, number of voyages, average voyage and discharge length, and number of cattle exported to South-East Europe from 2009 to 2018

Year	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days	Nil mortality voyages (No.)
2009	1	3,493	0.37	n/a	41.60	0.96	0
2010	11	78,673	0.44	0.00 – 0.83	25.08	5.03	1
2011	15	83,033	0.51	0.19 – 1.43*	26.78	5.00	0
2012	14	75,170	0.28	0.00 – 0.87	28.78	3.58	1
2013	5	44,560	0.18	0.00 – 0.61	24.58	3.87	0
2014	5	54,006	0.47	0.34 – 0.60	25.62	3.88	0
2015	4	40,666	0.53	0.23 – 0.79	30.52	3.59	0
2016	12	86,846	0.29	0.08 – 0.65	24.71	1.97	0
2017	3	20,791	0.21	0.00 – 0.32	25.61	3.26	1
2018	10	61,657	0.24	0.00 – 0.47	24.80	4.68	3

* exceptional voyage; see 6.2 Appendix 2

3.2.6.1 Port of loading

All cattle exported to South-East Europe in 2018 were loaded at southern ports, with most being loaded at Portland (40%) followed by Fremantle (36% - Table 30).

The mortality rate was highest for cattle exported from Portland (0.47%) followed by Fremantle (0.39%).

The voyages from each port were classified into various mortality categories as shown in Table 31. All voyages were in the low or nil categories in 2018

Table 30 Mortality rates, number of voyages, average voyage and discharge length, and number of cattle exported from various ports to South-East Europe in 2018

Port	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days
Portland	2	24,907	0.29	0.18 – 0.47	29.65	5.69
Fremantle	5	22,264	0.24	0.00 – 0.39	21.82	4.34
Geelong	1	11,575	0.17	n/a	27.88	5.70
Adelaide	2	2,911	0.07	0.00 – 0.08	25.86	4.02

Table 31 Number of voyages is nil, low, medium and high mortality categories for shipments from various ports to South-East Europe for 2018

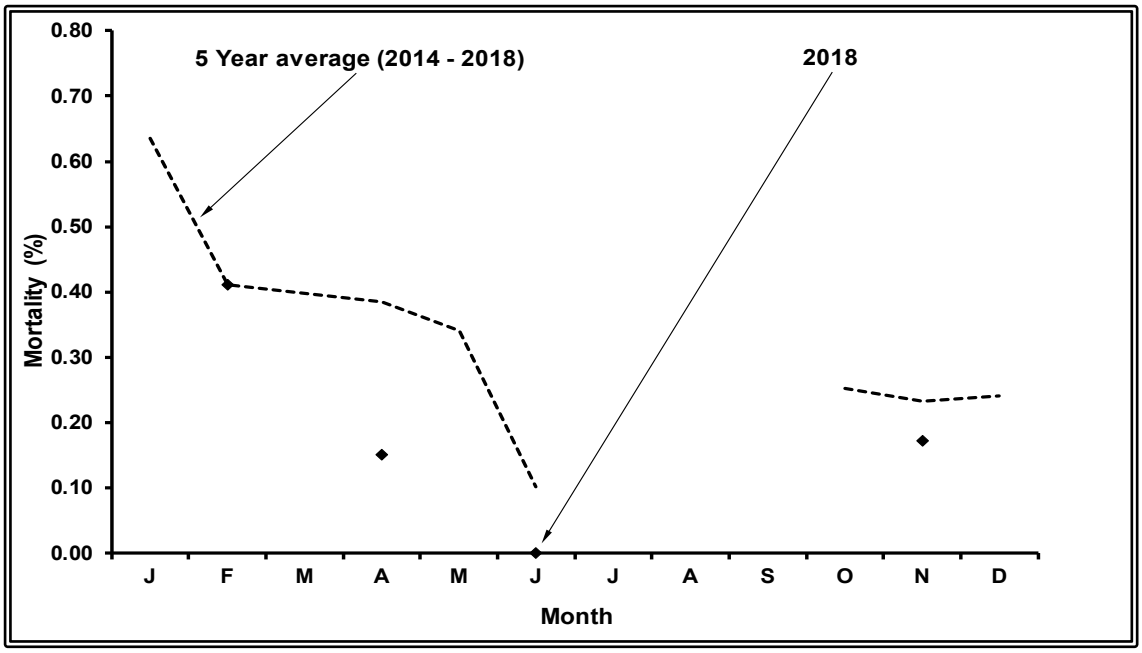
Port	Mortality rate				Total
	Nil 0.0%	Low >0.0 – 0.5%	Medium >0.5 – 1.0%	High >1.0%	
Fremantle	2	3	0	0	5
Portland	0	2	0	0	2
Adelaide	1	1	0	0	2
Geelong	0	1	0	0	1
Total	3	7	0	0	10

3.2.6.2 Time of year

Monthly mortality rates (total mortality as a proportion of total loaded for each month) for voyages to South-East Europe in 2018 were at or below 0.4% (Figure 18).

For the four months on which voyages occurred during 2018 the monthly mortality values approximated the 5-year average profile, except for the month of April, where the 2018 value was less than half of the 5-year average.

Figure 18 Monthly mortality rates of cattle on voyages from all ports to South-East Europe for 2018 and the 5-year average monthly rates for the period 2014 to 2018



3.2.6.3 Ship

The voyages of each ship carrying cattle from Australia to South-East Europe were classified into various mortality categories as shown in Table 32. All voyages for 2018 were in the nil or low mortality categories.

Table 32 Number of voyages in nil, low, medium and high mortality categories for shipments to South-East Europe for 2018

	Mortality rate				
Ship (code)	Nil 0.0%	Low >0.0 – 0.5%	Medium >0.5 – 1.0%	High >1.0%	Total
35	2	3	0	0	5
43	1	2	0	0	3
50	0	2	0	0	2
Total	3	7	0	0	10

3.2.6.4 Class of cattle

Exports to South-East Europe were all in steer and bull classes, mainly to Russia and Turkey respectively.

The 200% rise in exports to the region can be attributed to the steers sent to Russia, which re-entered the market for Australian live export cattle in 2018.

Mortality rates for each class of cattle exported to South-East Europe during 2018 are presented in Table 33. The highest mortality rates occurred in weaner steers (0.26%)

Table 33 Mortality rate, number of voyages and number of cattle in the classes exported to South-East Europe in 2018

Class	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)
Steer adults	10	42,984	0.25	0.00 – 0.57
Bull adults*	5	16,751	0.21	0.00 – 0.37
Steer weaners	2	1,922	0.26	0.21 – 0.30

* may include young as well as mature animals (i.e. animals not separately classified as "weaner")

3.3 Air Transport

3.3.1 Air transport of live sheep

During 2018 air transport accounted for the 2.86% of live sheep exports (31,834 out of 1,111,606 sheep exported). The 31,834 sheep exported by air in 2018 represents a fall of 24% compared to 42,144 in 2017, and falls below the average export figure of approximately 37,000 for the 2009 to 2018 period.

Air transport of live sheep comprises a mix of breeding and slaughter types. In 2018, 80% of air-transported sheep were for slaughter.

3.3.1.1 Load point / destination

The loading points and destination countries for sheep transported by air from Australia in 2018 are shown in Table 34. Almost all sheep were loaded at Adelaide, Perth and Sydney airports, each accounting for 37.0%, 27.4%, and 27.1% of the number exported respectively.

Avalon airport, near Geelong, took part in air export of sheep for the first time in 2018.

The main importing countries for Australian sheep exported by air in 2018 were Malaysia (78.2%), Singapore (12.3%) and China (4.5%).

Table 34 Load point and destination country for sheep exported by air from Australia during 2018

Country	Adelaide	Avalon	Melbourne	Perth	Sydney	Total
Malaysia	11,765		1,079	4,782	7,266	24,892
Singapore				3,924		3,924
China		1,344	88			1,432
Sabah					532	532
Indonesia					392	392
Philippines					278	278
UAE			212			212
Bangladesh					157	157
Argentine					5	5
New Zealand			5			5
Uruguay					3	3
Russia					2	2
Total	11,765	1,344	1,384	8,706	8,635	31,834

SOURCE – Department of Agriculture, Mar 2019

3.3.1.2 Mortalities

The reportable level for air-transported sheep is 2.0% or 3 sheep, whichever is the greater number of animals. There was one high mortality flight in 2009 (7.34%), 2013 (38.39%), 2014 (7.91%) and 2015 (18.66%). If these flights were excluded, the mortality rates for those years would have been 0.05%, 0.01%, 0.01% and 0.02% respectively.

Note that references to Federal Department of Agriculture investigation reports into mortalities over 2% are included in 6.2 Appendix 2.

For air transported sheep from 2009 to 2018, all but 4 mortalities occurred in slaughter types and all but 13 mortalities occurred in the second half of the year. Mortalities occurred on 3.1% of flights over the decade (42 of 1,358).

Sheep exported by air experienced 0.01% mortalities during 2018 (Table 35). The expected level of mortality is 0.03%.

Table 35 Mortality rates and number of sheep exported by air to all destinations from 2009 to 2018

Year	Flights	Sheep (No.)	Total Mortalities (No.)	Mortality rate overall (%)
2009	68	23,238	148	0.64
2010	82	21,201	3	0.01
2011	94	30,865	42	0.14
2012	120	23,688	0	0.00
2013	139	35,875	45	0.13
2014	162	39,227	177	0.45
2015	194	56,945	137	0.24
2016	308	62,588	10	0.02
2017	138	42,144	16	0.04
2018	53	31,834	4	0.01

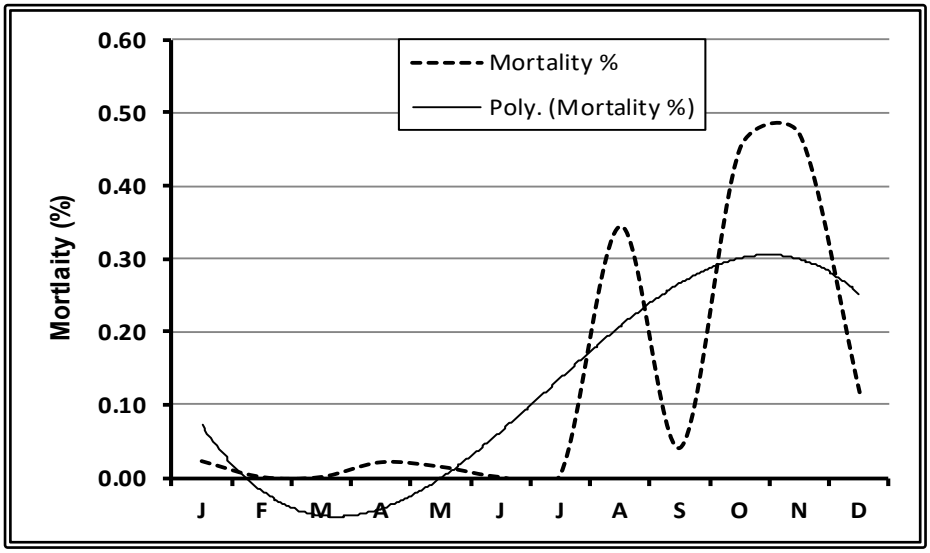
SOURCE – Department of Agriculture, Mar 2019

Over the period 2009 to 2018, mortalities were significantly higher in the second half of the year ($P < 0.05$, Figure 19), with 5 of the ten years being significantly different and one having no mortalities. Of the remaining years, three had higher second-half mortality rates which were not significantly different, while 2018 had a higher first-half mortality, which, again, was not significantly different.

All but 13 mortalities occurred in the second half of the year over the period.

It is interest to note that the trend line for the annual mortality profile approximates the enduring reverse tilde pattern seen in sheep exported by sea.

Figure 19 Monthly mortality (%) of sheep exported by air from Australia to all destinations since 2009



Mortalities were higher in slaughter sheep than breeder sheep ($P < 0.05$) with all but 4 mortalities occurring in slaughter types.

3.3.2 Air transport of live cattle

During 2018 air transport accounted for 1.03% of live cattle exports (11,646 out of 1,127,490 cattle exported).

The 11,646 cattle exported by air in 2018 represents a rise of 25.8% compared to 9,261 in 2017. The 2018 figure exceeds the average export figure of just over 9,000 for the 2009 to 2018 period.

Air transport of live cattle is almost exclusively confined to breeding types. 2015 and 2016 saw 7% and 11% respectively of slaughter cattle exported by air, but this figure was 1.6% in 2018.

3.3.2.1 Load point / destination

Load points and destinations for cattle transported by air from Australia in 2018 are shown in Table 36. Almost all cattle were loaded at Sydney and Melbourne airports, accounting for 57.0% and 31.4% respectively.

Avalon took part in air exports of cattle for the first time in 2018, and Perth took part again after an absence of six years.

The main importing countries for Australian cattle exported by air in 2018 were Indonesia (31.6%), Taiwan (17.6%), Malaysia (16.4%) and Japan (14.9%).

Table 36 Load point and destination country for cattle exported by air from Australia during 2018

Country	Adelaide	Avalon	Melbourne	Perth	Sydney	Total
Indonesia			242		3,440	3,682
Taiwan			1,942		113	2,055
Malaysia					1,912	1,912
Japan			545	849	345	1,739
Sabah					411	411
UAE			408			408
Sarawak		203			110	313
Bangladesh	300					300
Sri Lanka			246			246
Philippines					240	240
Vietnam			231			231
Thailand			40		69	109
Total	300	203	3,654	849	6,640	11,646

SOURCE – Department of Agriculture, Mar 2019

3.3.2.2 Mortalities

The reportable level for air-transported cattle is 0.5% or 3 cattle, whichever is the greater number of animals. There were two high mortality flights in 2013 (6.45% and 15.26%). If these flights were excluded, the mortality rates for the year would have been nil.

Note that references to Federal Department of Agriculture investigation reports into mortalities over 2% are included in 6.2 Appendix 2.

Cattle exported by air experienced nil mortalities during 2018 (Table 37). The expected level of mortality is 0.00%. Mortalities occurred on 1.1% of flights over the 2009 to 2018 period (6 of 606).

Table 37 Mortality rates and number of cattle exported by air to all destinations from 2009 to 2018

Year	Flights	Cattle (No.)	Total Mortalities (No.)	Mortality rate overall (%)
2009	62	9,315	0	0.00
2010	43	8,271	1	0.01
2011	48	8,738	0	0.00
2012	41	7,825	1	0.01
2013	54	9,691	67	0.69
2014	74	9,458	0	0.00
2015	76	11,315	2	0.02
2016	57	6,060	0	0.00
2017	72	9,261	0	0.00
2018	79	11,646	0	0.00

SOURCE – Department of Agriculture, Mar 2019

3.3.3 Air transport of live goats

Air transport has played a significant role in the export of live goats for many years, and during 2018 accounted for all live goat exports.

The 22,644 goats exported by air in 2018 represent a significant rise of 84% compared to 12,245 in 2017, but are still just over one third of the average figure of 61,000 for the years 2008 to 2019.

Air transport of live goats comprises a mix of breeding and slaughter types, the great majority of which are for slaughter. Like 2017, 2018 was unusual in that only 57.8% of air-transported goats were for slaughter. As in 2017, this decreased number of slaughter goats represents the reduction in overall numbers for the year.

3.3.3.1 Load point / destination

The loading points and destination countries for goats transported by air from Australia in 2018 are shown in Table 38.

47.1% of these goats were loaded at Sydney airport, followed by Adelaide and Melbourne airports, with 33.8% and 18.0% respectively.

The main importing countries for Australian goats exported by air in 2018 were Malaysia (57.8%), Sabah (18.9%) and China (12.5%).

Table 38 Load point and destination country for goats exported by air from Australia during 2018

Country	Adelaide	Melbourne	Perth	Sydney	Total
Malaysia	7,659	217	263	4,959	13,098
Sabah				4,269	4,269
China		2,840			2,840
UAE		840			840
Philippines				549	549
Indonesia				286	286
Thailand		56		225	281
Nepal		32		140	172
Bangladesh				136	136
Vietnam				80	80
Taiwan		36			36
Singapore		35			35
New Zealand		11			11
Russia				11	11
Total	7,659	4,067	263	10,655	22,644

SOURCE – Department of Agriculture, Mar 2019

3.3.3.2 Mortalities

The reportable level for air-transported goats is 2.0% or 3 goats, whichever is the greater number of animals. For the years 2009 to 2018, there has been only one flight with a reportable mortality level. Note that a reference to the Federal Department of Agriculture investigation reports into this 2015 flight is included in 6.2 Appendix 2

All mortalities for goats transported by air from 2009 to 2018 occurred in slaughter types except for one breeder goat in 2017 and three breeder goats in 2018. It should be noted that slaughter types have comprised the vast majority of goats exported. Mortalities occurred on 3.2% of flights (40 out 1,254) over the decade.

Goats exported by air experienced 0.053% mortalities during 2018 (Table 39). The expected level of mortality is 0.014%.

Table 39 Mortality rates and number of goats exported by air to all destinations from 2009 to 2018

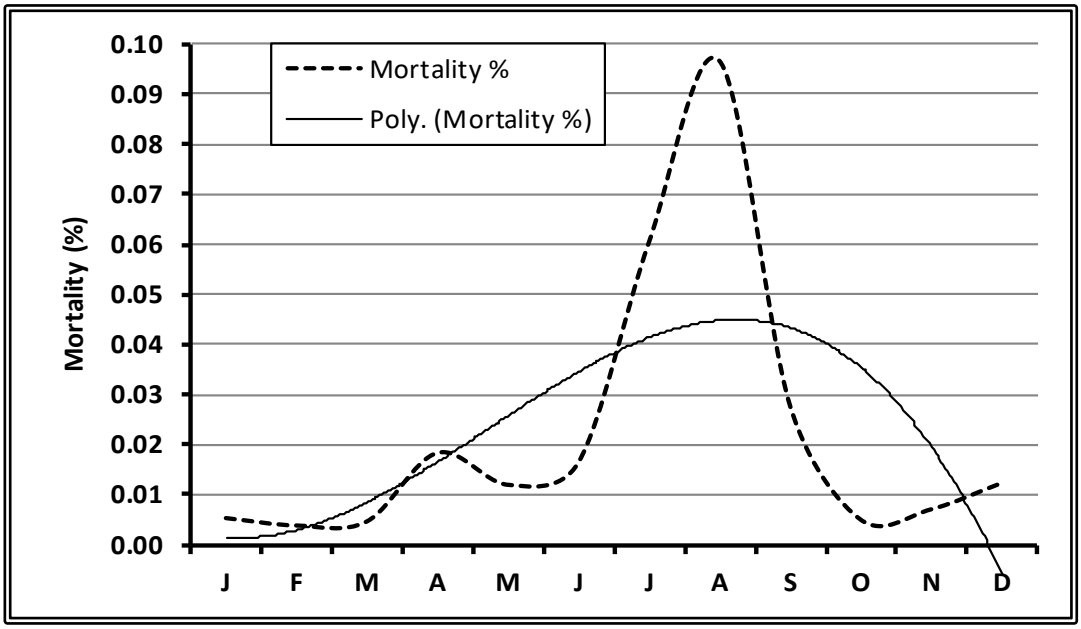
Year	Flights	Goats (No.)	Total Mortalities (No.)	Mortality rate overall (%)
2009	199	81,571	0	0.000
2010	214	79,949	8	0.010
2011	99	51,487	1	0.002
2012	90	64,209	0	0.000
2013	111	74,484	9	0.012
2014	159	86,705	11	0.013
2015	129	86,925	74	0.085
2016	130	53,959	22	0.041
2017	54	12,245	2	0.016
2018	69	22,644	12	0.053

SOURCE – Department of Agriculture, Mar 2019

Over the period 2009 to 2018, mortalities were significantly higher in the second half of the year ($P < 0.05$, Figure 20). However, this broke down to the years 2009 to 2012, 2017 and 2018 not being different, 2014 being significantly higher in the first half of the year, and the years 2013, 2015 and 2016 being significantly higher in the second half of the year.

Overall, 81% of mortalities occurred in the second half of the year over the period 2009 to 2018.

Figure 20 Monthly mortality (%) of goats exported by air from Australia to all destinations since 2009



With the exception of one breeder goat in 2017 and three in 2018, all mortalities for goats transported by air from 2009 to 2018 occurred in slaughter types, which comprised 87.1% of goats exported.

4 Conclusion and recommendations

4.1 Sheep, cattle and goats

This report successfully summarises the mortalities of sheep, cattle and goats exported live for the 2018 calendar year. Mortality trends were analysed and the overall mortalities for sheep and cattle exported by sea were shown to be 0.46%, 0.12% respectively, while overall mortalities for sheep, cattle and goats exported by air were 0.01%, 0.00% and 0.05% respectively. No goats were exported by sea in 2018.

This is the only comprehensive report of its type, providing breakdowns by ship, species, time of year, load ports and major destinations over the calendar year for both shipboard and air exports, as well as summary analyses of trends over time. The report is of interest and importance to a wide range of stakeholders, and while it is considered that the report effectively presents the Industry performance during the export phase, it is recommended that data held be turned to a broader range of analyses than those currently presented.

It is recommended that this project continue to be funded and to report on an annual basis in the future, but that the format be altered to account for changes to the ways in which animal welfare are measured. In the future, it is expected that a growing body of data derived from the Animal Welfare Indicators project (See Appendix 1- 6.1.4) will be available to augment the mortality data.

It is recommended that expression of results move from rates (mortality/loaded) to median values, with comparisons made to standardised rates of performance in the trade for classes of animal, time of year, destination etc. This use of standardised rates is intended to clarify trends over time.

In the past much of the analysis for the South-East Asia region was derived from the ship Master's Report, a voyage report for all shipments of livestock that must provide details meeting the reporting requirements of AMSA and the Department of Agriculture. Unfortunately updates to the ship Master's Report in 2009 meant that we have had to seek Industry data from then on for the details that had become unavailable in that version.

However, in mid-2018 a newer Master's Report version saw much of the previous information returned to the format, once again enabling much of the analysis for the South-East Asia region to be taken from this source. This has removed a significant burden for ships' Officers who have voluntarily filled the gap over the previous decade. Industry cooperation in the matter is laudable for the wholehearted support shown.

It has long been the practise in this series of reports to include exceptional high-mortality voyages in summary data. Where more-detailed analyses are concerned, it has been the practise to exclude exceptional voyages if they bias the results that would be expected under normal industry conditions. Such exclusions have been annotated in relevant text, tables and figures.

It is recommended that Industry information is continued as the source for the section regarding export destinations for sheep (Table 2, Section 4.1.4, p8).

5 Appendices

5.1 Appendix 1 – Research update

5.1.1 Heat load in sheep exported to Middle Eastern feedlots

Managing high environmental heat load in exported livestock is not restricted to onboard vessels but continues throughout the supply chain in the Middle East. MLA's Live Export Program (LEP) has conducted ongoing research into this area to promote the development of best practice guidelines for infrastructure design and livestock management. This research has been conducted in several phases:

Phase 1 gathered information about the internal rumen temperatures of sheep exported from Western Australia to the Middle East at various times of the year, with comparison to environmental conditions.

Phase 2 focused on monitoring environmental conditions and animal responses under different shade types and the impact of various additional measures applied to cool sheep.

A Tips and Tools document will be produced as a result of the first two phases, providing guidance on infrastructure and management practices to support improved heat management.

The temperature and humidity in Middle Eastern countries make managing sheep in-market difficult. Appropriately managing high environmental heat load continues to be an area where more work is needed.

Phase 3 of the research will look into developing a heat load management tool to be applied within feedlots in the Middle East, similar to the HSRA, to help reduce the incidence of high environmental heat load in animals within these facilities.

In 2018 -19 there is an ongoing commitment from the LEP Research and Development Program, along with Murdoch University, to continue working with Australia's key importing countries to achieve best practice and optimal outcomes for a superior product, whilst ensuring the welfare of animals.

5.1.2 Pinkeye on long haul cattle voyages

Pinkeye in sheep and goats is an infection of the eye caused by bacteria (Mycoplasma conjunctivae, Chlamydia organisms, and other mycoplasma), targeting the conjunctiva and cornea. In cattle, pinkeye is mainly caused by Moraxella bovis, but may be associated with other bacteria including Mycoplasma and Neisseria.

The condition can spread rapidly in susceptible groups of animals, although most cases recover within 4 to 6 weeks (for cattle) or 2 weeks (for sheep and goats).

Under ASEL, pinkeye is a condition that requires the rejection of the animal as unfit to export. In some export consignments, pinkeye can affect many animals leading to increased costs for exporters.
In 2013, the LEP a project (Ovine Pink Eye Treatment Strategies) to investigate best treatment strategies for pinkeye in sheep ended, concluding that early identification and treatment was key to successfully resolving the infection.

Two core treatment strategies were investigated using Oxytetracycline (OTC). The first was as an in-water medication, which had a negative side effect of reducing appetite and thirst. The second method was two injections of OTC (4 days apart) and this was found to be the most effective, resolving pinkeye in sheep up to and including grade 5 infections.

In 2014, the current research was initiated to investigate pinkeye on long haul cattle voyages. This project will review existing strategies and propose best practice management of pinkeye in cattle.

The project is currently scheduled to be completed in 2019.

5.1.3 Within crate ventilation on board aircraft

Livestock export by air has consistently delivered very low mortalities and provided a safe means of moving animals around the world. However, the conditions on aircraft are quite different to those on a ship and it is important that these are well understood to maintain, and continue to improve, welfare outcomes.

This project continues to collect and analyse data on the aircraft environment, particularly carbon dioxide and ammonia levels, and temperature and humidity (and their relationship to ventilation).

The initial focus of this project was short-haul flights, as these are the most common form of export by air. Long-haul flights may be targeted for data collection at a later stage.

When completed, the report will provide a clearer picture of the on-board experience and outline recommendations to support ongoing improvements. The project was extended to ensure that a statistically relevant data set can be collected and to enable trialling of potential best practice approaches.

5.1.4 Animal Welfare Indicators project - measuring and recording welfare performance in the Livestock Export Industry

Historically, welfare performance measurement and data collection in the Livestock Export Industry has stemmed from the reporting of voyage mortalities and non-compliances with ESCAS requirements. While it has been comprehensive within its scope, this information has provided a narrow view of the industry's performance and commitment to animal welfare.

Further information is needed to effectively measure and assess the current standards of practice. The use of standardised animal welfare measures throughout the supply chain facilitates transparency and creates confidence with continuous improvement and positive outcomes being achieved by industry.

The current research focus is onboard vessel data collection, with future extension throughout the livestock export supply chain. The project is being undertaken through a partnership between Murdoch University and the LEP.

The body of work is broken up into three key project streams:

1 Animal Welfare Indicators Validation

In 2016, Murdoch University researchers identified internationally accepted indicators of animal welfare for cattle, sheep and goats for each point along the livestock export supply chain. This was achieved through a literature review of standards and a survey of more than 900 people from across the community, animal welfare groups and the livestock export industry.

Their aim was to define a set of parameters that would provide a comprehensive overview of the environmental conditions and the behavioural expression of animals at these points throughout the supply chain. Around fifty useful indicators were identified, including twenty which were already being measured and recorded by industry.

The indicators can be classified into five groups:
• Animal-based, including expressions of social behaviour, body condition score and respiration rate / panting.
• Environmental-based, including space allowance, ventilation and noise.
• Resource-based, including feed access, time off feed and time to resume feeding.
• Management-based, including hospital pen access, stocking rate and time at feedlot.
• Industry-based, including auditing, compliance and standard operating procedures.

In 2017, a second project was initiated titled Animal Welfare Indicators Pilot for the Live Export Industry. This project focussed on scientific validation of the indicators to ensure that the right things were collected correctly and that any concerns regarding data reliability were overcome.

As the project progressed, additional indicators were added to the Pilot, including trials on the use of qualitative behavioural assessments - a structured scientific approach for capturing animal behaviours in a form that can be evaluated statistically.

This ongoing project will also develop assessment protocols applicable for all species throughout the supply chain, bringing quality control, stakeholder assurance and the detection of risk areas. However, the primary aim is to ensure the assessment is effective for onboard environments, as this is an area undergoing continuous improvement and of primary concern to industry and the community.

The final report for the initial phase of the project can be viewed at:
http://www.livecorp.com.au/LC/files/41/4183eb87-54b5-4e4e-b564-eb08b3a235ed.pdf

2 Technology Toolkit

The technology toolkit is the combination of a number of resources that allow the Animal Welfare Indicators Validation research to run efficiently and provide accessible data outputs. The toolkit includes three components: a mobile phone app', an online database and a user "dashboard" interface. Together these enable capture, aggregation and analysis of data, as well as its presentation in a meaningful and user-friendly format.

The app' ("LIVEX-Collect") enables the collection of a broad range of animal health and welfare data in real-time. It also enables uploading in a standardised format, which is critical for data analysis.

The developing database is a component of a greater "data pipeline" project that will ultimately bring together the vast volume of data collected throughout the supply chain.

The app' database will result in standardised datasets, allowing analysis across individual or multiple shipments. In conjunction with the database, a new "dashboard" is being developed with varying access levels. The login-based system will allow exporters to assess their data on an individual shipment basis or overall performance. It will also enable industry-based trend analysis and benchmarking.

3 Industry Welfare Data Collection

As a result of poor animal welfare outcomes in recent years, the Industry recognised an immediate need for assessing animal welfare beyond mortality, which could not wait for completion of the Animal Welfare Indicators Validation in 2021. The LEP fast-tracked the development of the LIVEX-Collect app' to allow easy and accurate real-time data collection of the standardised animal welfare measures identified in the initial animal welfare indicators research.

Fast-tracking the implementation of LIVEX-Collect meant that the measures used are not yet fully understood or validated. However, the data collected will inform the validation project as well as the regulator, public community, and further Industry research and development priorities. It will play a critical role in identifying emerging welfare trends, areas for further improvement and in bringing Industry transparency.

Industry acknowledges that the quality of the data will be subject to the capability of those collecting it. As a result, extensive training is being undertaken to ensure there is a standardised approach across the export process.

The real-time data capture, together with an integrated user-friendly data analysis system, will empower the industry to demonstrate transparency and proactive welfare management progress.

Validation of the research is still expected to be completed in 2021

5.1.5 Fodder On Board

The feed provided to livestock during export is clearly vital to maintaining their health and welfare. ASEL sets out minimum regulatory requirements for ration volume, pellet specifications for sheep and goats and chaff provision.

In 2011, the LEP commissioned a review of fodder quality and quantity in the Livestock Export Trade, the report of which can be viewed at:
https://www.mla.com.au/download/finalreports?itemId=1330

A new LEP initiative saw engagement with Australian Accredited Veterinarians (AAVs) through an annual research and development forum. At the end of 2017, AAVs identified fodder on board as an area of priority, and as such the Fodder On Board research project was initiated.

The project is being undertaken by an AAV who will review the findings of the 2011 report and assess the ongoing validity of its recommendations. The project will also review and provide recommendations on the current fodder/pellet requirements under ASEL, and investigate methods to address/minimise the issue of pellet fines.

The process will involve extensive consultation with industry participants exporters, nutritionists, pellet manufacturers, AAVs and stock people.

The final research outcomes will inform the on-going ASEL Review.

5.1.6 Stockperson's manual for export of livestock by air

The development of this manual targets exporters, operators and stockmen involved in the live air export industry, to assist in the planning and safe completion of each stage of the export process.

The step-by-step guide begins with the planning of a consignment, addresses each stage and concludes with procedures for disembarking, end-of-flight reporting and advice for managing stock in the destination country.

Tips and tools and benchmarks have been included to give specific advice and outline compulsory regulatory standards.

Drafting for this project is progressing with the final report expected in 2019.

5.1.7 Heat Stress Risk Assessment Model 5.0

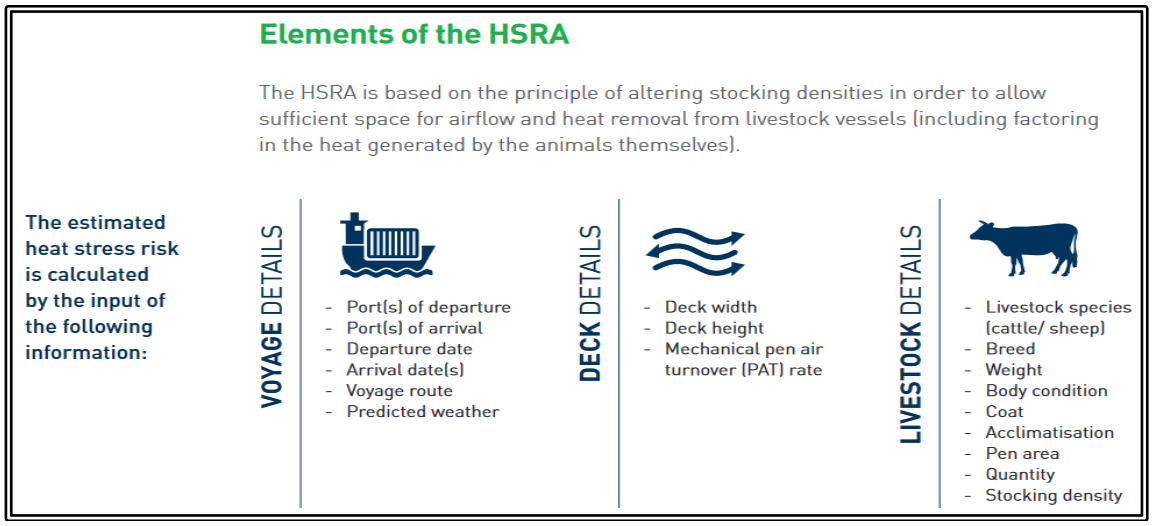
In 2000, research was undertaken to develop a scientific method to determine the risk of heat stress for export voyages to the Middle East. The research focused on ventilation and on-board studies to calculate appropriate stocking densities for various classes of livestock. This resulted in an engineer-developed industry Heat Stress Risk Assessment (HSRA) model.

The HSRA is a predictive modelling tool that combines sea and land-based weather data, vessel configuration, and voyage and livestock data to determine the maximum stocking density of sheep and cattle on each voyage to the Middle East. The software is designed to estimate risks within a 2% chance of a 5% animal mortality from a consignment.

The livestock export industry continually aims to invest and improve its research and systems and as such, in 2008, the HSRA was independently reviewed to ensure the elements that underpin the model were current and provided the most accurate risk estimates possible. It found that the "assumptions central to the model are sound, reasonable and supported by scientific literature."

The currently used HSRA version (4.0) has the ability to calculate the heat stress risk for both open and closed vessel configurations and to identify the heat stress risk for vessels both while in transit and docked in port. The HSRA continues to provide exporters with a tool to assist them manage the exposure of exported livestock to heat stress.

An updated version of the HSRA (5.0) has been finalised and a submission to the Australian Government is being prepared for approval. It includes a platform upgrade to ensure that the software is compatible with a variety of computer operating systems, as well as the addition of new ports and routes and refinements to the cross wind (open deck) parameters.

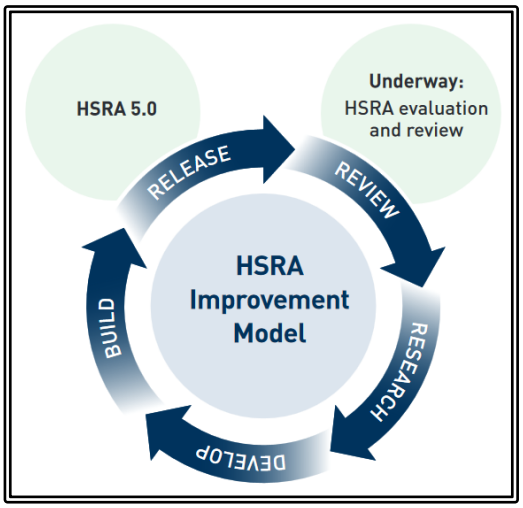


While it is impossible to single out a sole cause, the impact of HSRA since its implementation has been a meaningful reduction in livestock mortality rates during export by sea. The introduction of the Australian Standards for the Export of Livestock (ASEL), improvements in vessels and changes to the types of livestock exported are all likely to have played a part.

Livestock mortality rates for cattle and sheep have consistently remained below 1.0% and 2.0%, respectively, for over ten years.

Industry research has also identified that heat stress is not the primary cause of mortality in livestock exported to the Middle East. However, heat stress remains an animal welfare risk and HSRA continues to be a tool in its management.

As part of the research and development commitment to continued improvement of the model, the HSRA is subject to continued evaluation and review (as below).



The report into HSRA Model 5.0 can be viewed at:
https://www.mla.com.au/download/finalreports?itemId=3685
while Addenda to the report can be viewed at:
https://www.mla.com.au/download/finalreports?itemId=3684

5.1.8 Best practice use of veterinary drugs at sea

The health and welfare of all livestock during export is essential to the sustainability of the industry. Therefore it is essential that standards, relating to the practices and equipment used by veterinarians and stock people on board vessels, are up to date.

Terms of reference for a research project are soon to be tendered to review and make recommendations on the current ASEL veterinary equipment / drug requirements, develop resource material on the best practice use of veterinary drugs at sea and explore improved treatment recording methods.

The project will be supported by a consultative committee consisting of shipboard veterinarians, stockpersons and exporters.

5.1.9 Livestock Export Global Assurance Program (LGAP) - Update

In 2011, the Farmer Review of the Livestock Export Industry (commissioned by the Australian Government) recommended that the industry explore the application of quality assurance to complement the Government's regulatory compliance and control program - the Exporter Supply Chain Assurance System (ESCAS).

In response, Industry initiated research that explored the role of quality assurance and risk assessment as tools to assist exporters in demonstrating their commitment to animal welfare and compliance with ESCAS. As a result of over four years of research, a welfare and risk assessment and certification program – the Livestock Global Assurance Program (LGAP) - was developed.

The Livestock Global Assurance Program (LGAP) is an assurance and conformity assessment program aimed at enabling world's best practice in the welfare and management of livestock. The program is an Australian Livestock Export Industry initiative, intended to be applicable for any country to use in assisting management of animal welfare.

The Program sets out specific requirements for exporters and importers (referred to as Operators) and farms, feedlots and abattoirs (referred to as Facilities) to achieve various levels of accreditation. LGAP will enable facilities to take ownership of their actions and be recognised for their compliance and continual improvement in performance and animal welfare outcomes.

LGAP will also ensure traceability within the in-market supply chain and that there are clear distinctions and records of ownership and possession of Australian livestock.

Full implementation of LGAP is intended by 2021

5.2 Appendix 2 – Federal Department of Agriculture and Water Resources high-mortality investigations

The Australian Standards for the Export of Livestock (ASEL) define a reportable mortality level for sheep, cattle or goats on a voyage or air journey as the percentages listed below or 3 animals, whichever is the greater number of animals;

- Sheep and goats: 2% (sheep 1% as of mid-2018)
- Cattle on a voyage less than 10 days: 0.5%
- Cattle on a voyage more than 10 days: 1%

In the interest of improved transparency of the Live Export Trade, where mortalities on a voyage or air journey exceed the reportable limits, the Federal Department of Agriculture, in agreement with the Live Export Industry Consultative Committee, has undertaken to publicize reports of investigations conducted.

The current publication refers to a number of these investigations conducted by the Department of Agriculture, listed below in order of reference. For each, the introduction to the report summary, the investigation findings, and the internet address of the full report is given.

It should be noted that the author took no part in these the Department of Agriculture investigations, and so provides no comments on any of the findings or recommendations made.

Internet addresses provided were current at the date of publication.

1. 2013 voyage carrying sheep loaded at two ports(see sections 4.1.4, p8; 4.1.4.2, p11; 4.1.4.4, p13):

Mortality exceeded the reportable level in two consignments of sheep exported from Adelaide and Fremantle to Qatar and the United Arab Emirates in September 2013. The reportable level for sheep is two percent. In the Adelaide consignment the mortality rate was 7.28% while in the Fremantle consignment the mortality rate was 3.00%.

The main cause of mortalities for this voyage was heat stress, accounting for 97% of mortalities. Heat stress mortalities occurred on day 21 when the vessel encountered extreme weather conditions.

http://www.agriculture.gov.au/export/controlled-goods/live-animals/livestock/regulatory-framework/compliance-investigations/investigations-mortalities/report-46

2. 2009 voyage carrying cattle loaded at Portland (see section 4.2.3, p24)

Four consignments of livestock were loaded on the vessel, bound for the Middle East.

There were 9 mortalities in 500 cattle loaded as one consignment, giving a mortality rate of 1.8%. There were no mortalities in the 7 cattle loaded as a second consignment. The investigation is limited to the first consignment.

It was found that all mortalities occurred in heavily pregnant cattle (8 cows; 1 heifer). Complications around the time of calving appear to have played a significant role in at least 6 of the mortalities. Poor quality chaff provided to the cattle was also noted as was a reduction in feed intake associated with increasing ambient temperature.

Location of stock on-board the vessel and weather conditions did not appear to play a significant role. In addition, inaccuracies in pregnancy diagnosis were noted, given that 19 full term calves were born (16 live; 3 stillborn) during the voyage.

This report is no longer presented: it can be obtained by request from the Department of Agriculture.

3. 2010 voyage carrying cattle loaded at Fremantle (see section 4.2.3, p24):

16,460 cattle were loaded on a vessel in Fremantle in February 2010, bound for the Middle East. There were 295 mortalities reported but 28 were the result of a counting dispute, giving a mortality percentage of 1.62%.

The main cause of cattle mortality was reported to be pneumonia. In this case breed, lack of immunity to infectious pathogens, heat stress, deck conditions, stress of co-mingling, environment and transport are likely to have contributed to the development of pneumonia in these cattle.

Unavailability of crew and stockmen to clean the lower decks may have contributed to increased wet bulb temperatures and clinical heat stress on these decks. While there is insufficient information available to determine if this had a significant effect on mortality, failure to clean these decks may suggest that there was too low a ratio of stockmen and crew to animals on this voyage.

Records indicated there was no breakdown or interruption of livestock services, equipment or machinery on the vessel that could have contributed to the mortality.

The livestock export industry is currently undertaking a research project titled 'Investigating Causes of Mortality in Cattle'. The objectives of this research are to develop standardised systems for ongoing collection of mortality data and to determine the causes of mortality in cattle exported live by sea, with an emphasis on bovine respiratory disease. This reportable mortality event reiterates the need for such research.

This report is no longer presented: it can be obtained by request from the Department of Agriculture.

4. 2014 voyage carrying cattle and sheep loaded at Fremantle (see section 4.2.3, p24):

In January 2014, a consignment of cattle and sheep was exported from Fremantle, Western Australia to Eilat, Israel and Aqaba, Jordan.

During the voyage, the ship experienced mechanical failure, extending the length of the journey. Additional fodder was loaded to meet requirements for the extended journey.

The mortality rates for the voyage exceeded both the cattle and sheep reportable mortality levels. The voyage recorded a mortality rate for cattle of 2.75 per cent (165 cattle out of 6000 loaded) and for sheep of 3.89 per cent (1654 sheep out of 42 550 loaded).

An investigation found that the cause of the majority of mortalities was ruminal acidosis due to a sudden change in fodder. The change in fodder occurred when extra fodder was loaded while on route to Israel. Due to importing country requirements the additional fodder was sourced from Israel and transferred at sea. The composition of the additional fodder was substantially different to that which had been fed on board.

http://www.agriculture.gov.au/export/controlled-goods/live-animals/livestock/regulatory-framework/compliance-investigations/investigations-mortalities/cattle-sheep-israel-jordan-51

5. 2014 voyage carrying cattle loaded at Geraldton (see section 4.2.4, p27):

In January 2014, a consignment of cattle was exported from Australia to Vietnam.

The mortality rate for the voyage exceeded the reportable level. The reportable level for cattle on a voyage of ten or more days is one percent. The voyage recorded a mortality rate of 3.52% (49 cattle out of 1393 loaded).

The main cause of mortality was euthanasia due to injuries sustained as a result of bad weather during the voyage.

http://www.agriculture.gov.au/Style%20Library/Images/DAFF/__data/assets/pdffile/0009/2398239/cattle-exported-to-vietnam.pdf

6. 2015 voyage carrying cattle loaded at Darwin (see section 4.2.4, p27):

In February 2015, a consignment of cattle was exported from Darwin to Thailand. Records supplied to the Department of Agriculture showed that there were 33 mortalities in this consignment of 924 cattle, a mortality rate of 3.57 per cent. This exceeds the reportable mortality level of 1.0 per cent for cattle on voyages of ten days or longer as prescribed by the Australian Standards for the Export of Livestock (ASEL).

From the information available a definitive cause of the mortalities could not be determined.

http://www.agriculture.gov.au/export/controlled-goods/live-animals/livestock/regulatory-framework/compliance-investigations/investigations-mortalities/cattle-thailand-report-58

7. 2016 voyage carrying cattle loaded at Townsville (see section 4.2.4, p27):

In March 2016, a consignment of slaughter cattle was exported by sea from Townsville to Vietnam.

There were 25 mortalities in this consignment of 1,764 cattle, a mortality rate of 1.42 per cent. This exceeds the reportable mortality level of 1.0 per cent for cattle on voyages greater or equal to 10 days duration as prescribed by the Australian Standards for the Export of Livestock (ASEL).

The main cause of mortalities on this voyage was that 14 cattle were unable to stand or walk (downer animals) and were euthanased. One additional downer animal was not euthanased and died overnight. Five cattle died from pneumonia, one from a broken leg and four others were reported as ‘misadventure’ due to unknown causes.

http://www.agriculture.gov.au/SiteCollectionDocuments/biosecurity/export/live-animals/61-vietnam.pdf.pdf

8. 2017 voyage carrying cattle loaded at Darwin (see section 4.2.4, p27,):

In April 2017, 896 slaughter and 340 breeder cattle were exported by sea to Brunei Darussalam and Sarawak. The cattle travelled on the maiden voyage of a new livestock export ship. The journey was completed in 8 days and discharged at Brunei Darussalam and Sarawak.

A mortality rate of 7.69 per cent (95 animals) was experienced in this consignment. The reportable mortality level for cattle exported by sea on voyages of less than ten days is 0.5 per cent as prescribed by the Australian Standards for the Export of Livestock (ASEL).

The department concluded that the cause of this mortality event was ineffective non-slip flooring in a new livestock export ship.

http://www.agriculture.gov.au/export/controlled-goods/live-animals/livestock/regulatory-framework/compliance-investigations/investigations-mortalities/cattle-brunei-darussalam-sarawak-report-68

9. 2018 voyage carrying cattle loaded at Darwin (see sections 4.2.4, p27; 4.2.4.1, p27; 4.2.4.3, p30; 4.2.4.4, p31):

In January 2018, a consignment of 1,570 feeder cattle was exported by sea to Indonesia. The voyage was completed in eight days. A mortality rate of 1.85 per cent (29 cattle) was reported. The mortality rate exceeds the reportable mortality level of 0.5 per cent for cattle on voyages of less than ten days as prescribed by the Australian Standards for the Export of Livestock (ASEL).

Of the 29 mortalities reported during the voyage, 20 died in their pens of suspected bovine respiratory disease related illness or were downers (unable to stand). The exporter suggested the cause of mortalities was bovine respiratory related illness brought on by excessive stress from unfamiliar surroundings, weather and cattle type. The remaining nine were unfit for discharge and were euthanised in port. The exporter has reviewed and revised their Higher Risk Cattle Management plan and a Bovine Respiratory Disease (BRD) management plan to address the risk factors associated with export of cattle by sea to all markets.

http://www.agriculture.gov.au/export/controlled-goods/live-animals/livestock/regulatory-framework/compliance-investigations/investigations-mortalities/cattle-indonesia-report-72

10. 2013 voyage carrying cattle loaded at Brisbane (see section 4.2.5, p32):

In May 2013, two consignments of cattle were exported on the same vessel from Australia to Japan.

In one consignment of 1260 cattle there were 18 mortalities, a mortality rate of 1.43 per cent. This exceeds the reportable mortality level of one per cent for cattle on voyages of ten days or greater duration as prescribed by the Australian Standards for the Export of Livestock (ASEL).

According to the information available none of the 18 cattle that died were identified as being sick or injured before death. No definitive cause for the mortalities could be determined. A combination of bovine respiratory disease (BRD), cool weather before export resulting in poor acclimatisation to the high temperature and humidity during the voyage and rough shipping conditions may have contributed to the mortalities.

http://www.agriculture.gov.au/export/controlled-goods/live-animals/livestock/regulatory-framework/compliance-investigations/investigations-mortalities/cattle-japan-report-45

11. 2014 voyage carrying cattle loaded at Portland (see section 4.2.5, p32):

In February 2014, a consignment of 2400 cattle was exported by sea from Portland to Tianjin (China). There were 49 mortalities on the voyage, a mortality rate of 2.04 per cent. This exceeds the reportable mortality level of 1.0 per cent for cattle on voyages of ten days or greater as prescribed by the Australian Standards for the Export of Livestock (ASEL).

Rough seas during the first day of the voyage caused injuries, resulting in euthanasia of many of the injured animals.

http://www.agriculture.gov.au/export/controlled-goods/live-animals/livestock/regulatory-framework/compliance-investigations/investigations-mortalities/cattle-china-report-52

12. 2018 voyage carrying cattle loaded at Portland (see sections 4.2.5, p32; 4.2.5.1, p32; 4.2.5.4, p34):

In July 2018, a consignment of cattle was exported by sea from Portland to China. There were 33 mortalities in the consignment of 2,192 cattle, resulting in a mortality rate of 1.51 per cent. This exceeds the reportable mortality level of 1.0 per cent for cattle on voyages of ten days or greater duration as prescribed by the Australian Standards for the Export of Livestock (ASEL) V2.3.

It was found that the sourcing and type of the cattle were not suited to the conditions they would experience on the voyage. The cause of the mortality incident was heat stress related to sourcing, class/type of livestock and extreme weather.

An additional factor was that these cattle were sent from cold wet conditions in Australia across the equator to a Northern Chinese summer contributed to the cattle experiencing heat stress. Also, cattle from one property of origin showed signs of stress and loss of appetite in the registered premises prior to loading onto the vessel.

http://www.agriculture.gov.au/export/controlled-goods/live-animals/livestock/regulatory-framework/compliance-investigations/investigations-mortalities/cattle-china-report-74

13. 2018 voyage carrying cattle loaded at Fremantle (see sections 4.2.5.1, p32; 4.2.5.4, p34):

In May 2018, a consignment of cattle was exported by sea from Fremantle to China. There were 46 mortalities in the consignment of 3,180 cattle, which resulted in a mortality rate of 1.45 per cent. This exceeds the reportable mortality level of 1 per cent for cattle on voyages of ten days or greater duration as prescribed by the Australian Standards for the Export of Livestock (ASEL) V2.3.

After investigation, it was found that pneumonia and heat stress were the main cause of the mortalities. The type and class of cattle were not suited to the conditions they experienced on this voyage.

The department determined the combination of cold and wet weather during quarantine, BRD, unsuitable class and type of livestock, and potential vessel factors such as ventilation are thought to have led to the cattle mortalities.

http://www.agriculture.gov.au/export/controlled-goods/live-animals/livestock/regulatory-framework/compliance-investigations/investigations-mortalities/cattle-china-report-73

14. 2011 voyage carrying cattle loaded at Portland (see sections 4.2.6, p35):

In June 2011, 5,022 cattle and 2,914 sheep were loaded in Portland, Victoria. A further 3,978 cattle and 43,596 sheep were loaded in Fremantle, Western Australia.

During the voyage to Turkey, 72 deaths occurred in the Portland cattle and 29 deaths occurred in the Portland sheep, equating to mortality percentages of 1.43% and 1.0% respectively. There were 35 deaths in the Fremantle cattle and 342 deaths in the Fremantle sheep, equating to mortality percentages of 0.88% and 0.78% respectively.

The lack of a detailed treatment history for the cattle hindered the analysis and the ability to draw specific conclusions. However what can be drawn from the analysis is as follows:

The cattle are likely to have been stressed by continuous cold, wet weather while in pre-export quarantine. Some cattle were further stressed by being trucked from one registered premises to the other, having spent some time in water-logged paddocks. These stressors are likely to have predisposed the cattle to pneumonia, the main cause or a significant contributing cause in the majority of diagnosed mortalities.

Vaccination of cattle against bovine respiratory disease may not have been effective, because the manufacturer's directions (two inoculations) were not followed.

This report is no longer presented: it can be obtained by request from the Department of Agriculture.

15. 2009 flight carrying sheep loaded at Perth (see section 4.3.1.2, p38):

In November 2009, 1,873 sheep were exported by air from Perth to Kuala Lumpur, Malaysia. There were 138 mortalities on the flight, equating to a mortality rate of 7.36%.

The aircraft had two operating air conditioning packs and one air conditioning pack deactivated. Inadequate ventilation in the main cargo hold causing increased temperature, humidity and ammonia levels is suspected as the most likely cause of the mortalities.

Inadequate ventilation in the main cargo hold causing increased temperature, humidity and ammonia levels is suspected as the most likely cause of the mortalities. Triple-tiered crates are routinely used by exporters to load sheep and goats without incident.

This report is no longer presented: it can be obtained by request from the Department of Agriculture.

16. 2013 flight carrying sheep loaded at Perth (see section 4.3.1.2, p38):

In November 2013, 112 sheep were exported by air from Perth to Kuala Lumpur. There were 44 mortalities during the flight, a mortality rate of 39.3 percent. This exceeds the reportable mortality level for sheep of two percent as prescribed by the ASEL.

Inadequate ventilation is the most likely cause of the mortalities. The high mortality of sheep in the top tiers of the crates is consistent with inadequate ventilation causing increased temperature, humidity, carbon dioxide and ammonia levels during the flight.

There was no significant differences identified in the preparation and procedures used for this consignment compared with previous consignments.

http://www.agriculture.gov.au/export/controlled-goods/live-animals/livestock/regulatory-framework/compliance-investigations/investigations-mortalities/sheep-malaysia-report-49

17. 2014 flight carrying sheep loaded at Perth (see section 4.3.1.2, p38)

In October 2014, 2,200 sheep were exported by air from Perth to Changi, Singapore. There were 174 mortalities during the flight, a mortality rate of 7.91 per cent. This exceeds the reportable mortality level for sheep of two percent as prescribed by the Australian Standards for the Export of Livestock (Version 2.3) April 2011 (ASEL).

Inadequate ventilation is the most likely cause of the mortalities. The high mortality of sheep in the upper decks of the crates is consistent with inadequate ventilation causing increased temperature, humidity, carbon dioxide and ammonia levels during the flight.

There was no significant differences identified in the preparation and procedures used for this consignment compared with previous consignments.

http://www.agriculture.gov.au/export/controlled-goods/live-animals/livestock/regulatory-framework/compliance-investigations/investigations-mortalities/sheep-singapore-report-53

18. 2015 flight carrying sheep loaded at Sydney (see sections 4.3.1.2, p38; 4.3.3.2, p42):

In August 2015, two consignments of sheep and goats were exported by air from Sydney to two separate destinations. There were 670 slaughter sheep and 1000 slaughter goats consigned to Kuala Lumpur, Malaysia and 833 breeding goats consigned to Kota Kinabalu, East Malaysia.

During the flight between Kota Kinabalu and Kuala Lumpur, 125 mortalities were recorded from the 670 slaughter sheep loaded (18.66 per cent mortality) and 48 mortalities were recorded from the 1000 slaughter goats loaded (4.8 per cent mortality). This exceeds the reportable mortality level of two per cent for both species as prescribed by the Australian Standards for the Export of Livestock (Version 2.3) April 2011 (ASEL).

The investigation found that a period of inadequate ventilation is the most likely cause of the mortalities. During transit at Kota Kinabalu, there was failure in starting the auxillary power unit to run the ventilation system, delay in starting the backup ventilation and an extended period on the ground.

http://www.agriculture.gov.au/export/controlled-goods/live-animals/livestock/regulatory-framework/compliance-investigations/investigations-mortalities/sheep-goats-malaysia-report-59

19. 2013 flight carrying cattle loaded at Melbourne (see section 4.3.2.2, p40):

In September 2013, 279 cattle were exported by air from Melbourne to Harbin (China). There were 18 mortalities on the flight, a mortality rate of 6.45 per cent. This exceeds the 0.5 per cent reportable mortality level for cattle on voyages less than 10 days as prescribed by the ASEL.

A definitive cause of the mortalities was not determined from this investigation. From the information available inadequate ventilation in the region of these two crates causing increased temperature, humidity, carbon dioxide and ammonia levels is suspected as the most likely cause of the mortalities. However an underlying cause for the reduced ventilation was not determined.

The investigation also found that the exporter load plan approved by the department is not always provided in a hard copy form to the airline.

http://www.agriculture.gov.au/export/controlled-goods/live-animals/livestock/regulatory-framework/compliance-investigations/investigations-mortalities/report-47

20. 2013 flight carrying cattle loaded at Melbourne (see section 4.3.2.2, p40):

In October 2013, 321 cattle were exported by air from Melbourne to Almaty (Kazakhstan). There were 49 mortalities during the flight, a mortality rate of 15.3 per cent. This exceeds the 0.5 per cent reportable mortality level for cattle on voyages less than 10 days as prescribed by the ASEL.

Inadequate ventilation within the double crates is the most likely cause of the mortalities. The high mortality of cattle in the upper decks of the crates is consistent with inadequate ventilation causing increased temperature, humidity, carbon dioxide and ammonia levels during the flight. There was no identified or known defect in the aircraft's ECS.

The placement of double crates loaded side by side in one block may have impacted the airflow on the main deck to the point where it influenced the compartment's environmental conditions. Inadequate ventilation was further compounded by a stop in Singapore with a hot, humid climate.

There were no significant differences identified in the preparation and procedures used for this consignment compared with previous consignments that may have contributed to the mortalities.

http://www.agriculture.gov.au/export/controlled-goods/live-animals/livestock/regulatory-framework/compliance-investigations/investigations-mortalities/report-48

5.3 Appendix 3 - Published studies

A list of scientific and extension publications, relevant to the livestock export trade, is shown below in order of publication date.

Norris, RT and Richards, RB (1989) Deaths in sheep exported by sea from Western Australia – analysis of ship Master's reports Aust Vet J **66:** 97-102

Norris, RT, Richards, RB and Dunlop, RH (1989a) An epidemiological study of sheep deaths before and during export by sea from Western Australia Aust Vet J **66:** 276-279

Norris, RT, Richards, RB and Dunlop, RH (1989b) Pre-embarkation risk factors for sheep deaths during export by sea from Western Australia Aust Vet J **66:** 309-314

Richards, RB, Norris, RT, Dunlop, RH and McQuade, NC (1989) Causes of death in sheep exported live by sea Aust Vet J **66:** 33-38

McDonald, CL, Norris, RT, Ridings, H and Speijers, EJ (1990) Feeding behaviour of Merino wethers under conditions similar to lot-feeding before live export Aust J Exp Agric **30:** 343-348

Norris, RT, McDonald, CL, Richards, RB, Hyder, MW, Gittins, SP and Norman, GJ (1990) Management of inappetant sheep during export by sea Aust Vet J **67:** 244-247

Thomas, KW, Kelly, AP, Beers, PT and Brennan, RG (1990) Thiamine deficiency in sheep exported live by sea Aust Vet J **76:** 215-218

Higgs, ARB, Norris, RT and Richards, RB (1991) Season, age and adiposity influence death rates in sheep exported by sea Aust J Agric Res **42:** 205-214

Norris, RT (1991) Studies of factors affecting sheep deaths during lot-feeding and sea transport PhD Thesis, Murdoch University, Perth

Richards, RB, Hyder, MW, Fry, JM, Costa, ND, Norris, RT and Higgs, ARB (1991) Seasonal factors may be responsible for deaths in sheep exported by sea Aust J Agric Res **42:** 215-226

Norris RT, Richards RB and Norman, GJ (1992) The duration of lot-feeding of sheep before sea transport Aust Vet J **69**: 8-10

Scharp, DW (1992) Performance of Australian wethers in Arabian Gulf feedlots after transport by sea Aust Vet J **69:** 42-43

Higgs, ARB, Norris, RT and Richards, RB (1993) Epidemiology of salmonellosis in the live sheep export industry Aust Vet J **70:** 330-335

Richards, RB, Norris, RT and Higgs, ARB (1993) Distribution of lesions in ovine salmonellosis Aust Vet J **70:** 326-330

McDonald, CL, Rowe, JB and Gittins, SP (1994) Feeds and feeding methods for assembly of sheep before export Aust J Exp Agric **34:** 589-94

Higgs, ARB, Norris, RT, Baldock, FC, Campbell, NJ, Koh, S and Richards, RB (1996) Contagious ecthyma in the live sheep export industry Aust Vet J **74:** 215-220

Higgs, ARB, Norris, RT, Love, RA and Norman, GJ (1999) Mortality of sheep exported by sea: evidence of similarity by farm group and of regional differences Aust Vet J **77:** 729-733

Norris, RT, Richards, RB, Creeper, JH, Jubb, TF, Madin, B and Kerr JW (2003) Cattle deaths during sea transport from Australia Aust Vet J **81:** 156-161

Norris, RT, (2005) Transport of animals by sea Rev Sci Tech Off Int Epiz **24:** 673-681

Beatty, DT, Barnes, A, Taylor, E, Pethick, D, McCarthy, M and Maloney, SK (2006) Physiological responses of Bos taurus and Bos indicus cattle to prolonged, continuous heat and humidity J Anim Sci **84:** 972-985

Stockman, CA (2006) The physiological and behavioural responses of sheep exposed to heat load within intensive sheep industries PhD Thesis, Murdoch University, Perth

Beatty, DT, Barnes, A, Taplin, R, McCarthy, M and Maloney, SK (2007) Electrolyte supplementation of live export cattle to the Middle East Aust J Exp Agric **47:** 119-124

Phillips, CJC, Pines, MK, Latter, M, Muller, T, Petherick, JC, Norman, ST and Gaughan, JB (2010) The physiological and behavioural responses of steers to gaseous ammonia in simulated long distance transport by ship J Anim Sci **88:** 3579-3589

Pines, MK and Phillips, CJ (2012) Accumulation of ammonia and other potentially noxious gases on live export shipments from Australia to the Middle East J Environ Monit **13:** 2798-2807

Stockman, CA, Barnes, AL, Maloney, SK, Taylor, E, McCarthy, M and Pethick, D (2012) Effects of prolonged exposure to continuous heat and humidity similar to long haul live export voyages in Merino wethers Anim Prod Sci **51:** 135-143

Australian Government Department of Agriculture, Fisheries and Forestry (2012) Australian standards for the export of livestock (version 2.3) and Australian position statement on the export of livestock (Note – this publication is now available for download onto mobile devices by entering “asel handbook app” into your internet browser and choosing the method most appropriate to you)

Pines MK, Phillips CJ (2013) Microclimatic conditions and their effects on sheep behavior during a live export shipment from Australia to the Middle East J Anim Sci **91(9):** 4406-4416

The Veterinary Handbook for Cattle, Sheep and Goats Application (2014) is available for download onto mobile devices at: http://www.veterinaryhandbook.com.au/

Moore SJ, Madin B, Norman G, and Perkins N (2015) Risk factors for voyage mortality in cattle during live export from Australia by sea Aust Vet J **93:** 339-348

Phillips CJ (2016) The welfare risks and impacts of heat stress on sheep shipped from Australia to the Middle East Vet J **28:** 78-85

Zhang Y, Lisle AT, Phillips CJ (2017) Development of an effective sampling strategy for ammonia, temperature and relative humidity measurement during sheep transport by ship Biosystems Engineering **155:** 12-23

Collins T, Hampton JO, A Barnes AL (2018) Systematic Review of Heat Load in Australian Livestock Transported by Sea Animals **8(10):** 164-180

5.4 Appendix 4 - Acknowledgements

This is to be the last report in this series in the current format. The legislated changes regarding sea transport of livestock introduced in 2018/19 mean that long-term databases have been irretrievably disrupted.

The legislative changes have also shifted emphasis from mortality as a measure of animal welfare to the recording and analysis of various animal welfare indicators (AWI). While a description of the trade in terms of animal welfare indicators may be achieved by the end of 2019/20, a wide debate around interpretation of the findings must inevitably follow.

The cooperation of ships' officers in recording details of daily mortalities for this series of reports is again acknowledged with thanks. Some of these officers have faithfully contributed to the work for over 30 years, and their dedication to the project and to the voluntary exposure of their Industry to public scrutiny is remarkable and worthy of high praise and grateful appreciation.

The cooperation of Exporters, Shipping Agencies and Port Authorities for additional help in collating data is also gratefully acknowledged. Again, some of these Industry participants haven faithfully and unstintingly contributed to the work for over 30 years, marking an exemplary willingness to see their industry fully presented for public scrutiny, and their great trust in the integrity of this surveillance work and its findings.

The Australian Maritime Safety Authority (AMSA) is again gratefully acknowledged for ongoing provision of ship Master's Reports

The cooperation of the Australian Government Department of Agriculture and Water Resources for provision of miscellaneous information and data regarding the transport of livestock by air is again also gratefully acknowledged.

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