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National livestock export industry sheep, cattle and goat transport performance report 2017

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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 2017.

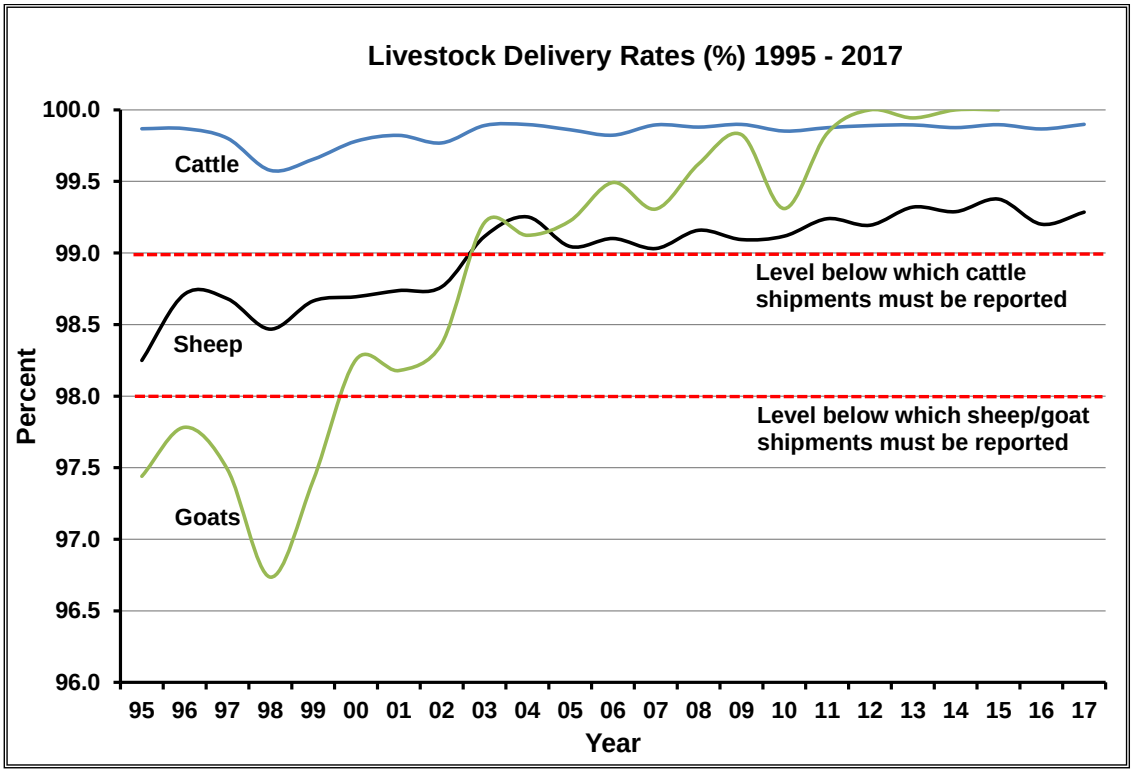
Industry stakeholders, government, animal welfare groups and the general public have a keen interest in monitoring performance in different sectors of the livestock export trade. This summary report provides the only comprehensive breakdown by species, time of year, ships, load ports and major destinations 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 2017 was 0.71% (13,183 mortalities in 1.85 million sheep exported). This was an 11% fall compared the mortality rate of 0.80% observed in 2016. The main port of loading was Fremantle, which exported 1.59 million sheep with a mortality rate of 0.74% (11,854 mortalities), followed by Adelaide exporting 0.24 million sheep with a mortality rate of 0.54% (1,296 mortalities) and Portland which exported 0.01 million sheep with a mortality rate of 0.28% (33 mortalities).

The overall mortality rate for cattle during sea transport to all destinations during 2017 was 0.10% (867 mortalities in 0.86 million cattle exported). This was a 24% fall compared to the mortality rate of 0.13% observed in 2016, and represents a new record low. The overall mortality rates on voyages to the Middle East/North Africa, North-East Asia and Miscellaneous destinations were 0.17% (72 mortalities in 0.04 million cattle exported), 0.11% (100 mortalities in 0.09 million cattle) and 0.17% (5 mortalities in 3,000 cattle) respectively. The highest overall mortality rate on a regional basis was 0.21%, for exports to South-East Europe (44 mortalities in 0.02 million cattle exported), while the lowest overall mortality rate was 0.09% for exports to South-East Asia (646 mortalities in 0.70 million cattle exported).

No goats were exported by sea from Australia in 2017.

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



For completeness, summary information regarding the 42,144 sheep, 9,261 cattle and 12,245 goats exported by air during 2017 has also been included in this report. These experienced overall mortality rates of 0.04% (16 mortalities), 0.00% (nil mortalities) and 0.02% (2 mortalities) respectively.

Contents

1 Background

The live export of sheep, cattle and goats makes a significant contribution to the Australian economy, valued at around $1,275 million in 2017, 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 and Water Resources (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.

2 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 2017 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.

3 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 2017. 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 DAWR.

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 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 DAWR 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).

3.1 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.

3.1.1 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.

4 Results and discussion

4.1 Sheep

4.1.1 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 1.78 million sheep exported in 2016 was the lowest number exported since recording began in 1985. The number of sheep exported annually since 2008 has varied between 4.19 and 1.78 million, and the annual mortality has varied between 0.91 and 0.62%. 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 2008

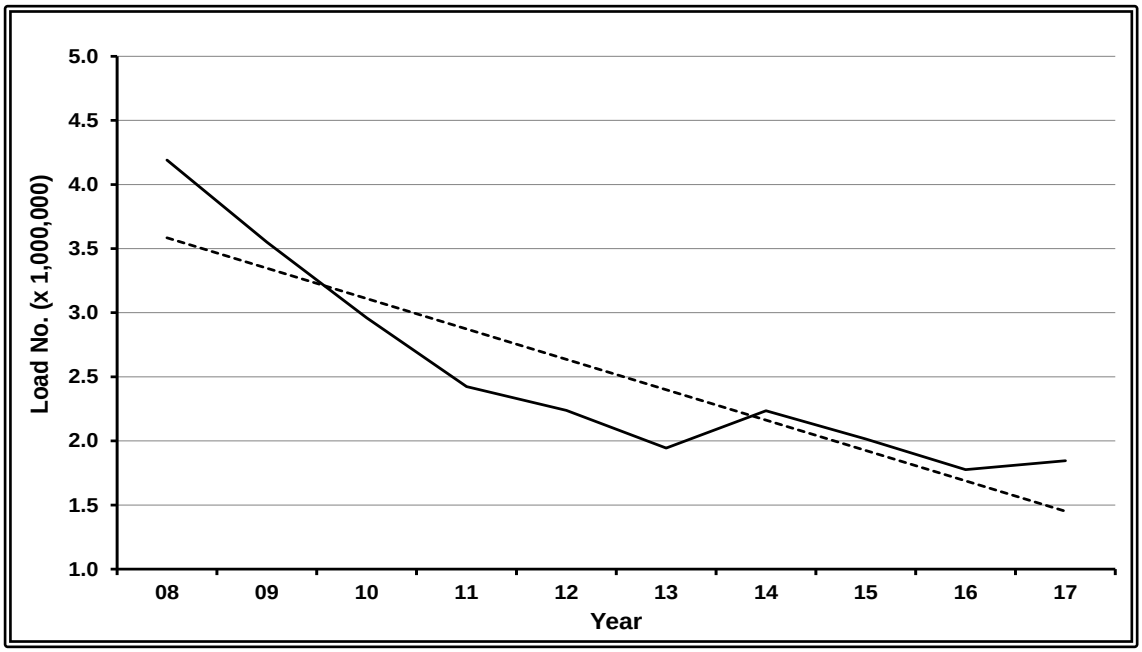
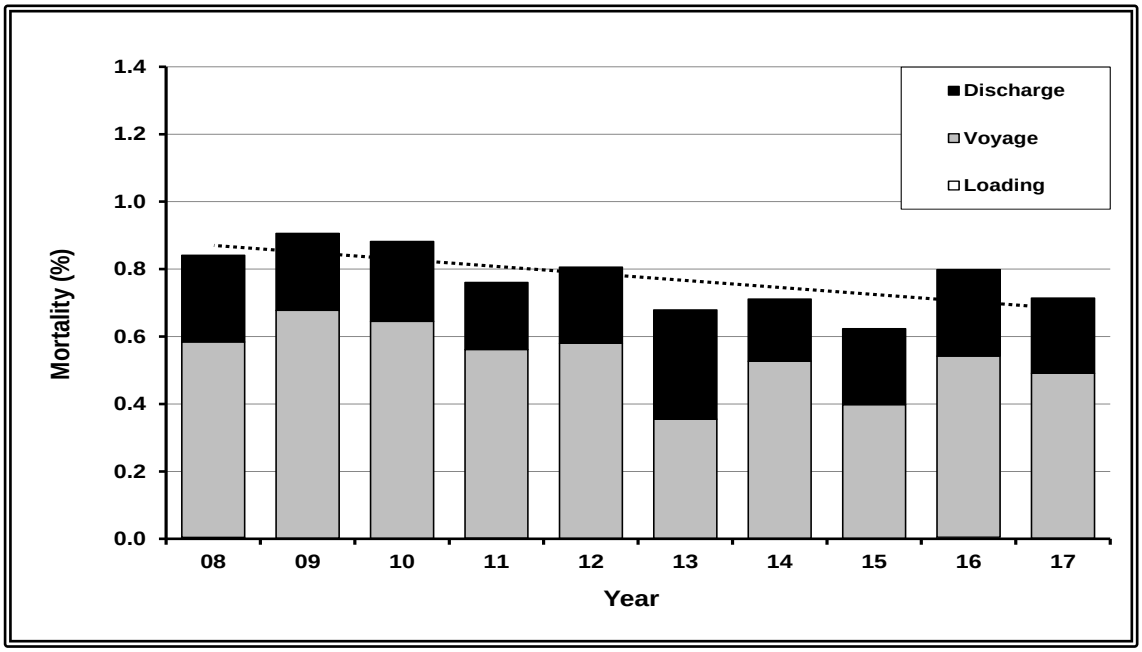


Figure 2 Annual mortality of sheep exported by sea from Australia to all destinations since 2008



4.1.2 Overview

All sheep exported live by sea from Australia in 2017 were loaded either at Fremantle (86.4%), Adelaide (13.0%), or Portland (0.6%). The overall average voyage and discharge lengths were 18.18 and 3.21 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 8 voyages to the Middle East/North Africa and South-East Europe in 2017 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 2017. 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 62 "voyages" of sheep to the Middle East/North Africa and South-East Europe during 2017. This involved 32 ship journeys, eight of which were split-loaded, and seven of which were split for discharge.

1,646,965 sheep were exported to the Middle East/North Africa (89.3% of all sheep exported) and the average voyage length (voyage to first discharge port) for exports to this region was 17.45 days with 3.14 days for discharge. Most voyages had multiple discharge ports, but the fall in discharge figure 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 0.74%.

198,303 sheep were exported to South-East Europe (10.7% of all sheep exported) and the average voyage length (voyage to first discharge port) for exports to this region was 26.48 days with 3.99 days for discharge. The overall mortality for these sheep was 0.50%.

Table 1 Mortality rates, number of voyages, voyage and discharge days, and number of sheep exported for voyages to major destination regions during 2017

Parameter	ME/N Africa	SE Europe	Total
Voyages (No.)	57	5	62
Sheep (No.)	1,646,965	198,303	1,845,268
Mortality rate overall (%)	0.74	0.50	0.71
Mortality rate range (%)	0.15 – 4.58*	0.41 – 0.62	0.15 – 4.58
Voyage days (Ave.)	17.45	26.48	18.18
Discharge days (Ave.)	3.14	3.99	3.21

* exceptional voyage; see 6.2 Appendix 2

4.1.4 Destination country

Countries that imported Australian sheep in 2017 are shown in Table 2. The main importing countries were Qatar (33% of all Australian sheep exports), followed by Kuwait (32%) and Turkey (11%).

Overall export numbers rose by 2.7% compared to 2016. Markets changed variously, but the biggest change contributing to the overall rise in exports was the re-entry of Turkey into the market. Oman and Qatar rose by 54% and 11% respectively, while Jordan and Kuwait fell by 65% and 8% respectively. Both Israel and South-East also experienced falls of 46% and 29% respectively.

Table 2 Destination countries for sheep exported from Australia during 2017

Country	Fremantle	Adelaide	Portland	Other	Total
Israel	84,339				84,339
Jordan	53,702				53,702
Kuwait	524,569	74,619	1,990		601,178
Oman	156,813	6,000			162,813
Qatar	508,273	97,893	9,834		616,000
Turkey	144,345	53,958			198,303
U.A.E.	121,507	7,426			128,933
S.E. Asia				38,937	38,937
N.E. Asia				3,109	3,109
Other				98	98
Total	1,593,548	239,896	11,824	42,144	1,887,412

Note: figures include exports by air.

4.1.5 Middle East/North Africa

1,646,965 sheep were exported to the Middle East/North Africa (89.3% of all sheep exported) and the average voyage length (voyage to first discharge port) for exports to this region was 17.45 days with 3.14 days for discharge. The overall mortality for these sheep was 0.74%.

Table 19 Mortality rates, number of voyages, average voyage and discharge length, and number of sheep exported from various ports to Middle East/North Africa for 2017

Port	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days
Fremantle	46	1,449,203	0.77	0.15 – 4.58*	16.23	3.18
Adelaide	10	185,938	0.57	0.26 – 1.13	22.74	2.82
Portland	1	11,824	0.28	n/a	20.41	4.50

* exceptional voyage; see 6.2 Appendix 2

One high-mortality voyage each for 2013, 2014 and 2017 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.

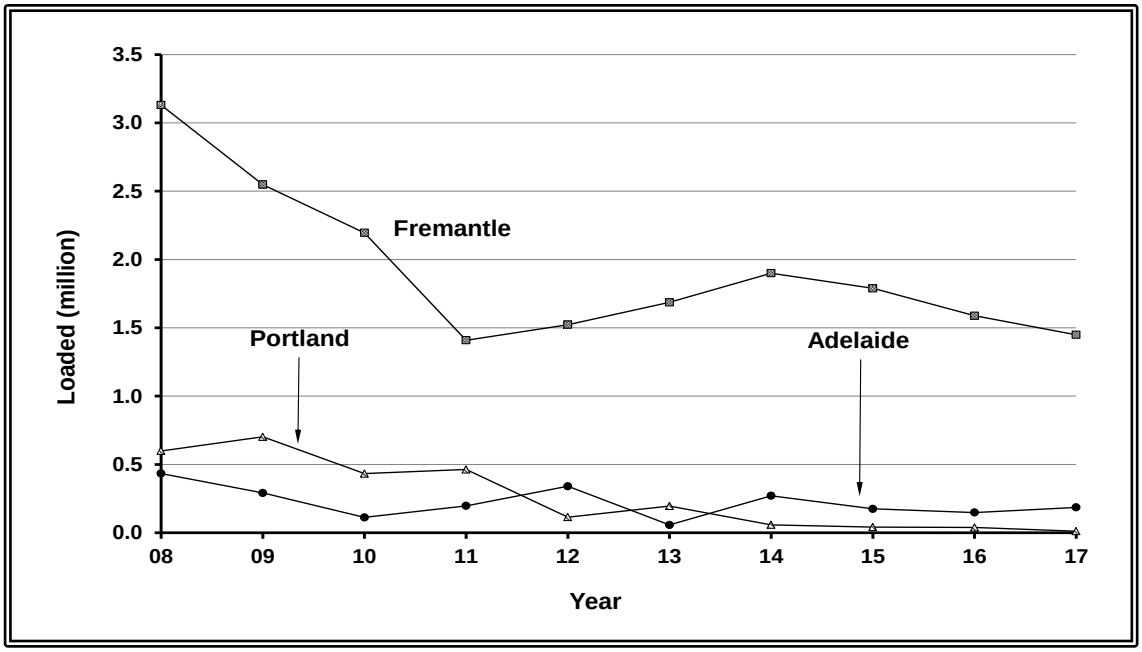
Where exclusions apply within sections 4.1.5.2 through to 4.1.5.8, text, tables and figures are appropriately annotated.

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

4.1.5.1 Port of loading

Most sheep exported by sea from Australia to the Middle East/North Africa during 2017 were loaded at Fremantle (88.0%, Figure 3) with smaller numbers loaded at Adelaide (11.3%), and Portland (0.7%).

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 2008



The number and class of sheep exported by sea to the Middle East/North Africa from Fremantle, Adelaide and Portland during 2017 are shown in Table 3. Overall numbers exported to the region in 2017 fell by 6.3% compared to 2016, with exports from Fremantle and Portland falling by 7.8% and 69.3% respectively, while exports from Adelaide rose by 25.6%.

The main changes by class in 2017 compared to 2016 were a decrease in exports of all wether classes (-2.1%, -21.0% and -6.9% for wether adults, hoggets and lambs respectively) and also falls in the export of adult and lamb rams (-27.6% and -43.4% respectively).

The only substantial rise in exports was a 64.4% rise in adult ewes exported out of Fremantle.

Table 3 The numbers and classes of sheep exported by sea to the Middle East/North Africa from Fremantle, Adelaide and Portland during 2017

Livestock		Fremantle	Adelaide	Portland	Total
Wethers	adults	661,120	172,281	11,824	845,225
	hoggets	152,857	8,236		161,093
	lambs	464,615	2,648		467,299
Rams	adults	32,883			32,883
	hoggets	5,449			5,449
	lambs	39,498	1,004		40,502
Ewes	adults	66,494			66,494
	hoggets				
	lambs	26,287	1,733		28,020
Total	sheep	1,449,203	185,938	11,824	1,646,965

4.1.5.2 Mortality rates

The total mortality rate for all sheep exported to all destination regions during 2017 was 0.71% (Table 4), a substantial decrease from the 0.80% observed in 2016.

The Fremantle voyage mortality rate fell by 6% compared to the 2016 levels, while the discharge mortality rate remained the same (Table 4 and Figure 4).

Adelaide voyage, discharge and overall mortality rates fell, by 14%, 38% and 21% respectively.

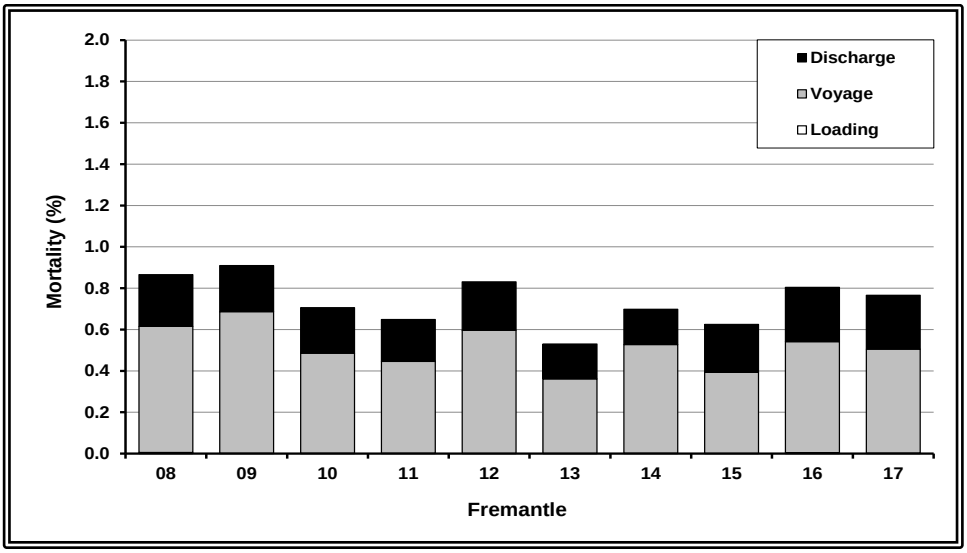
Changes in parameters for Portland cannot be considered meaningful due to there being only one shipment.

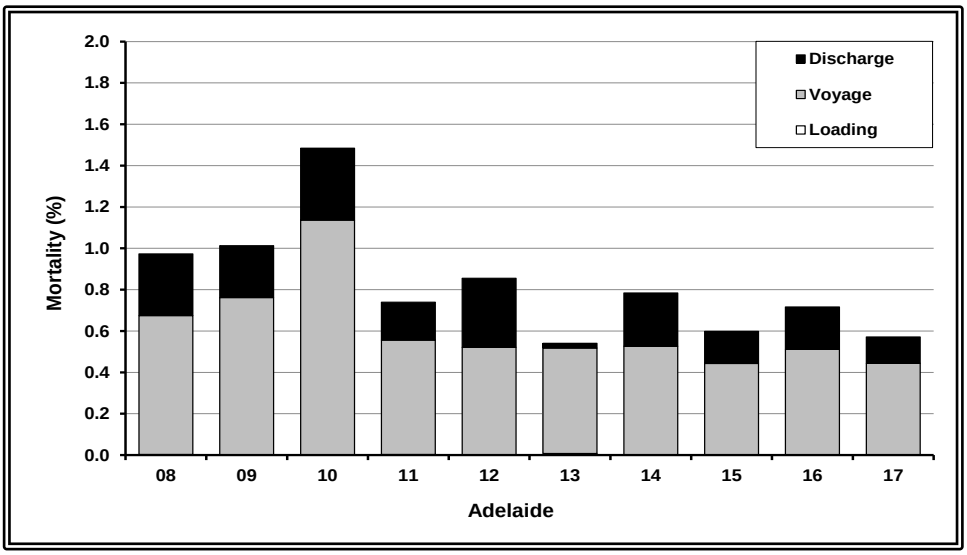
Table 4 Annual shipboard mortality rates for all sheep exported from Fremantle, Adelaide and Portland to the Middle East/North Africa, and Total mortality rate for all sheep exported to all destinations

		Mortality rate (%)			
	Year	Load	Voyage	Discharge	Total
Fremantle*	2013	0.00	0.36	0.17	0.53
	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
Adelaide*	2013	0.00	0.17	5.61	5.79
	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
Portland*	2013	0.00	0.35	0.11	0.47
	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
Total**	2013	0.00	0.35	0.32	0.68
	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

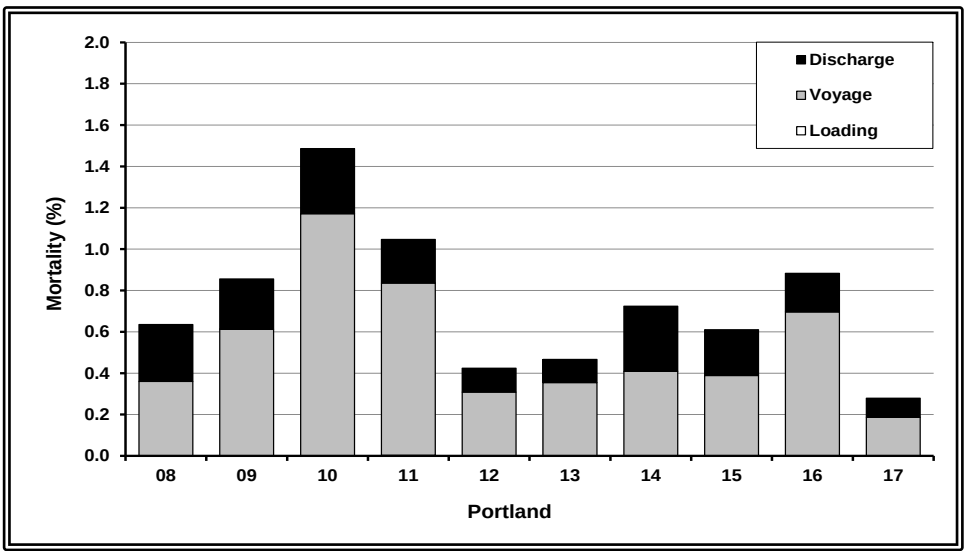
* Middle East/North Africa only
** Total includes all sheep exported by sea from Australia to all destinations

Figure 4 Annual mortality for sheep exported from Fremantle, Adelaide and Portland to the Middle East/North Africa from 2008 to 2017.





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



4.1.5.3 Class of sheep

The mortality rates of various classes of sheep exported from Australia to the Middle East/North Africa are shown in Table 5 and Figure 5. The highest total mortality rates by class for 2017 were in all ram classes (0.92%, 1.23% and 1.04% for adult, hogget and lamb rams respectively), followed adult wethers and ewes with 0.80% and 0.79% 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. See further discussion at section 4.1.4.7 Implications of long-term seasonal mortality patterns.

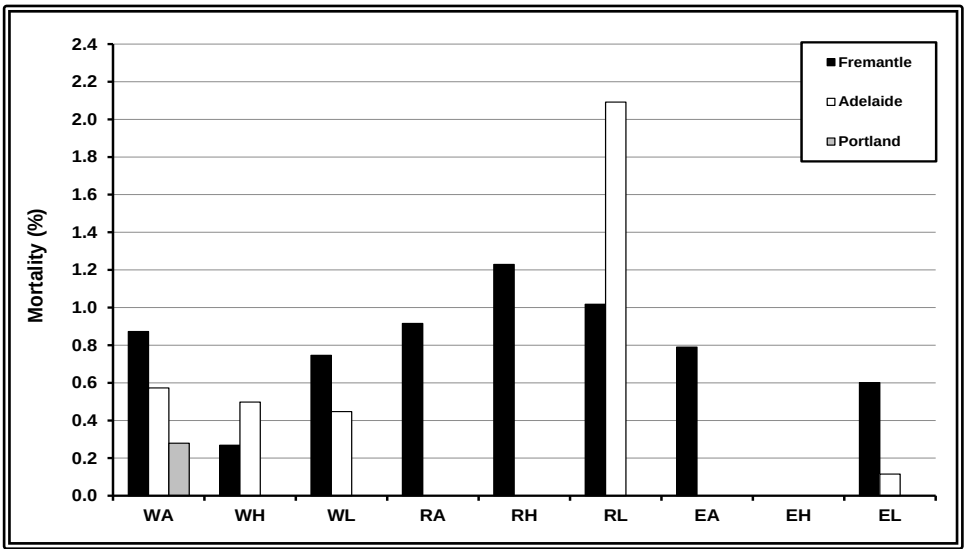
Table 5 Overall mortality (%) for classes of sheep exported from Fremantle, Adelaide and Portland to the Middle East/North Africa in 2017

Class of sheep		Fremantle	Adelaide	Portland	Total
Wethers	adult	0.87	0.57	0.28	0.80
	hogget	0.27	0.50	n/a	0.28
	lamb	0.75	0.45	n/a	0.74
Rams	adult	0.92	n/a	n/a	0.92
	hogget	1.23	n/a	n/a	1.23
	lamb	1.02	2.09	n/a	1.04
Ewes	adult	0.79	n/a	n/a	0.79
	hogget	n/a	n/a	n/a	n/a
	lamb	0.60	0.12	n/a	0.57

n/a - not applicable (no sheep of this class were loaded)

Figure 5 Overall mortality (%) for classes of sheep exported from Fremantle, Adelaide and Portland to the Middle East/North Africa in 2016

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

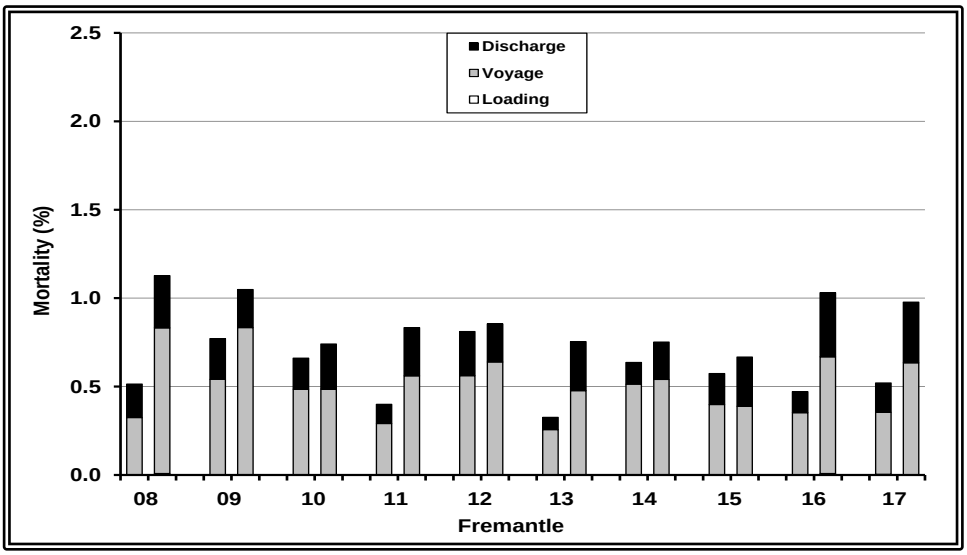


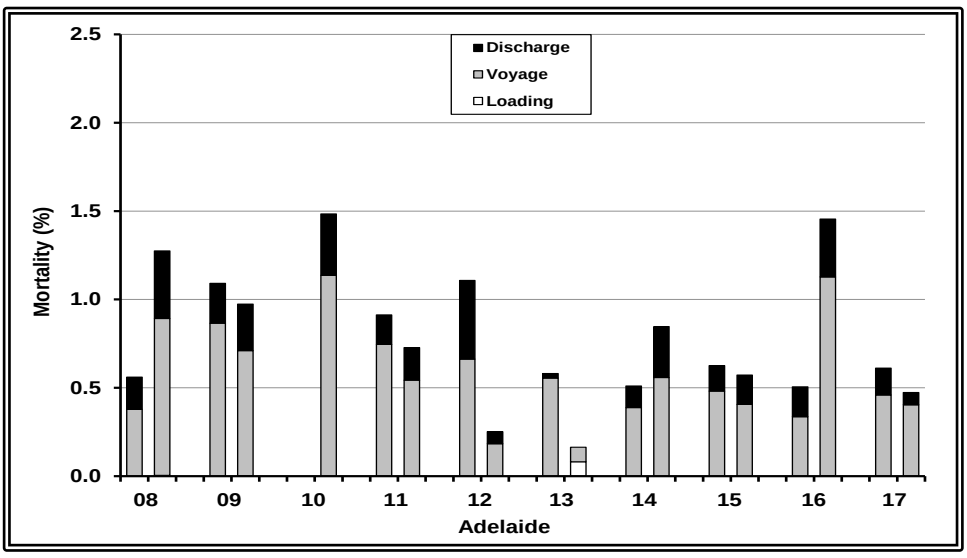
4.1.5.4 Time of year

Overall half-yearly mortality rates for sheep exported to the region were higher in the second half of the year compared with the first half. Fremantle sheep were significantly higher ($P < 0.05$) in the first half compared to the second (0.52% and 0.98% respectively) while Adelaide sheep were significantly higher in the first half compared to the second (0.61% and 0.47% respectively – see Figure 6).

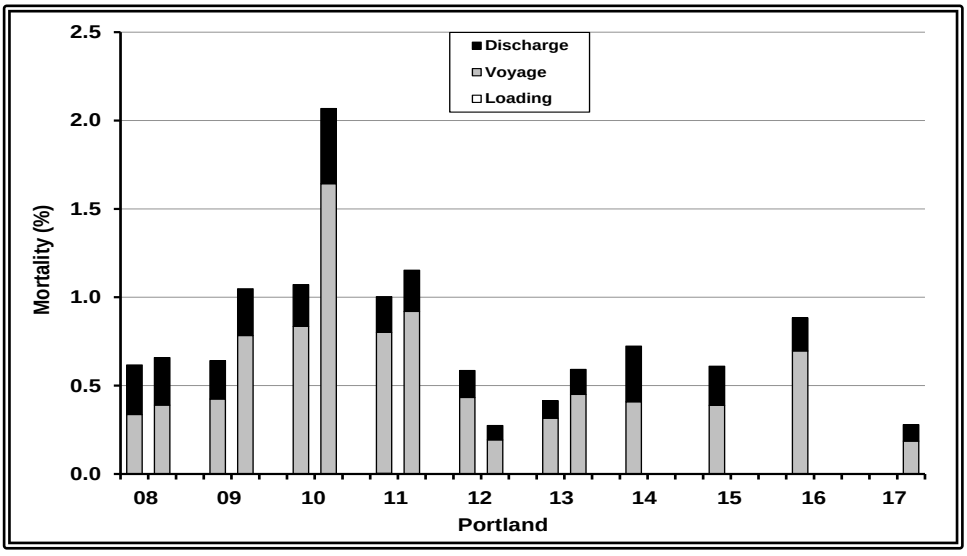
Portland exported sheep only in the second half of the year.

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 2008 to 2017



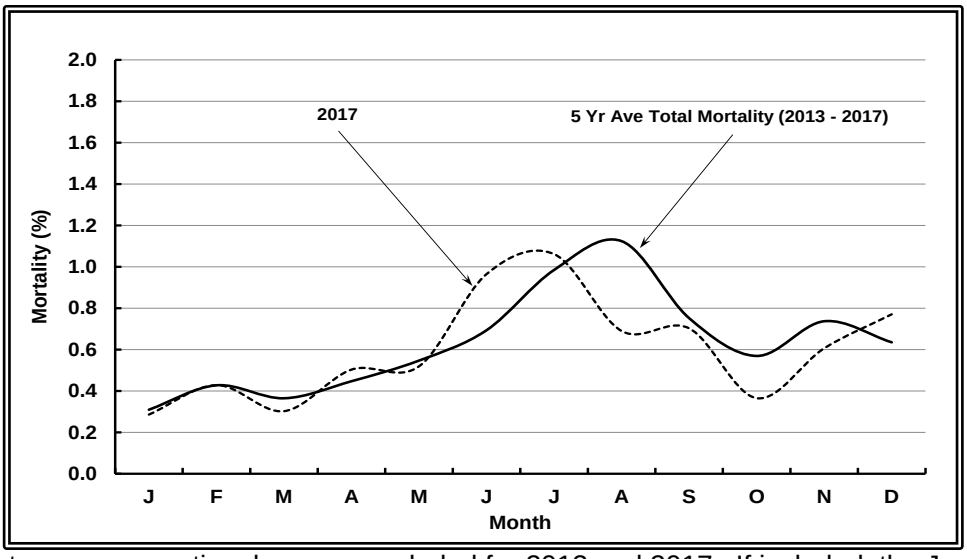


Note – one exceptional voyage excluded for 2013. If included, the 2013 second-half mortality would have been 5.79%



In 2017, monthly mortality rates (total mortality as a proportion of total loaded for each month) in sheep exported from Fremantle approximated the 5-year average profile, apart from being substantially higher in August (Figure 7).

Figure 7 Monthly mortality rates for shipments from Fremantle to the Middle East/North Africa in 2017 and the 5-year monthly averages for the period 2013 to 2017



Note – one exceptional voyage excluded for 2013 and 2017. If included, the January and August 5-year average figures would have been 0.61% and 2.1% respectively, and the 2017 August figure would have been 1.36%

4.1.5.5 Time of year and age of sheep

Figure 8 shows the monthly mortality rates (total mortality as a proportion of total loaded for each month) in wether and ram adults, hoggets and lambs, and ewe adults and lambs exported from Australia to the Middle East/North Africa from 2008 to 2017. Results for ewe hoggets are not presented because of the paucity of data.

Figure 9 shows the mortality rates in the first and second half of the year for the wether classes from 2008 to 2017. There were significantly more deaths ($P < 0.05$) in the second half of the year than in the first half for each year and each age category of wethers, with the following exceptions: adult wethers in 2011, wether hoggets in 2014 and 2017, and all three wether classes in 2012.

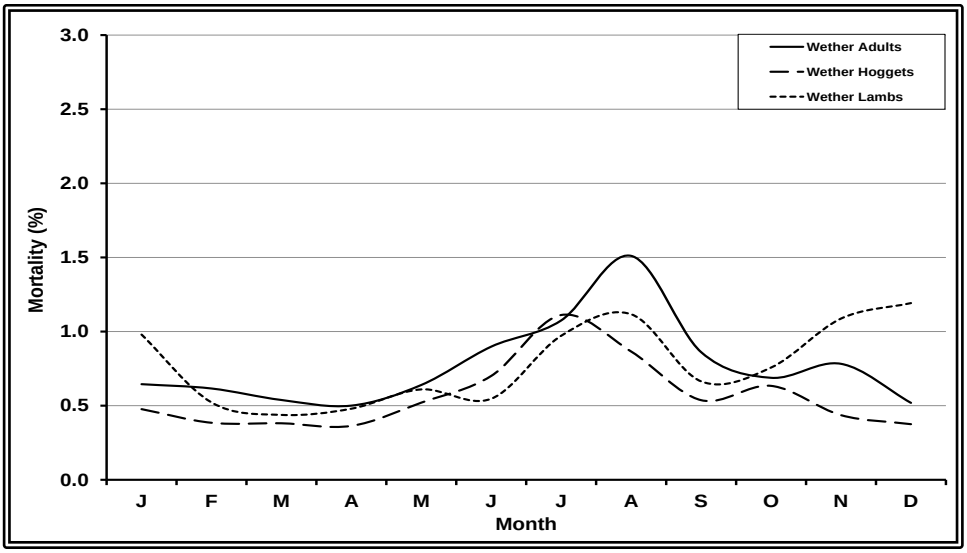
The return to the expected pattern for all wether classes in 2013 was also evident in all three ram classes and in adult ewes (results not presented). In 2013 ewe lambs showed higher mortalities in the second half of the year, but the difference was not significant.

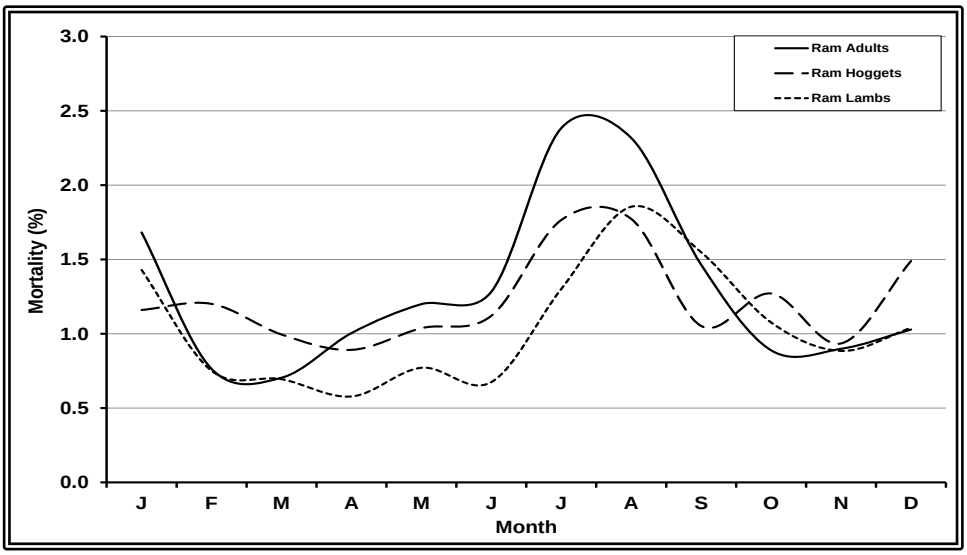
The reversal in the expected half-year mortality pattern that occurred in 2012 was quite remarkable, occurring in seven classes (all wethers, all rams and ewe lambs) out of the nine classes of sheep routinely examined in this report series. The return to the expected pattern in 2013 and continuing so has been quite definite, with the exception of significant reversals in ewe lambs for the years 2015 and 2017.

The results shown in Figures 8 and 9 for this current report and in previous reports in this series indicate that seasonal differences in mortality exist for wether hoggets and lambs as well as for adults. In general, similar findings were observed for ram classes and for ewe adults and lambs (half-year results for these classes are not presented here). For ewe hoggets, insufficient numbers are exported in most years to allow reliable conclusions to be made.

See further discussion at section 3.1.5.7 Implications of long-term seasonal mortality patterns.

Figure 8 Monthly mortality (%) for wether and ram adults, hoggets and lambs, and ewe adults and lambs exported by sea from Australia to the Middle East/North Africa from 2008 to 2017





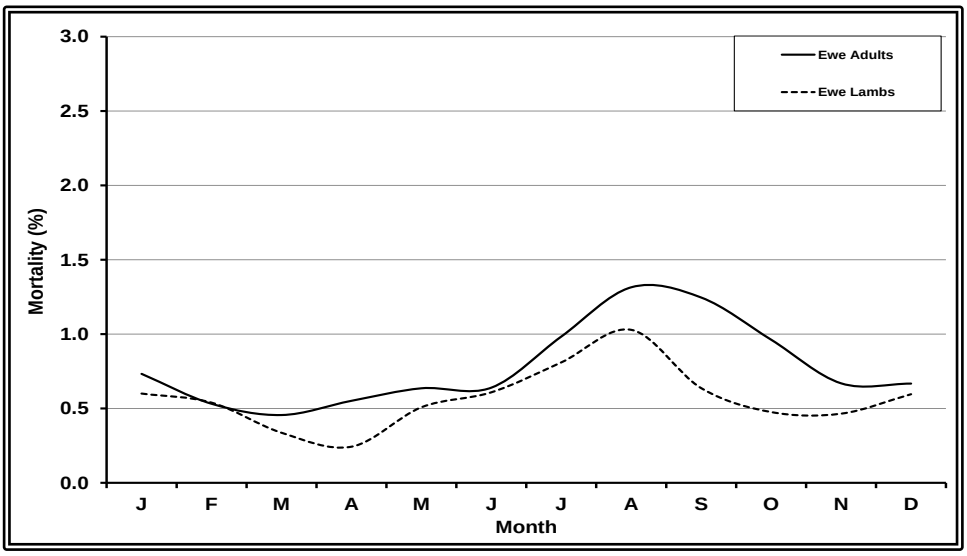
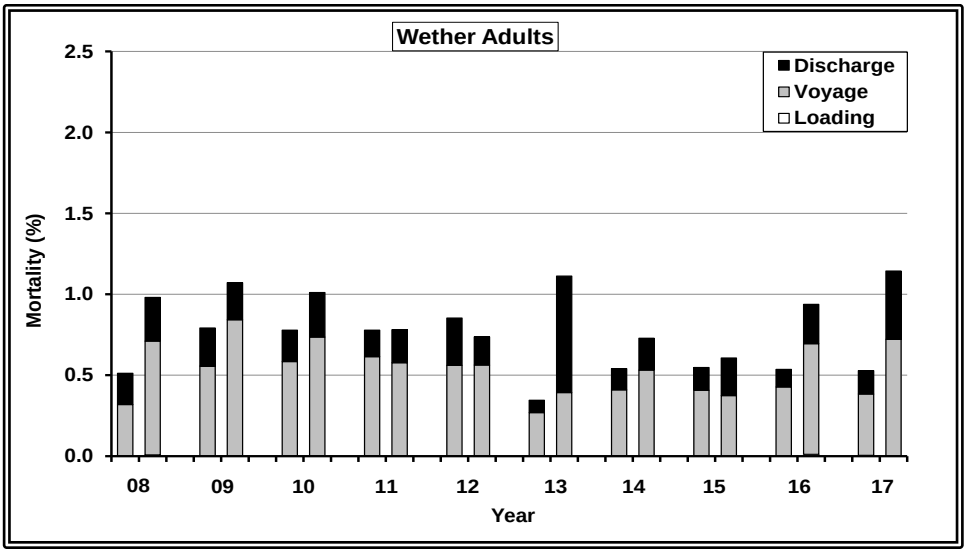
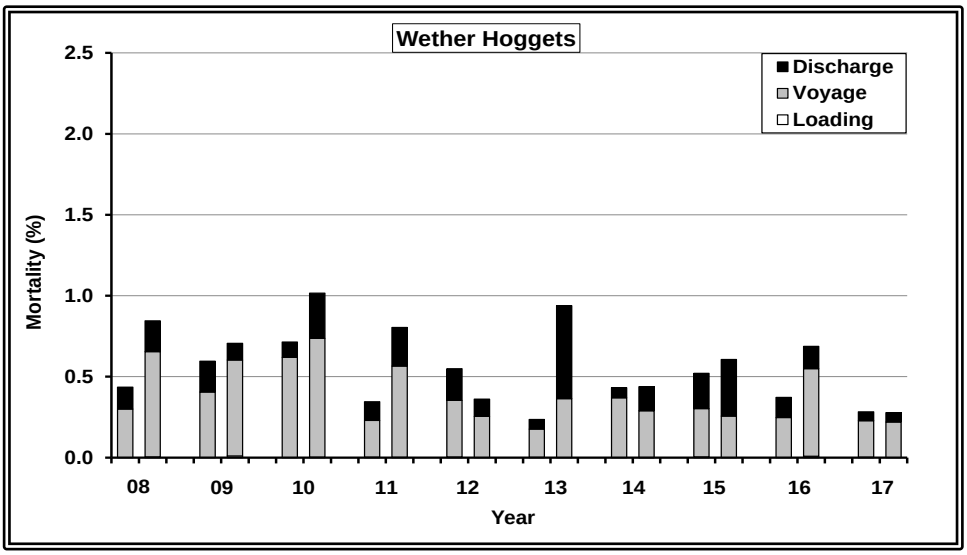
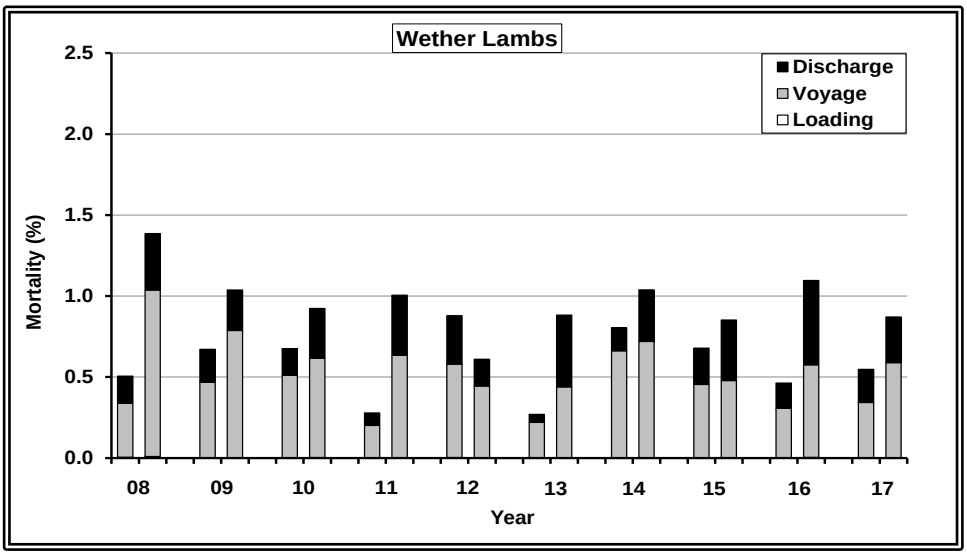


Figure 9 Mortality (%) for wether adults, hoggets and lambs exported by sea from Australia to the Middle East/North Africa for the first and second half of each year from 2008 to 2017







4.1.5.6 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 10).

Figure 10 Numbers by class of sheep exported from Australia, 1997 to 2017

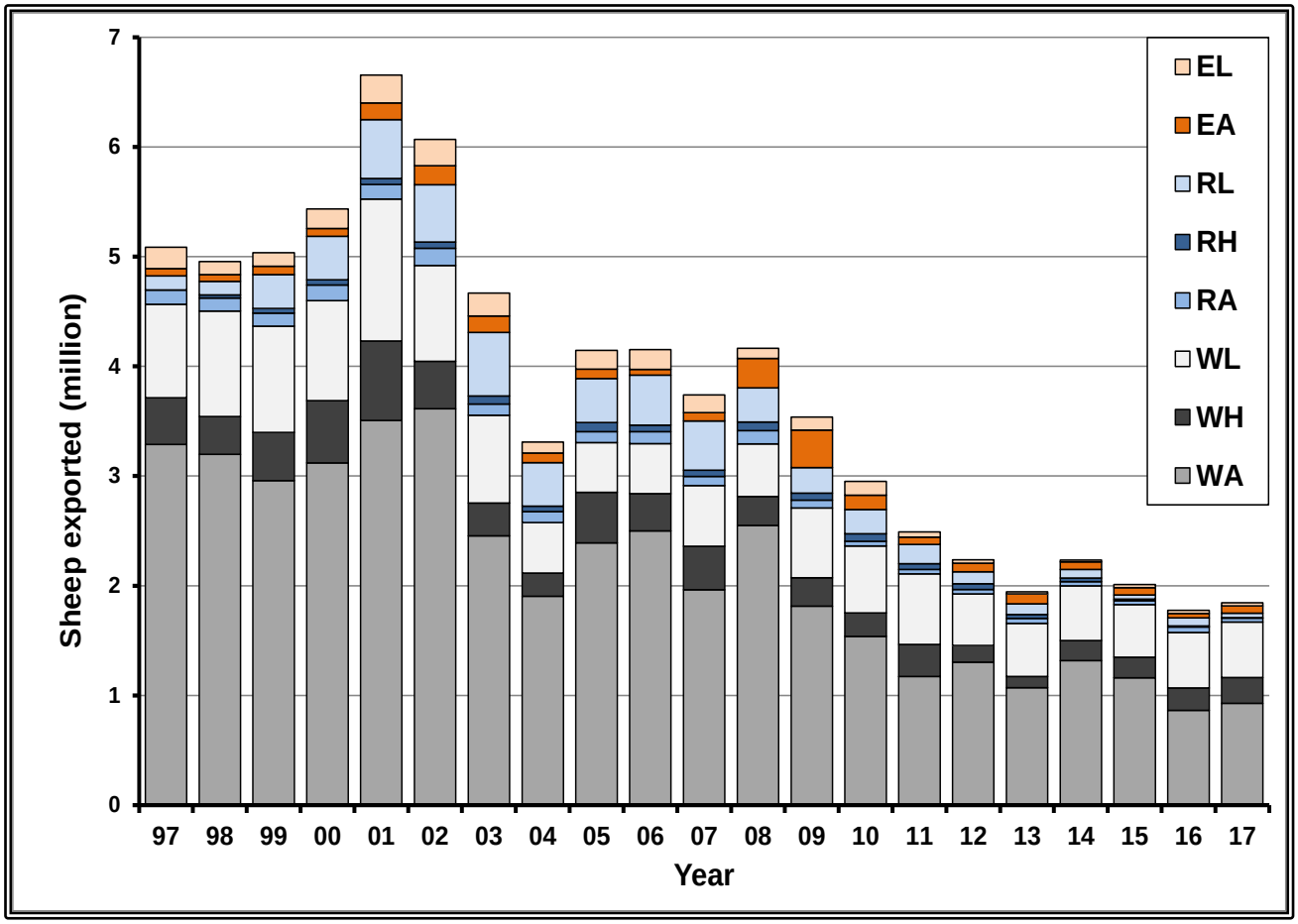
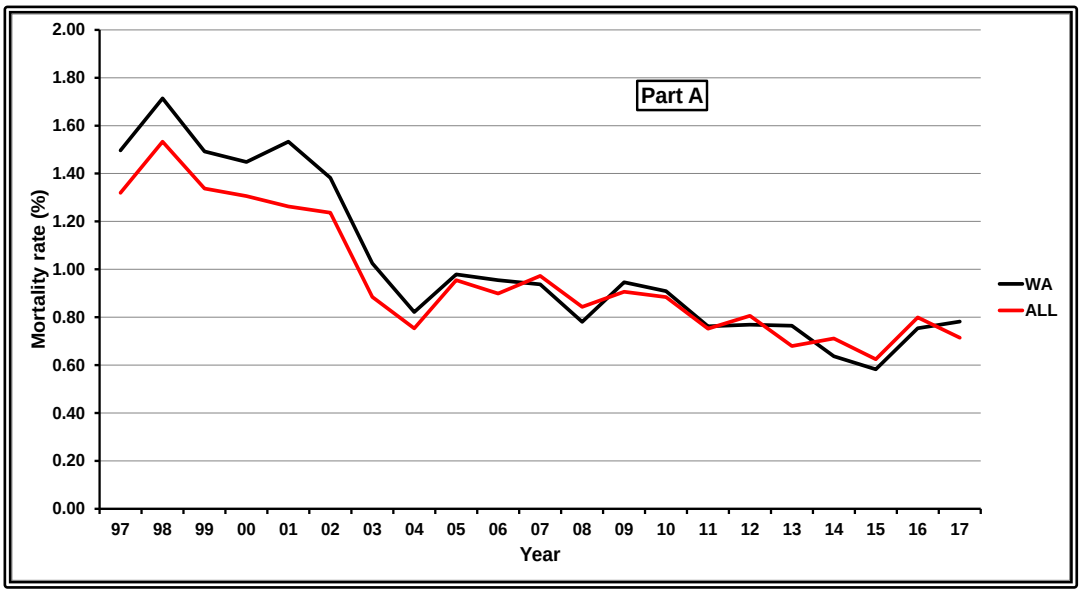


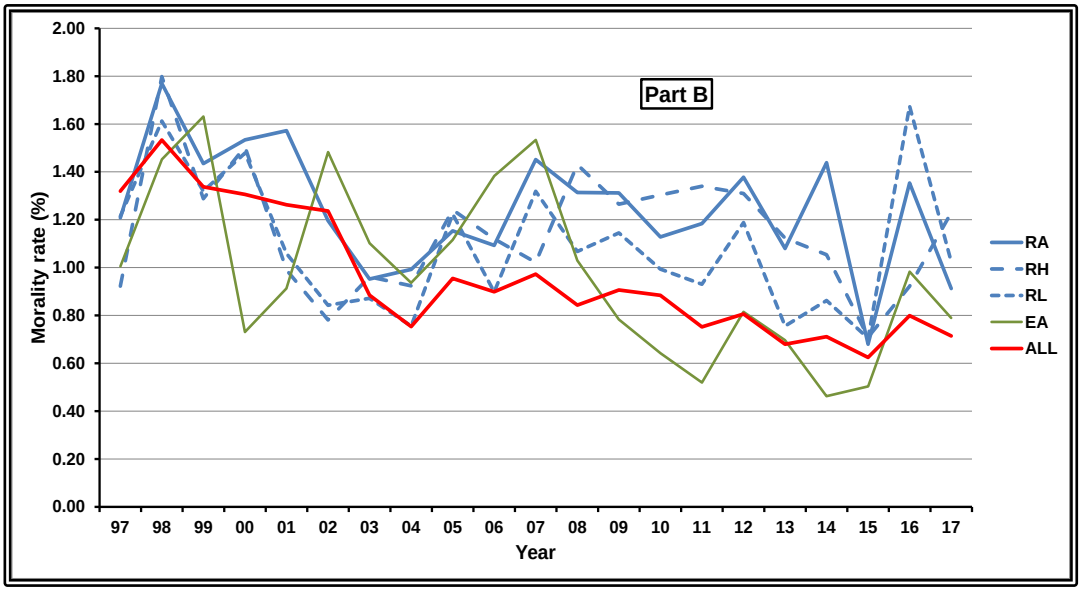
Figure 11, below, shows that the overall mortality rate is closely linked to the Adult Wether mortality (part A). It can also be seen that ram classes have had consistently high mortality rates over time, with Ram Adults (RA) nearly always at or near highest (Part B).

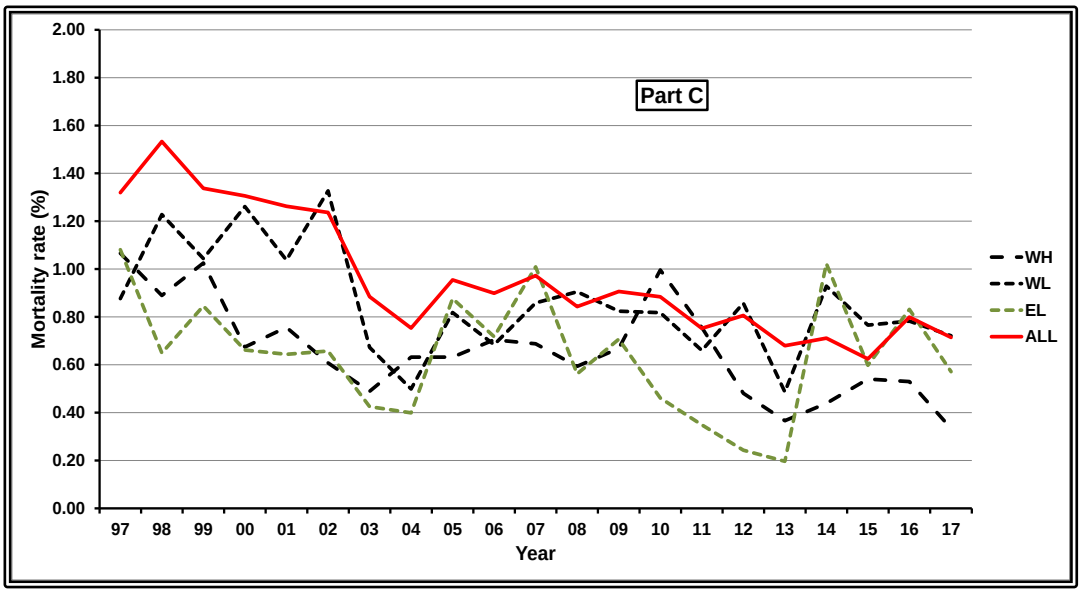
The Ewe Adults (EA) mortality rate has swung wildly over the time, but the three ram classes have remained the highest from 2008 onward, except in the case of Ewe Adults jumping slightly over Ram Lambs in 2016).

Wether Hoggets (WH) and Lambs (WL), and Ewe Lambs (EL) have been almost always lower than the overall average (Figure 11 Part C).

Figure 11 Mortality rate (%) by class of sheep exported from Australia, 1997 to 2017







4.1.5.7 Implications of 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 12 and 13 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 12 Average monthly mortality rate (%) for Adult Wethers for three periods

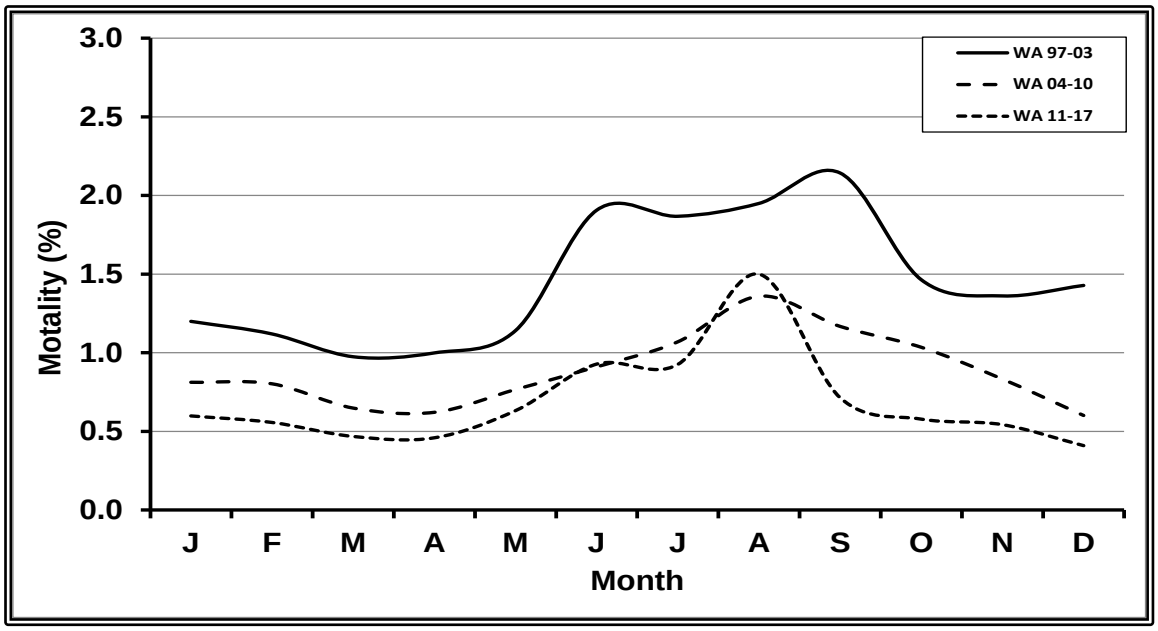
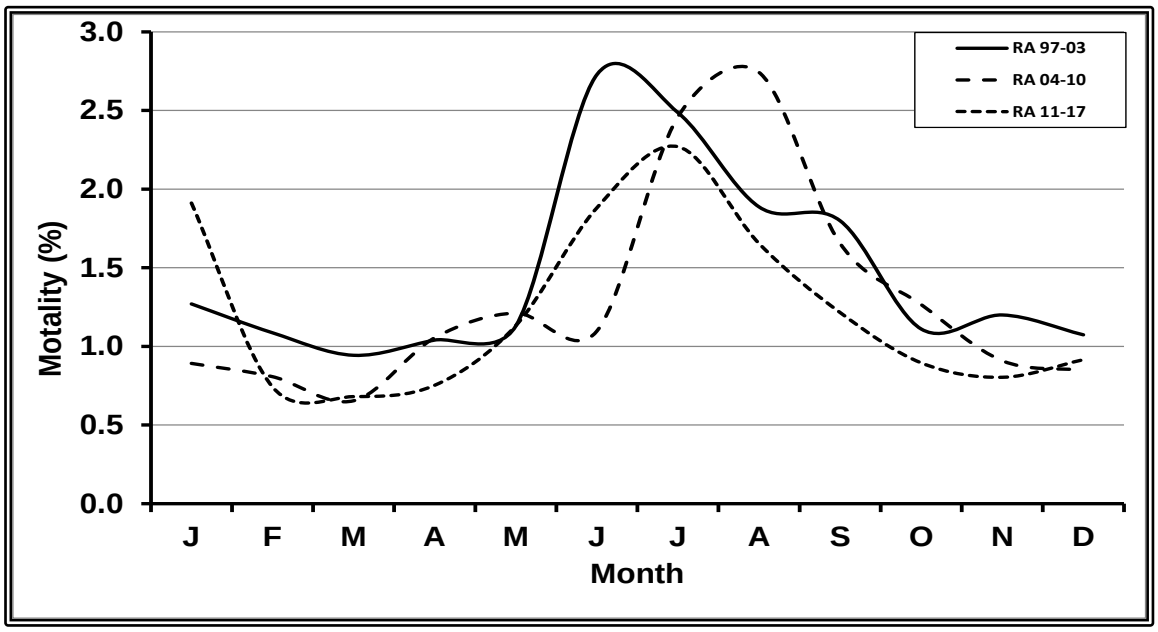


Figure 13 Average monthly mortality rate (%) for Adult Rams for three periods



It can be seen 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.

While the mortality rates of the ram classes particularly, and of Adult Ewes sporadically, have been highest, their impact on the overall mortality rate has been limited by the small numbers exported.

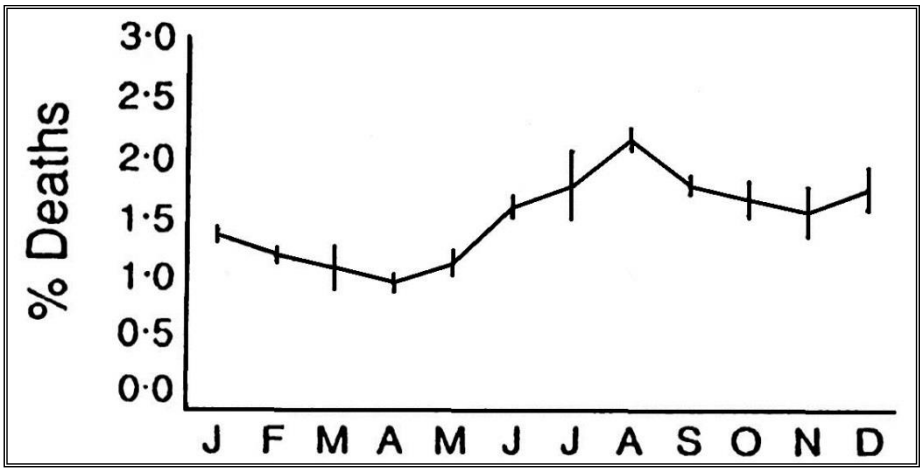
Nevertheless, overall mortality rate could be expected to increase if more sheep, and particularly more of the higher mortality classes, are exported between June and September.

With a constant annual cycle of exports, mortality rates and numbers would be expected to remain steady, but events such as the festivals of importing countries are not fixed in the calendar. As the Islamic calendar tracks forward by approximately 11 days each year, the requirement for suitable numbers and classes of sheep also advances each year.

It could be reasonably predicted that as exports for the festival of Eid Al Adha (early September in 2017) come forward into the highest mortality months of June - September, overall mortalities will rise significantly with the increased contribution of mortalities, particularly from ram classes. This might be expressed in a general rise over the at-risk period, or as an increase in the number of high mortality voyages breaching the reportable limits of DA / AMSA.

Higgs et al (1991) first documented in detail the seasonal mortality difference in relation to the Live Sheep Export Trade, and brought to light the enduring monthly mortality reverse ‘tilde’ pattern for adult wethers exported to the Middle East (Figure 14, below).

Figure 14 Average monthly voyage mortality rate (%) for Adult Wethers exported to the Middle East over 1985 to 1990



Since a similar established reverse ‘tilde’ pattern can be seen in other classes, the possibility of generating a rudimentary predictor of annual mortalities can be seen.

Forward-estimates of numbers and classes to be shipped and at what time of the year may be matched against the long-term mortality pattern to predict overall mortalities.

The reduced overall (reverse tilde) mortality pattern in the live sheep export trade is undoubtedly associated with improvements in ship design and 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 factor influencing mortality reduction the most.

Ongoing research to improve live sheep exports, as outlined in sections 6.1 Appendix 1 and 6.3 Appendix 3, may in the future focus on “flattening” the overall reverse tilde pattern, or servicing the trade in a way that compensates for the peak mortality period of the year.

4.1.5.8 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 6a), and Adelaide (6b).

There was only one voyage from Portland during 2017, which fell in the low category.

There were three voyages in the "high" category in 2017. Approximately 83% of voyages from Fremantle, and 90% of voyages from Adelaide were in the "low" category.

It should be noted that one ship code has been excluded for Fremantle 2017. The ship performed 10, 2 and 3 voyages in the Low, Medium and High categories respectively. Voyages in the High category for this ship were the subject of a Federal Department of Agriculture investigation; see 6.2 Appendix 2.

Table 6a Number of voyages in low, medium and high mortality categories for ships loaded at Fremantle in 2017

	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	8	0	0	8
35	1	0	0	1
44	2	1	0	3
45	1	1	0	2
46	2	0	0	2
47	2	1	0	3
128	1	0	0	1
131	2	0	0	2
138	2	0	0	2
139	2	0	0	2
-	10	2	3	15
Total	38	5	3	46

Table 6b Number of voyages in low, medium and high mortality categories for ships loaded at Adelaide in 2017

	Mortality rate			
Ship (code)	Low <1.0%	Medium 1.0 – 2.0%	High >2.0%	Total
34	1	1	0	2
50	8	0	0	8
Total	9	1	0	10

4.1.6 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.

198,303 sheep were exported to South-East Europe (10.7% of all sheep exported) and the average voyage length (voyage to first discharge port) for exports to this region was 26.48 days with 3.99 days for discharge. The overall mortality for these sheep was 0.50%.

The numbers of sheep exported to South-East Europe since the inception of the trade are shown in Table 18. Over the time, the mortality rate has progressively fallen from 1.16% to 0.50%.

Table 18 Mortality rates, number of voyages, average voyage and discharge length, and number of sheep exported to South-East Europe from 2010 to 2017

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

4.1.6.1 Port of loading

All sheep exported to South-East Europe in 2017 departed from Fremantle (73%) and Adelaide (27% - Table 19). Turkey was the destination country for all sheep exported to the region.

The voyages from each port were classified into various mortality categories as shown in Table 20.

During 2017 all voyages were in the low category.

Table 19 Mortality rates, number of voyages, average voyage and discharge length, and number of sheep exported from various ports to South-East Europe for 2017

Port	Voyages (No.)	Sheep (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days
Fremantle	3	144,345	0.52	0.44 – 0.62	24.17	3.70
Adelaide	2	53,958	0.43	0.41 – 0.44	29.95	4.42

Table 20 Number of voyages in the low, medium and high mortality categories for shipments from various ports to South-East Europe during 2017

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

4.1.6.2 Ship

The voyages of each ship taking sheep from Australia to South-East Europe were classified into various mortality categories as shown in Table 21.

During 2017 there were only two ships that carried sheep to the region, with all voyages in the low category.

Table 21 Number of voyages in the low, medium and high mortality categories for shipments from various ports to South-East Europe during 2017

Ship (code)	Mortality rate			Total
	Low <1.0%	Medium 1.0 – 2.0%	High >2.0%	
33	4	0	0	4
35	1	0	0	1
Total	5	0	0	5

4.1.6.3 Class of sheep

Mortality rates for classes of sheep exported to South-East Europe during 2017 are presented in Table 22.

The South-East Europe sheep trade comprised mainly wether classes exported to Turkey during 2017.

The highest mortality rates occurred in adult rams (0.77%) followed by adult wethers (0.51%). Ram and wether lambs had the lowest mortality rates with 0.28% and 0.44% respectively.

Table 22 Mortality rate, number of voyages and number of sheep in the classes exported to South-East Europe in 2017

Class		Voyages (No.)	Sheep (No.)	Mortality rate overall (%)	Mortality rate range (%)
Wethers	adults	4	84,243	0.51	0.11 – 0.62
	hoggets	4	73,825	0.45	0.40 – 0.51
	lambs	2	38,495	0.44	0.44 – 0.44
Rams	adults	1	650	0.77	n/a
	lambs	1	1,090	0.28	n/a

4.1.7 AMSA limit for reportable sheep mortality: what the numbers say

May 2018 saw the release of the McCarthy Report (Independent review of conditions for the export of sheep to the Middle East during the northern hemisphere summer), which made 23 recommendations to improve the Live Sheep Export industry. The Report can be viewed at - http://www.agriculture.gov.au/SiteCollectionDocuments/biosecurity/export/live-animals/mccarthy-report.pdf

Of particular interest is a recommended decrease in the Australian Maritime Safety Authority (AMSA) mortality limit for which a sheep voyage will incur an investigation. Currently this limit stands at 2.0%, with the McCarthy Report recommendation that it be lowered to 1.0%. The Federal Department of Agriculture has given its support for the recommendation.

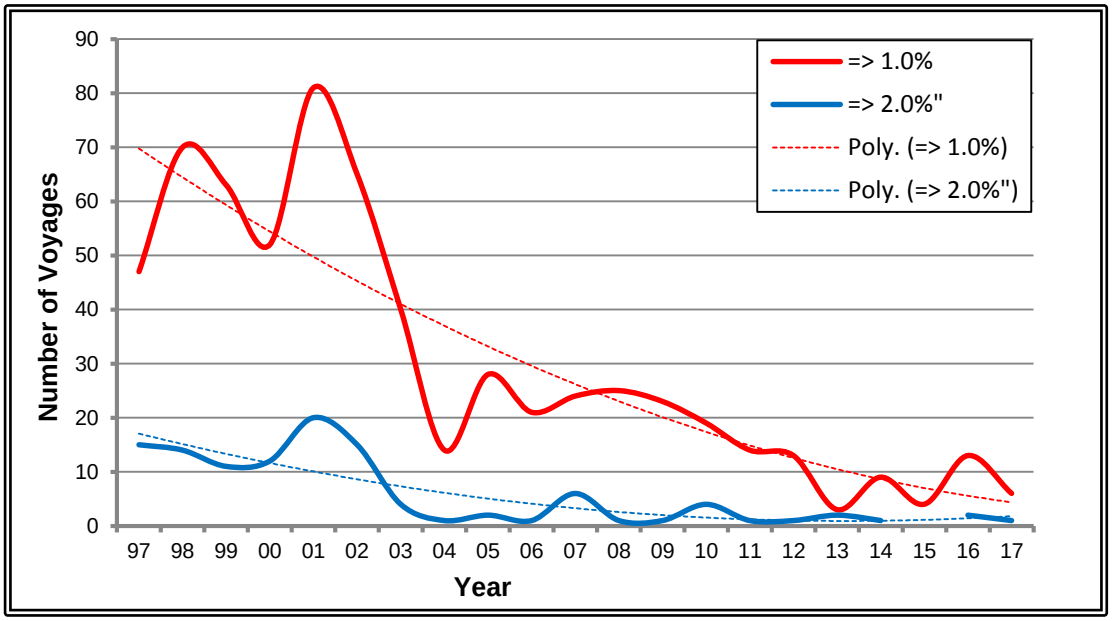
The Report mentions “reducing to 1% immediately and maintaining the level at 1% throughout the forthcoming northern hemisphere summer period”. It claims that “this may not have a big impact on the number of reportable voyages since the vast majority of voyages are below this level”. Further, it says that “the most likely scenario is that (Industry) behaviour would be modified and the number of reportable incidents would remain unchanged or more likely fall”.

In contrast to the Report, the accumulated data shows it to be almost certain that, without modification of Industry behaviour, the number of reportable voyages will rise with the new AMSA limit.

It should be noted that data for the following figures in this section have been modified to eliminate split discharge “voyages”, as these artificially inflate the number of voyages affected within the specified mortality parameters.

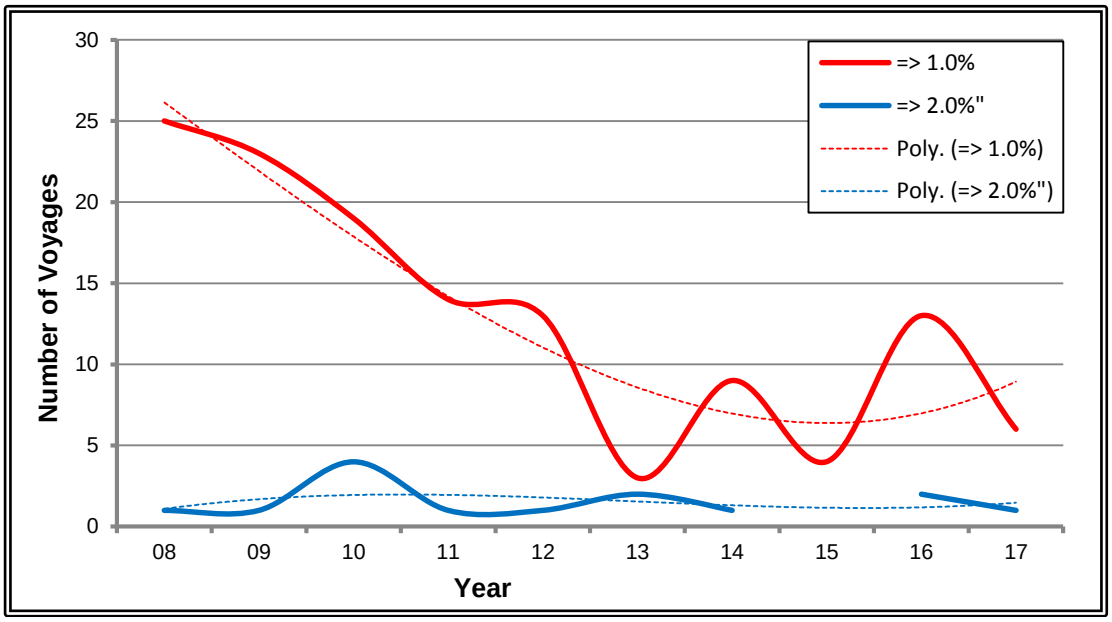
The numbers of voyages over the years 1997 to 2017 with total mortality rates greater than or equal to 1.0% and 2.0% are shown in Figure 15. This shows that while the number of voyages for both parameters has trended downward significantly over time, they both maintain a presence, particularly in voyages equal to or above 1.0%.

Figure 15 Number of voyages with mortality rates equal to or greater than 1.0% and 2.0% for sheep exported from Australia, 1997 to 2017



The same voyage number data is shown contracted to the last decade, 2008 to 2017 (Figure 16). This data more accurately reflects current trade conditions, and shows that the number of voyages with mortality equal to or above 1.0% is trending upward toward the end of the decade.

Figure 16 Number of voyages with mortality rates equal to or greater than 1.0% and 2.0% for sheep exported from Australia, 2008 to 2017



The impact of the proposed AMSA reduction is perhaps more telling when the same voyage numbers are examined as a percentage of the annual sheep voyages undertaken. Figure 17 shows the percentage of voyages over the years 1997 to 2017 with total mortality rates greater than or equal to 1.0% and 2.0%.

Figure 17 Percentage of voyages with mortality rates equal to or greater than 1.0% and 2.0% for sheep exported from Australia, 1997 to 2017

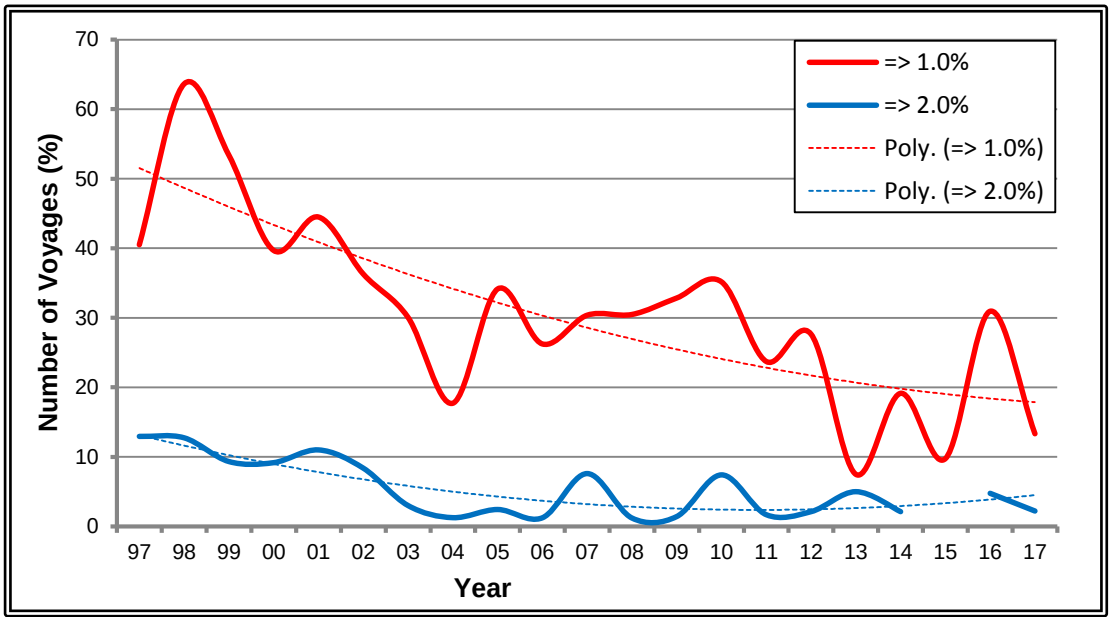
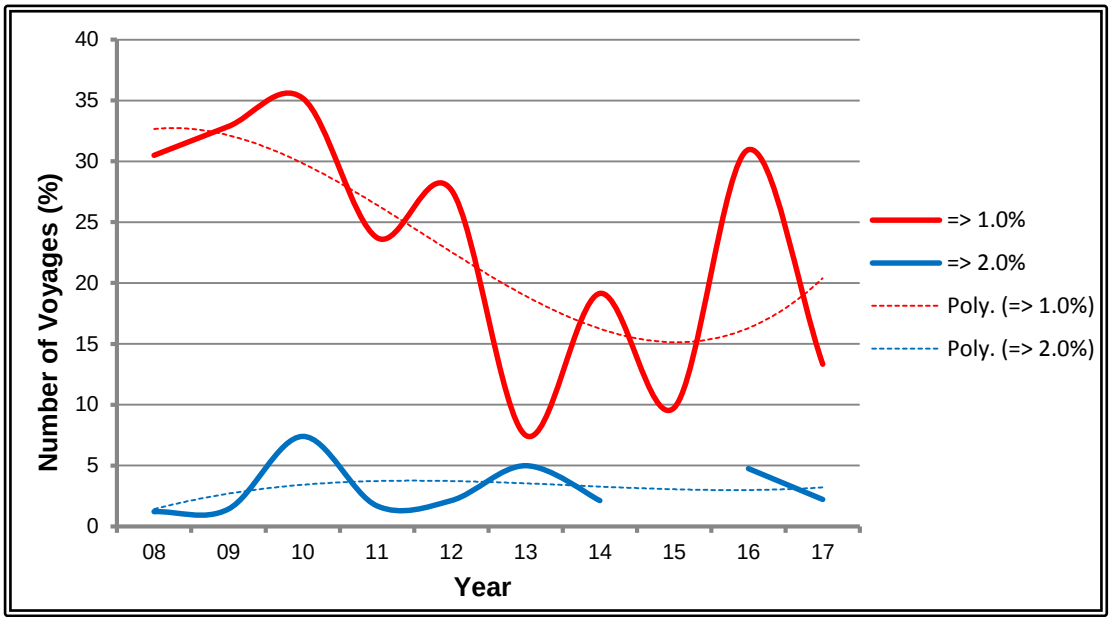


Figure 18 shows that the percentage of voyages with total mortalities of 2.0% or greater has maintained at about 4% over the last decade, while voyages of 1.0% or greater continued to trend downward from about 30% of all voyages to about 20% of all voyages over the last decade.

Again there is a trend toward a greater percentage of voyages with mortality equal to or above 1.0% toward the end of the decade.

Figure 18 Percentage of voyages with mortality rates equal to or greater than 1.0% and 2.0% for sheep exported from Australia, 2008 to 2017



It can be demonstrated that the percentage increase in the number of voyages affected by lowering the AMSA reportable limit from 2.0% to 1.0% would be substantial under current Industry conditions (Figure 19).

Figure 19 Percentage increase in numbers of voyages with mortality rates equal to or greater than 1.0% compared to 2.0% for sheep exported from Australia, 1997 to 2017

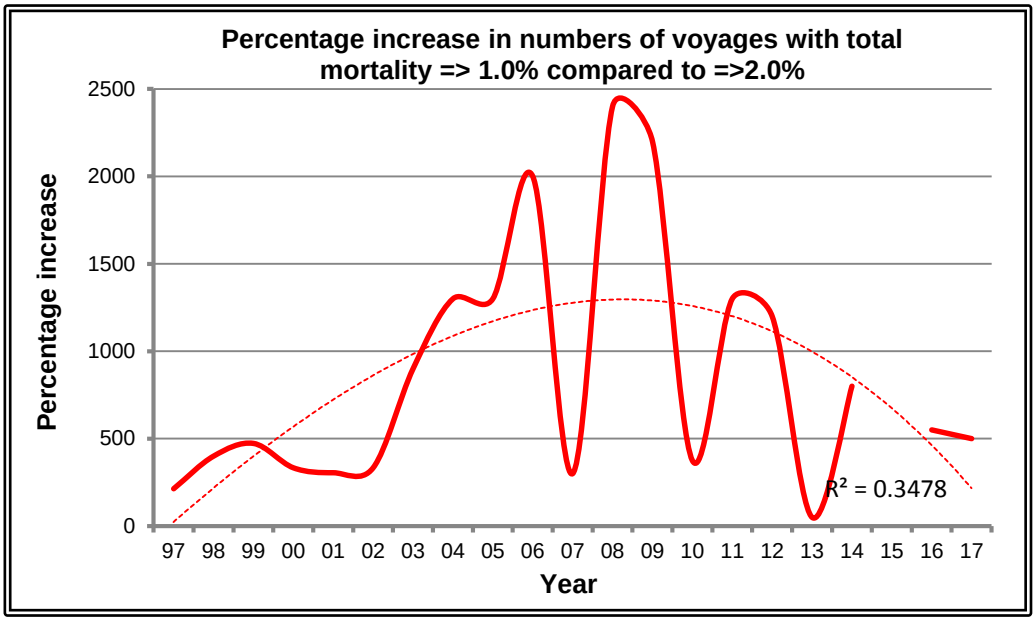
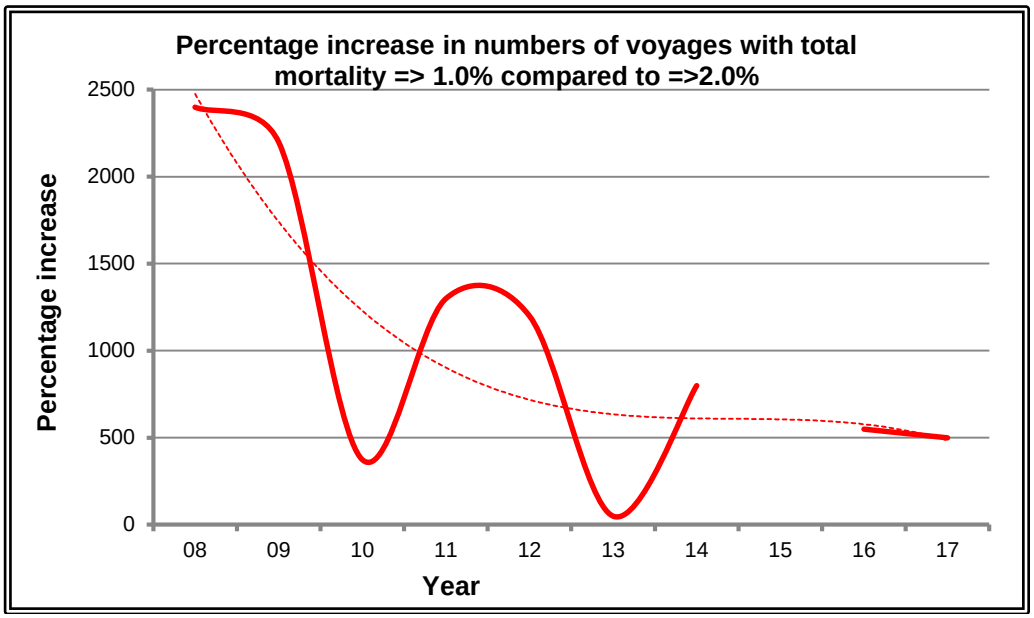


Figure 20 Percentage increase in numbers of voyages with mortality rates equal to or greater than 1.0% compared to 2.0% for sheep exported from Australia, 2008 to 2017



Considering the more recent data, voyages of 1.0% or more are currently in the order of 5 times as many as the number of voyages of 2.0% or more.

If changes to Industry conditions don't lower this difference, the impression will be that the Industry is suddenly five times worse than it was, as the inflated numbers of AMSA investigation reports begin to build.

This contrasts with the reality that the Industry has demonstrated considerable animal welfare gains, particularly through the export of younger classes of sheep, improved ship design and improved Industry practise, as mentioned in section 3.1.5.7 above.

4.2 Cattle

4.2.1 Performance trend

The number of cattle shipped from all ports in Australia to all destinations since 2008 as well as the trend line (linear regression) across those years is shown in Figure 15. Figure 16 shows the number of cattle mortalities during sea transport since 2008. 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 15 Number of cattle exported by sea from Australia to all destinations since 2008

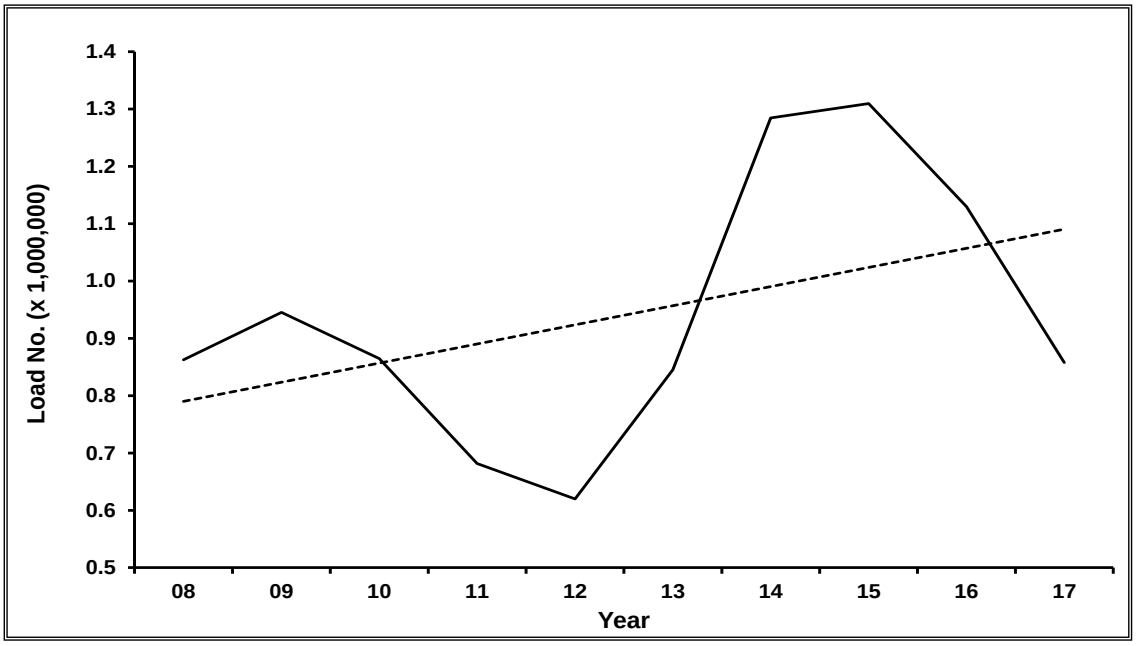
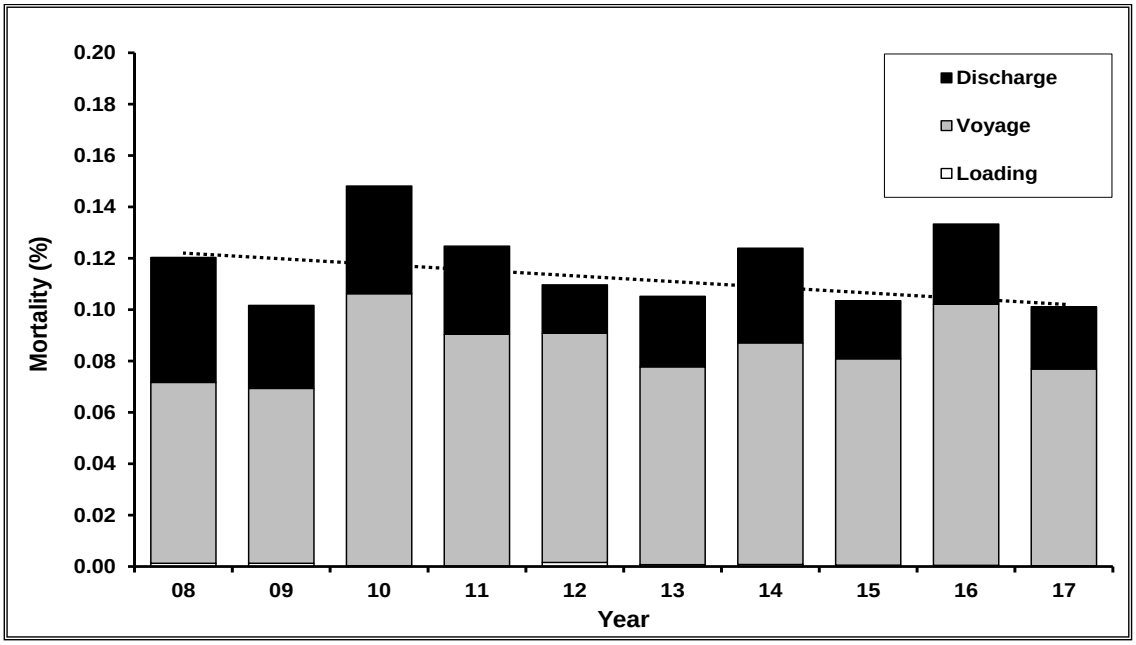


Figure 16 Annual mortality of cattle exported by sea from Australia to all destinations since 2008



4.2.2 Overview

The live cattle trade from Australia in 2017 was characterised by the large number of loading ports in Australia and regions to which the animals were shipped. This differs from the live sheep trade which has only three ports of loading, and nearly all sheep shipped to the Middle East/North Africa.

There were 292 cattle "voyages" during 2017. This involved 262 ship journeys, which was 14% less than in 2016. There were 25 ship journeys which were split for loading or discharge, and these generated a further 55 “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 2017 fell by 24% compared to 2016, to 0.86 million (Table 7, below). The overall mortality rate in 2017 was 0.10%, a fall of 24% on the figure of 0.13% observed in 2016. 35% of all cattle voyages returned a nil mortality rate during 2017.

The highest overall mortality rate on a regional basis was for exports to South-East Europe (0.21%), while the lowest overall mortality rate was for exports to South-East Asia (0.09%). There were no exports to Mexico destinations in 2017

The number of cattle exported to the Middle East/North Africa in 2017 fell by 43% compared to 2016, while the number of voyages fell by 7%, and the mortality rate approximately halved.

Exports to South-East Asia fell by 18% in 2017 compared to 2016, in a further “correction” to the high numbers of recent years. The number of voyages fell by 15%, from 271 in 2016 to 231 in 2017. Trade to South-East Asia accounted for 82% of all cattle exported in 2017.

Exports to South-East Asia involve a mix of smaller ships performing short single-load/single-discharge voyages, and larger ships which load and/or discharge at more than one port. In 2017 these larger vessels accounted for 33% of the cattle exported and 22% of the voyages made to South-East Asia.

Exports to North-East Asia in 2017 fell by 14% compared to 2016, while the mortality rate fell from 0.14% to 0.11%.

Exports to South-East Europe fell by 76% year-on-year, while the mortality fell from 0.29% to 0.21%.

Exports to Miscellaneous destinations comprised one voyage carrying 3,030 cattle with a mortality rate of 0.17%. It had a duration of 25.93 voyage and 2.23 discharge days. This voyage will not receive further examination in this report.

Table 7 Mortality rates, number of voyages, voyage and discharge days, and number of cattle exported for voyages to major destination regions during 2017

Parameter	ME/N Africa	SE Asia	NE Asia	Misc	SE Europe	Total
Voyages (No.)	26	231	31	1	3	292
Cattle (No.)	41,348	704,683	87,877	3,030	20,791	857,765
Mortality rate o/all (%)	0.17	0.09	0.11	0.17	0.21	0.10
Mortality rate range (%)	0.00 – 1.00	0.00 – 10.05*	0.00 – 0.52	n/a	0.00 – 0.32	0.00 – 10.05
Voyage days (Ave.)	17.14	7.49	17.18	25.93	25.61	9.62
Discharge days (Ave.)	4.13	1.44	0.81	2.23	3.26	1.63
Voyages with nil mortalities (No.)	15	83	4	0	1	103

* exceptional voyage; see 6.2 Appendix 2

4.2.3 Middle East/North Africa

The number of live cattle exported to the Middle East/North Africa during 2017 fell by 43% compared to 2016 (Table 8), and the number of voyages fell by 10%.

Overall mortality rates have remained below 0.5% over the last decade. In 2017 the mortality rate was 0.17%, well below the average across the decade of 0.27%.

Table 8 Mortality rates, number of voyages, average voyage and discharge length, and number of cattle exported to the Middle East/North Africa from 2008 to 2017

Year	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days	Nil mortality voyages (No.)
2008	46	120,122	0.29	0.00 – 0.79	17.09	5.02	19
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

4.2.3.1 Port of loading

There were 3 ports of loading for voyages to the Middle East/North Africa in 2017, with the majority of cattle exported from Fremantle (Table 9). Mortality rates in 2017 were highest from Portland.

The voyages from each port were classified into various mortality categories as shown in Table 10. There were two voyages in the medium or high categories, both loaded in Adelaide.

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

Table 9 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 2017

Port	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days
Fremantle	21	35,147	0.16	0.00 – 1.00	16.68	4.81
Portland	3	5,988	0.27	0.12 – 0.42	17.86	4.13
Adelaide	2	249	0.00	n/a	20.84	1.38

Table 10 Number of voyages in nil, low, medium and high mortality categories for shipments from various ports to the Middle East/North Africa for 2017

Port	Mortality rate				Total
	Nil 0.0%	Low >0.0 – 0.5%	Medium >0.5 – 1.0%	High >1.0%	
Fremantle	13	6	2	0	21
Portland	0	3	0	0	3
Adelaide	2	0	0	0	2
Total	15	9	2	0	26

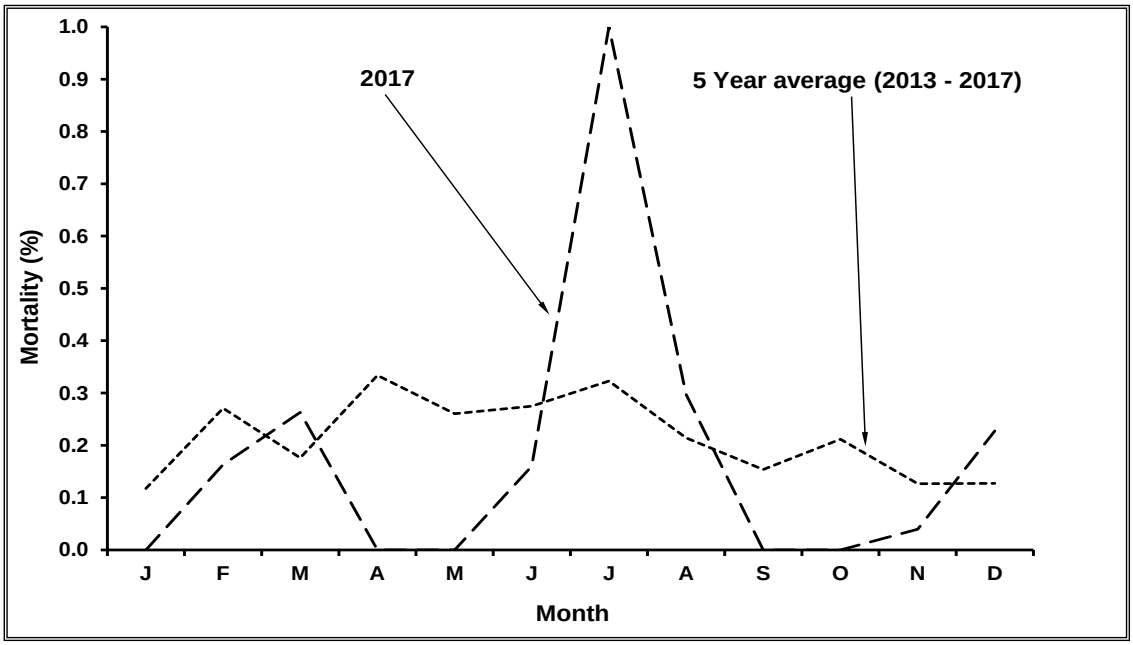
4.2.3.2 Time of year

In 2017, monthly mortality rates (total mortality as a proportion of total loaded for each month) in cattle exported from all ports to the Middle East/North Africa remained at or below 0.3% throughout the year with the exception of July (Figure 17). The monthly mortality rate profile for 2017 did not approximate the 5-year average, having five months of the year with a nil mortality rate.

The high 2017 July figure is for one voyage involving a small consignment of cattle with a few deaths. For this reason, the voyage did not receive a Federal Department of Agriculture investigation.

Note that one 2014 exceptional voyage has been excluded from the data. If this voyage was included, the January percentage for the 5-year average profile would have been 0.58%. A Federal Department of Agriculture investigation summary regarding this voyage is referred to in 6.2 Appendix 2.

Figure 17 Monthly mortality rates of cattle on voyages from all ports to the Middle East/North Africa for 2017 and the 5-year average monthly rates for the period 2013 to 2017



4.2.3.3 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 11 shows the number of voyages in the various mortality categories for each ship. There were two voyages in the medium or high categories, involving ships 34 and 35. 92% of voyages were in the nil or low categories.

Table 11 Number of voyages in nil, low, medium and high mortality categories for shipments to the Middle East/North Africa for 2017

Ship (code)	Mortality rate				Total
	Nil 0.0%	Low >0.0 – 0.5%	Medium >0.5 – 1.0%	High >1.0%	
32	3	0	0	0	3
33	0	1	0	0	1
34	6	0	1	0	7
35	0	1	1	0	2
46	1	1	0	0	2
50	4	0	0	0	4
123	0	1	0	0	1
128	0	1	0	0	1
130	0	1	0	0	1
131	1	0	0	0	1
139	0	3	0	0	3
Total	15	9	2	0	26

4.2.3.4 Class of cattle

In 2017, the highest overall class mortality rate occurred in dairy heifers (0.32%; Table 12). Bull classes made up 65% of all cattle shipped to Middle East/North Africa in 2017.

Table 12 Mortality rates, number of voyages and number of cattle in various classes exported to the Middle East/North Africa in 2017

Class	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)
Bull weaners	6	13,762	0.15	0.00 – 0.22
Bull adults*	15	13,158	0.15	0.00 – 1.00†
Heifers dairy	4	6,671	0.32	0.12 – 0.73
Steer adults*	18	4,190	0.07	0.00 – 0.49
Heifers beef	7	3,434	0.23	0.00 – 0.88
Steer weaners	1	169	0.00	n/a

* 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.

4.2.4 South-East Asia

After the record-breaking 1.07 million cattle exported to South-East Asia in 2015, this market has experienced a 360,000 head "correction", falling 34% to 0.71 million in 2017 (Table 13).

The mortality rate for voyages to the region during 2017 has remained at 0.09%, while the number of voyages fell by 15% compared to 2016. A nil mortality rate was reported on 36% of the voyages to the region. The mortality rate has remained at or below 0.1% over the last decade, the average being 0.07%.

Table 13 Mortality rates, number of voyages, average voyage and discharge length, and number of cattle exported to South-East Asia from 2008 to 2017

Year	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days	Nil mortality voyages (No.)
2008	219	682,264	0.10	0.00 – 1.93	6.33	1.14	93
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

* exceptional voyages; see 6.2 Appendix 2

4.2.4.1 Port of loading

Most cattle exported to South-East Asia in 2017 were loaded at Darwin (44%) followed by Townsville (29%) and Broome (14%, Table 14). The mortality rate was highest for cattle exported from Portland (0.15%) followed by Broome (0.15%) and Townsville (0.10%).

The voyages from each port were classified into various mortality categories as shown in Table 15. 97% of voyages were in the nil or low categories in 2017. There were six voyages in the medium and two in the high category involving the ports of Broome, Darwin, Geraldton and Townsville.

Table 14 Mortality rates, number of voyages, average voyage and discharge length, and number of cattle exported from various ports to South-East Asia in 2017

Port	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days
Darwin	117	307,004	0.07	0.00 – 10.05*	6.46	1.23
Townsville	52	205,675	0.10	0.00 – 0.78	9.51	1.68
Broome	25	96,290	0.15	0.00 – 0.91	6.06	1.53
Fremantle	20	46,705	0.09	0.00 – 0.33	10.01	1.81
Wyndham	6	26,162	0.03	0.00 – 0.06	5.22	3.05
Geraldton	6	12,147	0.03	0.00 – 0.70	9.49	0.79
Port Hedland	2	4,935	0.00	n/a	5.54	0.77
Portland	2	3,915	0.15	0.09 – 0.22	8.41	1.04
Karumba	1	1,850	0.05	n/a	11.51	0.99

* exceptional voyage; see 6.2 Appendix 2

Table 15 Number of voyages in nil, low, medium and high mortality categories for shipments from various ports to South-East Asia for 2017

Port	Mortality rate				Total
	Nil 0.0%	Low >0.0 – 0.5%	Medium >0.5 – 1.0%	High >1.0%	
Darwin	56	58	1	2	117
Townsville	7	42	3	0	52
Broome	7	17	1	0	26
Fremantle	6	14	0	0	20
Wyndham	3	3	0	0	6
Geraldton	2	3	1	0	6
Port Hedland	2	0	0	0	2
Portland	0	2	0	0	2
Karumba	0	1	0	0	1
Total	83	140	6	2	231

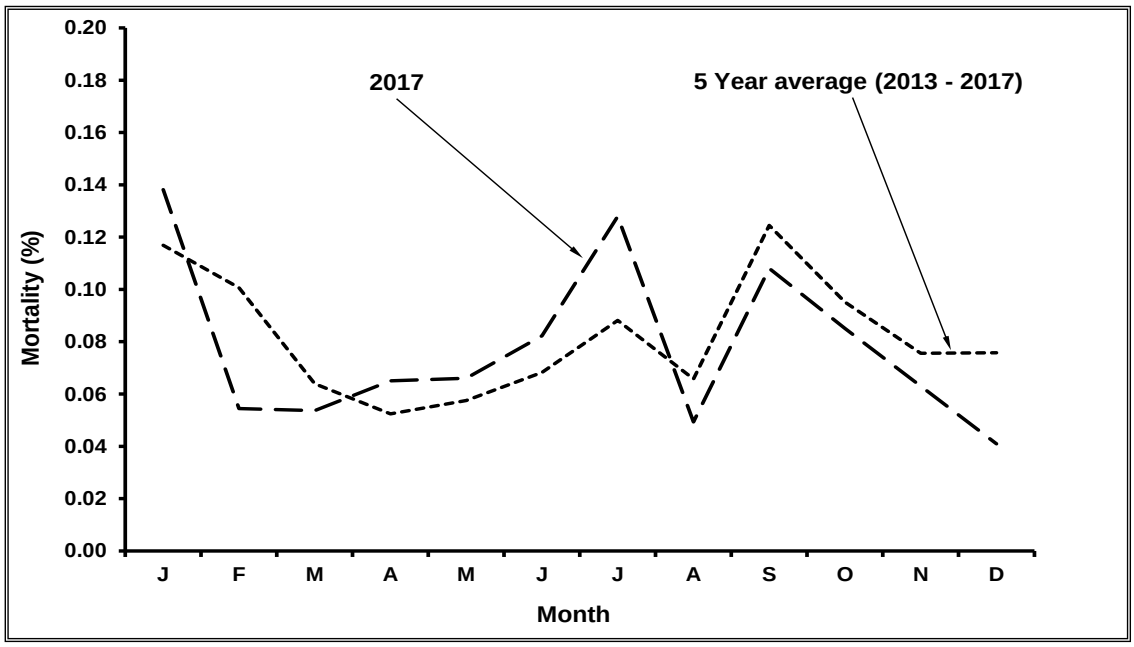
4.2.4.2 Time of year

Monthly mortality rates (total mortality as a proportion of total loaded for each month) for voyages to South-East Asia in 2017 were at or below 0.10% for the year except for the months of January, July and September (Figure 18).

Note that one exceptional voyage, split for destination countries, was excluded for April 2017. If this voyage were included, the 2017 value for April would have been 0.22%, while the 5-year value would have been 0.07%. A Federal Department of Agriculture investigation summary regarding this voyage is referred to in 6.2 Appendix 2

The monthly mortality rate profile for 2017 approximated that of the 5-year average.

Figure 18 Monthly mortality rates of cattle on voyages from all ports to South-East Asia for 2017 and the 5-year average monthly rates for the period 2013 to 2017



4.2.4.3 Ship

Voyages for each ship from Australia to South-East Asia were classified into various mortality categories as shown in Table 16. 97% of voyages were in the nil or low categories. Six voyages in the medium and two in the high category involving ships 44, 123, 124, 126, 136, and 138.

The number of voyages to the region fell from 271 in 2016 to 231 in 2017, a decrease of 15%.

Ships with a carrying capacity of 6,000 or more head accounted for 22% of voyages to South-East Asia in 2017. They also accounted for 33% of cattle exported, 35% of mortality, 25% of voyage days and 46% 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 16 Number of voyages in nil, low, medium and high mortality categories for shipments to South East Asia for 2017

	Mortality rate				
Ship (code)	Nil 0.0%	Low >0.0 – 0.5%	Medium >0.5 – 1.0%	High >1.0%	Total
43	3	11	0	0	14
44	2	4	1	0	7
45	0	2	0	0	2
47	0	10	0	0	10
49	1	9	0	0	10
59	4	5	0	0	9
77	1	1	0	0	2
95	4	3	0	0	7
115	0	1	0	0	1
117	0	5	0	0	5
120	0	1	0	0	1
122	4	2	0	0	6
123	6	7	1	0	14
124	9	4	2	0	15
125	4	2	0	0	6
126	0	4	1	0	5
127	2	8	0	0	10
128	4	4	0	0	8
129	2	7	0	0	9
130	3	2	0	0	5
131	1	5	0	0	6
132	11	13	0	0	24
133	11	13	0	0	24
134	0	1	0	0	1
135	5	11	0	0	16
138	2	1	1	0	4
140	0	2	0	0	2
-	4	2	0	2	8
Total	83	140	6	2	231

It should be noted that one ship code has been excluded for South-East Asia 2017. The ship performed 4, 2, nil and 3 voyages in the Nil, Low, Medium and High categories respectively. Voyages in the High category for this ship were the subject of a Federal Department of Agriculture investigation; see 6.2 Appendix 2.

4.2.4.4 Class of cattle

In 2017, 99.18% of cattle exported to South-East Asia were able to be identified by class. The 5,749 cattle that could not be identified to class were exported on one voyage, incurring a total mortality of 0.16%. These cattle will not be examined further in this section.

Adult steers and beef heifers comprised 52% and 21% respectively of all classes exported to the region in 2017 (Table 17).

The highest mortality rates occurred in beef cows (0.99%) followed by adult bulls (0.16%).

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 17 Mortality rates, number of voyages and number of cattle in various classes exported to the South-East Asia in 2017

Class	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)
Steer adults*	200	366,294	0.07	0.00 – 3.93†
Heifers beef	170	144,989	0.05	0.00 – 2.78
Bull adults*	136	87,305	0.16	0.00 – 2.43
Steer weaners	37	61,123	0.03	0.00 – 0.53
Bull weaners	25	13,760	0.04	0.00 – 0.21
Cows beef	40	15,117	0.99	0.00 – 11.56†
Heifers dairy	11	10,216	0.05	0.00 – 0.17
Cows dairy	1	130	0.00	n/a

* may include young as well as mature animals (i.e. animals not separately classified as "weaner")
† exceptional voyage; see 6.2 Appendix 2

4.2.5 North-East Asia

The number of cattle exported to North-East Asia in 2017 fell by 14% compared to 2016 and the number of voyages fell by 11% (Table 18). The mortality rate has remained under 0.2% over the last decade, at an average of 0.12%.

The North-East Asia cattle trade is characterised by steers exported to Japan and heifers sent to China. Occasional shipments are made to Korea and North-Eastern Russia, but none occurred in 2017.

Table 18 Mortality rates, number of voyages, average voyage and discharge length, and number of cattle exported to North-East Asia from 2008 to 2017

Year	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days	Nil mortality voyages (No.)
2008	19	29,873	0.06	0.00 – 0.36	17.51	1.04	10
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

4.2.5.1 Port of loading

The majority of cattle exported to North-East Asia in 2017 departed from Portland (55%), followed by Geelong (26%) and Brisbane (14%). 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 20. During 2017 there was one voyage in the medium mortality category, while 97% of all voyages were in the nil or low categories.

Table 19 Mortality rates, number of voyages, average voyage and discharge length, and number of cattle exported from various ports to North-East Asia for 2017

Port	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days
Portland	12	48,723	0.11	0.04 – 0.34	16.89	1.11
Geelong	6	23,084	0.10	0.03 – 0.14	17.12	0.78
Brisbane	10	12,375	0.15	0.00 – 0.52	16.91	0.45
Fremantle	3	3,695	0.16	0.00 – 0.33	19.30	0.83

Table 20 Number of voyages in nil, low, medium and high mortality categories for shipments from various ports to North-East Asia for 2017

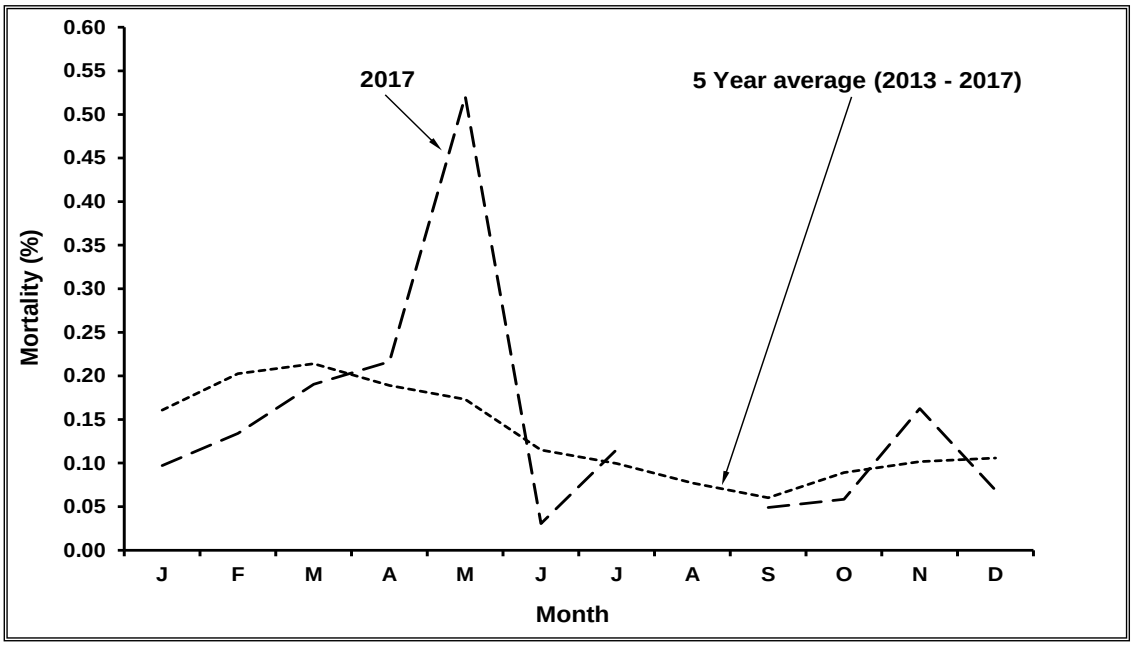
Port	Mortality rate				Total
	Nil 0.0%	Low >0.0 – 0.5%	Medium >0.5 – 1.0%	High >1.0%	
Portland	1	2	0	0	3
Brisbane	0	12	0	0	12
Geelong	3	6	1	0	10
Fremantle	0	6	0	0	6
Total	4	26	1	0	31

4.2.5.2 Time of year

Monthly mortality rates (total mortality as a proportion of total loaded for each month) for voyages to North-East Asia in 2017 were below 0.25% throughout the year except for the month of May. The monthly mortality rate profile for 2017 approximated the 5-year average except for the months of May and June.

The high 2017 May figure is for one voyage involving a small consignment of cattle with a few deaths. For this reason, the voyage did not receive a Federal Department of Agriculture investigation.

Figure 19 Monthly mortality rates of cattle on voyages from all ports to North-East Asia for 2017 and the 5-year average monthly rates for the period 2013 to 2017



4.2.5.3 Ship

The voyages of each ship taking cattle from Australia to North-East Asia were classified into various mortality categories as shown in Table 21.

During 2017 there was one voyage in the medium mortality category involving ship 115. 97% of voyages were in the nil or low categories.

Table 21 Number of voyages in nil, low, medium and high mortality categories for shipments to North-East Asia for 2017

Ship (code)	Mortality rate				Total
	Nil 0.0%	Low >0.0 – 0.5%	Medium >0.5 – 1.0%	High >1.0%	
44	0	1	0	0	1
47	0	1	0	0	1
49	0	1	0	0	1
50	1	1	0	0	2
59	0	1	0	0	1
77	1	2	0	0	3
95	0	3	0	0	3
115	2	3	1	0	6
122	0	1	0	0	1
125	0	1	0	0	1
126	0	2	0	0	2
127	0	3	0	0	3
131	0	2	0	0	2
132	0	1	0	0	1
135	0	2	0	0	2
140	0	1	0	0	1
Total	4	26	1	0	31

4.2.5.4 Class of cattle

Mortality rates for classes of cattle exported to North-East Asia during 2017 are presented in Table 22.

The North-East Asian cattle trade comprised mainly steers exported to Japan and China (20%) and heifer classes exported to China (76%).

The highest mortality rates occurred in dairy cows (0.20%) followed by weaner steers (0.17%).

Table 22 Mortality rate, number of voyages and number of cattle in the classes exported to North-East Asia in 2017

Class	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)
Heifers dairy	15	54,765	0.10	0.00 – 0.33
Steer adults*	15	17,470	0.16	0.00 – 0.52
Heifers beef	8	11,681	0.11	0.00 – 1.26†
Cows dairy	1	3,069	0.20	n/a
Steer weaners	1	602	0.17	n/a
Cows beef	1	172	0.00	n/a
Bull adults*	2	84	0.00	n/a
Bull weaners	1	34	0.00	n/a

* 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.

4.2.6 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 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 0.34% (Table 23).

The mortality rate in cattle exported to South-East Europe was 0.21% in 2017. Numbers exported fell by 76% compared to 2016, with a corresponding 75% decrease in voyages to the region.

Table 23 Mortality rates, number of voyages, average voyage and discharge length, and number of cattle exported to South-East Europe from 2008 to 2017

Year	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days	Nil mortality voyages (No.)
2008	8	14,341	0.11	0.00 – 0.23	25.42	1.17	1
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

4.2.6.1 Port of loading

All cattle exported to South-East Europe in 2017 were from the southern ports of Fremantle and Adelaide (Table 24). Most cattle were loaded at Fremantle (89%) followed by Adelaide (11%). The mortality rate was highest for cattle exported from Fremantle (0.24%). There were no deaths in cattle exported from Adelaide to the region in 2017.

The voyages from each port were classified into various mortality categories as shown in Table 25. There were no voyages in the high category in 2017

Table 24 Mortality rates, number of voyages, average voyage and discharge length, and number of cattle exported from various ports to South-East Europe in 2017

Port	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days
Fremantle	2	18,551	0.24	0.19 – 0.32	22.75	2.94
Adelaide	1	2,340	0.00	n/a	31.35	3.90

Table 25 Number of voyages is nil, low, medium and high mortality categories for shipments from various ports to South-East Europe for 2017

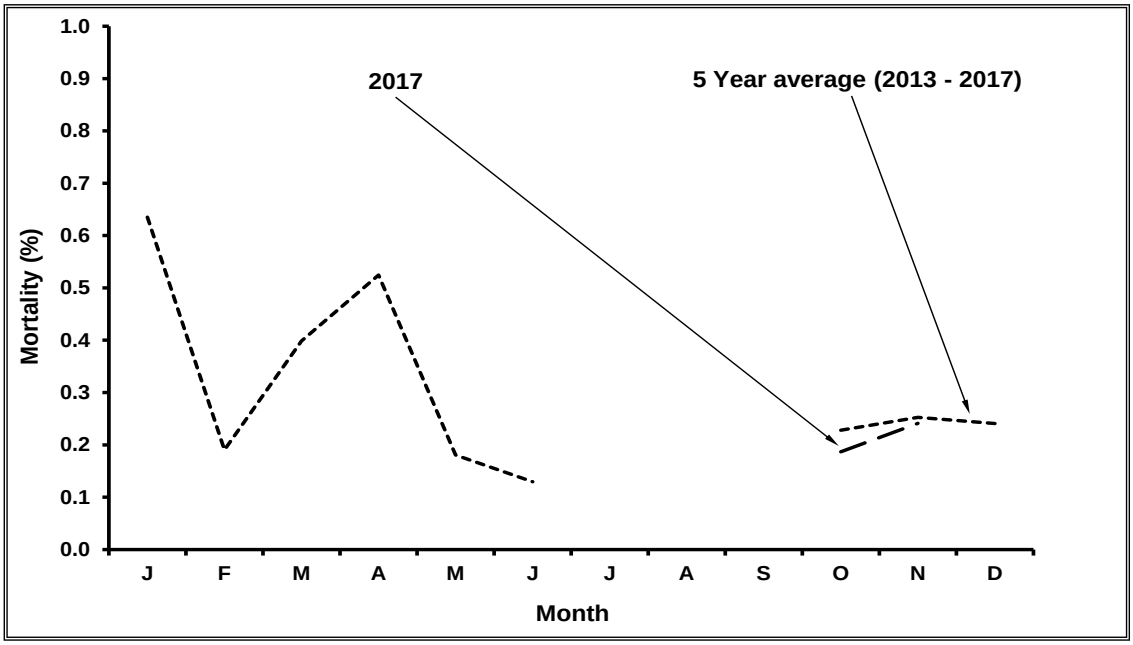
Port	Mortality rate				Total
	Nil 0.0%	Low >0.0 – 0.5%	Medium >0.5 – 1.0%	High >1.0%	
Fremantle	0	2	0	0	2
Adelaide	1	0	0	0	1
Total	1	2	0	0	3

4.2.6.2 Time of year

Monthly mortality rates (total mortality as a proportion of total loaded for each month) for voyages to South-East Europe in 2017 were 0.19% and 0.24% for October and November respectively (Figure 20).

For the two months on which voyages occurred during 2017, the monthly mortality profile was quite close to the 5-year average.

Figure 20 Monthly mortality rates of cattle on voyages from all ports to South-East Europe for 2017 and the 5-year average monthly rates for the period 2013 to 2017



4.2.6.3 Ship

Only one ship took cattle from Australia to the South-East Europe region during 2017. The voyages of this ship were classified into various mortality categories as shown in Table 26. There were no voyages in the high category during 2017.

Table 26 Number of voyages in nil, low, medium and high mortality categories for shipments to South-East Europe for 2017

	Mortality rate				
Ship (code)	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	Total
-	1	2	0	0	3
Total	1	2	0	0	3

4.2.6.4 Class of cattle

Mortality rates for each class of cattle exported to South-East Europe during 2017 are presented in Table 27. All exports to the region comprised bulls sent to Turkey.

In 2017 the highest mortality rates occurred in weaner bulls (0.23%)

Table 27 Mortality rate, number of voyages and number of cattle in the classes exported to South-East Europe in 2017

Class	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)
Bull weaners	3	17,893	0.23	0.00 – 0.41
Bull adults*	2	2,898	0.10	0.00 – 0.13

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

4.3 Goats

4.3.1 Exclusion of shipboard goat performance reporting

Historically, the live export of goats has mainly been to South-East Asia and the Middle East. The number of goats exported live by sea peaked at 113,651 in 2002.

While the air transport of goats has maintained a substantial presence since the 1990's, gradually this mode of carriage has expanded to take up almost the whole of live goat exports.

Currently the majority of goats exported live are transported by air to South-East Asia.

The seaborne export of goats has remained very low since 2008, making it difficult to present any meaningful analysis of trends.

There were no goats exported by sea from Australia in 2017, which constitutes a decade of negligible participation and justifies the deletion of shipboard goat performance reporting from this series of annual reports.

4.4 Air Transport

4.4.1 Air transport of live sheep

During 2017 air transport accounted for the 2.23% of live sheep exports (42,144 out of 1,887,412 sheep exported). The 42,144 sheep exported by air in 2017 represents a fall of 33% compared to 2016, but remains the third highest figure recorded over the 2008 to 2016 period.

Air transport of live sheep comprises a mix of breeding and slaughter types. In 2017, 82% of air-transported sheep were for slaughter.

4.4.1.1 Load point / destination

The loading points and destination countries for sheep transported by air from Australia in 2017 are shown in Table 29. The sheep were loaded at Perth, Adelaide, Sydney and Melbourne airports, each accounting for 47.5%, 42.5%, 6.1% and 3.9% of the number exported respectively.

The main importing countries for Australian sheep exported by air in 2017 were Malaysia (82.1%), Singapore (9.3%) and China (6.9%).

Table 29 Load point and destination country for sheep exported by air from Australia during 2017

Country	Adelaide	Melbourne	Perth	Sydney	Total
Malaysia	16,537		16,094	1,950	34,581
Singapore			3,924		3,924
China	1,380	1,520			2,900
Other		138		601	739
Total	17,917	1,658	20,018	2,551	42,144

SOURCE – Department of Agriculture and Water Resources
Other includes Argentina, Canada, Chile, Indonesia, Japan, New Zealand, Philippines, Sabah, Sarawak, United Kingdom and Uruguay.

4.4.1.2 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 2008 to 2017, all but 3 mortalities occurred in slaughter types and all but 10 mortalities occurred in the second half of the year. Mortalities occurred on 2.9% of flights (40 of 1,393).

Sheep exported by air experienced 0.04% mortalities during 2017 (Table 30). The expected level of mortality is 0.03%.

Table 30 Mortality rates and number of sheep exported by air to all destinations from 2008 to 2017

Year	Flights	Sheep (No.)	Total Mortalities (No.)	Mortality rate overall (%)
2008	88	11,667	0	0.00
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

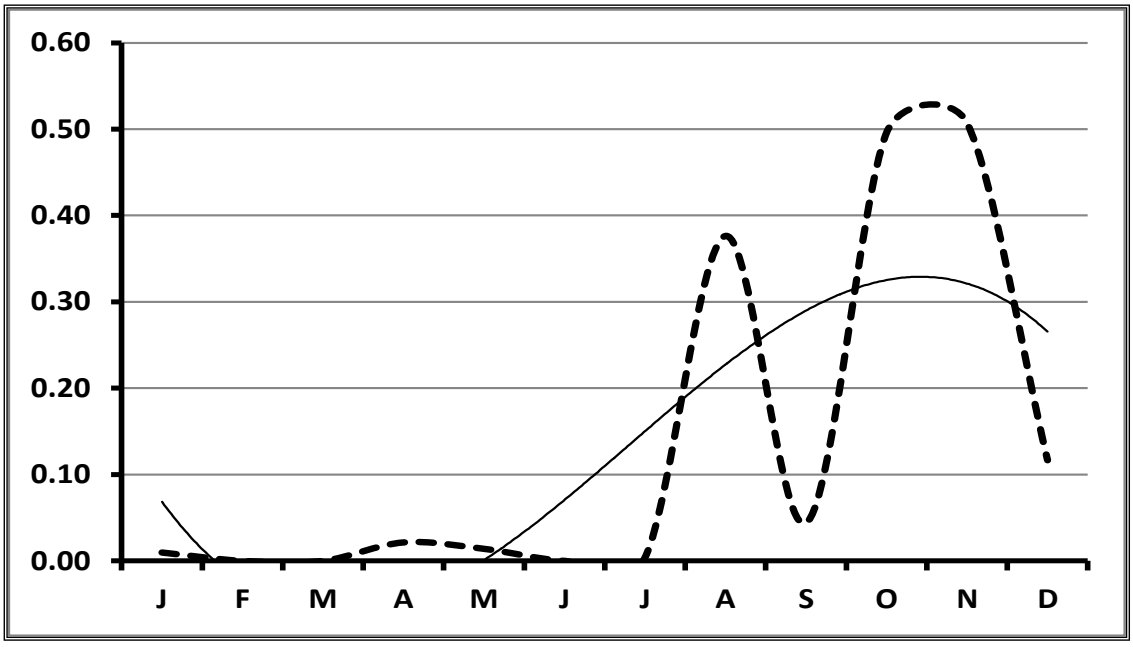
SOURCE – Department of Agriculture and Water Resources

Over the period 2008 to 2017, mortalities were significantly higher in the second half of the year ($P < 0.05$, Figure 23), with 5 of the ten years being significantly different and two having no mortalities. The remaining three years had a higher second-half mortality rate, but this was not significantly different.

All but 10 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 23 Monthly mortality (%) of sheep exported by air from Australia to all destinations since 2008



Mortalities were higher in slaughter sheep than breeder sheep ($P < 0.05$) with all but 3 mortalities occurring in slaughter types.

4.4.2 Air transport of live cattle

During 2017 air transport accounted for 1.07% of live cattle exports (9,261 out of 867,026 cattle exported).

The 9,261 cattle exported by air in 2017 represents a rise of 52.8% compared to 2016, and also represents a return to average export figures over the 2008 to 2016 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 returned to 0.4% in 2017.

4.4.2.1 Load point / destination

Load points and destinations for cattle transported by air from Australia in 2017 are shown in Table 31. Almost all cattle were loaded at Melbourne and Sydney airports, accounting for 67.1% and 32.5% respectively.

The main importing countries for cattle exported by air in 2017 were Japan (31.4%), Taiwan (22.8%) and Malaysia (19.5%).

Table 31 Load point and destination country for cattle exported by air from Australia during 2017

Country	Adelaide	Melbourne	Sydney	Total
Japan		2,060	849	2,909
Taiwan		2,113		2,113
Malaysia	36	75	1,693	1,804
Vietnam		957		957
Philippines		240	187	427
Indonesia		197	60	257
Thailand		207	4	211
China		199		199
Sabah			169	169
UAE		166		166
Bangladesh			48	48
Canada		4		4
Total	36	6,218	3,007	9,261

SOURCE – Department of Agriculture and Water Resources

4.4.2.2 Mortalities

The reportable level for air-transported cattle is 0.5% or 3 cattle, whichever is the greater number of animals. There was one high mortality flight in 2008 (11.38%) and two in 2013 (6.45% and 15.26%). If these flights were excluded, the mortality rates for those years 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 2017 (Table 32). The expected level of mortality is 0.00%. Mortalities occurred on 1.2% of flights over the 2008 to 2017 period (7 of 571).

Table 32 Mortality rates and number of cattle exported by air to all destinations from 2008 to 2017

Year	Flights	Cattle (No.)	Total Mortalities (No.)	Mortality rate overall (%)
2008	44	9,719	14	0.14
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

SOURCE – Department of Agriculture and Water Resources

4.4.3 Air transport of live goats

Air transport has played a significant role in the export of live goats for many years, and during 2017 accounted for all live goat exports.

The 12,245 goats exported by air in 2017 represents a significant fall of 77% compared to 2016, and is the lowest figure recorded over the 2008 to 2017 period.

Air transport of live goats comprises a mix of breeding and slaughter types, the majority of which are for slaughter. 2017 is unusual in that only 36.0% of air-transported goats were for slaughter, and this decreased number of slaughter goats represents the reduction in overall numbers for the year.

4.4.3.1 Load point / destination

The loading points and destination countries for goats transported by air from Australia in 2017 are shown in Table 33.

43.8% of these goats were loaded at Sydney airport, followed by Melbourne and Adelaide airports, accounting for 24.5% and 24.1% respectively.

The main importing countries in 2017 were Malaysia and Nepal, which took 54.9% and 26.3% respectively of all goats exported by air.

Table 33 Load point and destination country for goats exported by air from Australia during 2017

Country	Adelaide	Melbourne	Perth	Sydney	Total
Malaysia	2,016	31	894	3,784	6,725
Nepal		2,754		463	3,217
Philippines	410	128		448	986
Sabah	165			417	582
UAE	338	20			358
Sarawak				201	201
Vietnam		70			70
New Zealand	21	3	30		54
Indonesia				52	52
Total	2,950	3,006	924	5,365	12,245

SOURCE – Department of Agriculture and Water Resources

4.4.3.2 Mortalities

The reportable level for air-transported goats is 2.0% or 3 goats, whichever is the greater number of animals. For the years 2008 to 2017, 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 2008 to 2017 occurred in slaughter types except for one breeder goat in 2017. It should be noted that slaughter types comprise the vast majority of goats exported. Mortalities occurred on 2.7% of flights (35 out 1,286) over the decade.

Goats exported by air experienced 0.016% mortalities during 2017 (Table 34). The expected level of mortality is 0.01%.

Table 34 Mortality rates and number of goats exported by air to all destinations from 2008 to 2017

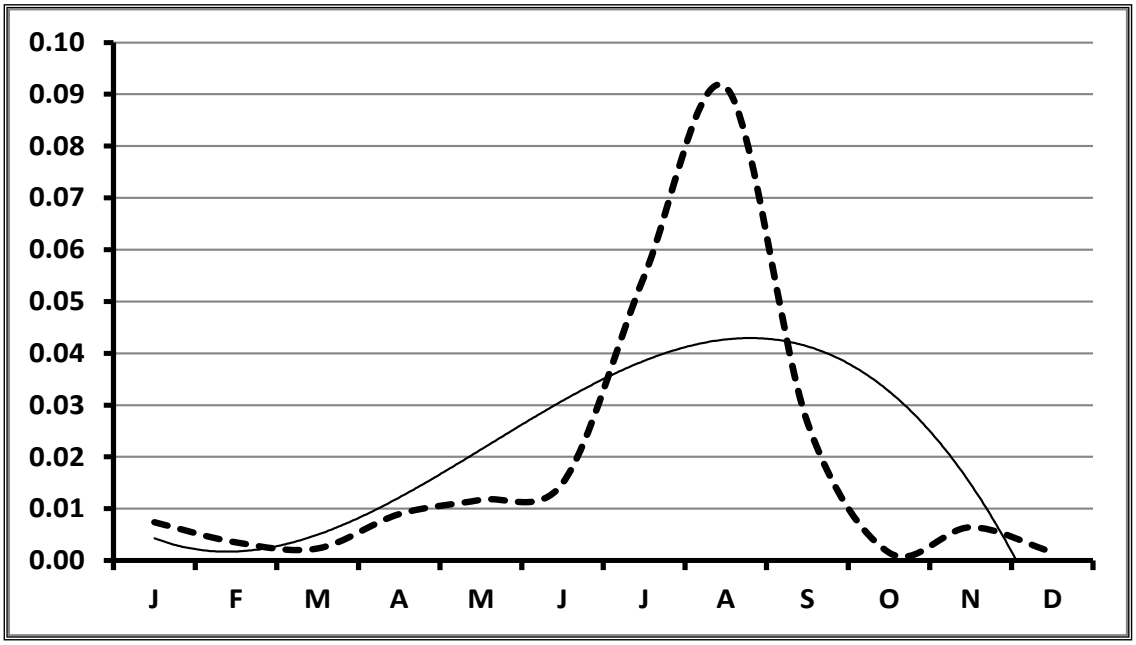
Year	Flights	Goats (No.)	Total Mortalities (No.)	Mortality rate overall (%)
2008	136	73,149	1	0.001
2009	199	81,571	0	0.000
2010	214	79,949	8	0.010
2011	99	51,487	1	0.002
2012	90	64,209	0	0.000
2013	111	74,484	9	0.012
2014	159	86,705	11	0.013
2015	129	86,925	74	0.085
2016	130	53,959	22	0.041
2017	54	12,245	2	0.016

SOURCE – Department of Agriculture and Water Resources

Over the period 2008 to 2017, mortalities were significantly higher in the second half of the year ($P < 0.05$, Figure 24), but this broke down to the years 2008 to 2012 and 2017 not being different, 2014 being significantly higher in the first half of the year, with the years 2013, 2015 and 2016 being significantly higher in the second.

Overall, 82% of mortalities occurred in the second half of the year over the period 2008 to 2016.

Figure 24 Monthly mortality (%) of goats exported by air from Australia to all destinations since 2008



With the exception of one breeder goat in 2017, all mortalities for goats transported by air from 2008 to 2017 occurred in slaughter types, which comprised 85.2% of goats exported.

5 Conclusion and recommendations

5.1 Sheep, cattle and goats

This report successfully summarises mortalities of sheep, cattle and goats exported live for the 2017 calendar year. Mortality trends were analysed and the overall mortalities for sheep and cattle exported by sea were shown to be 0.71% and 0.10%, while overall mortalities for sheep, cattle and goats exported by air were 0.04%, 0.00% and 0.02% respectively. No goats were exported by sea in 2017.

It is recommended that this project continue to be funded and to report on an annual basis in the future. 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 shipment phase, it is recommended that data held be turned to a broader range of analyses than those currently presented, as exemplified in the AMSA reportable limit study at section 4.1.7 (p24), and the observations on class numbers and mortality rates over time at sections 4.1.5.6 (p17) and 4.1.5.7 (p19).

In the past much of the analysis for South-East Asia was derived from a version of the ship Master's Report (a voyage report that must be provided to the Australian Government for all shipments of livestock) that presented details meeting the reporting requirements of AMSA and DA. Unfortunately updates to the ship Master's Report have meant that we have had to seek Industry data for certain details that are now unavailable in the current version of the Master's Report. In 2017, 99.18% of cattle exported to South-East Asia could be identified by class, and the Industry cooperation facilitating this outcome is both laudable and very much appreciated.

Analysis over time for sheep, cattle and goats exported by air was introduced for the first time in 2013. The continuation of this information in 2017 completes the coverage of live exports for these species, allowing comparison between the sea and air export industries and analysis of air exports over the past nine years.

In the current format of this report, 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.

It has long been the practise in this series of reports to include exceptional high-mortality voyages in summary data. Where more-detailed analyses for trends over time are concerned, it has been the practise to exclude exceptional voyages if they bias the results that would be expected under normal industry conditions. The distortion created by the inclusion of some exceptional events has the potential to render the presentation of related data meaningless, or, even worse, misleading. Such exclusions have been annotated in relevant text, tables and figures.

It is recommended that reference to Federal Department of Agriculture investigations continue to be appended to this series of reports where exceptional voyages receive specific mention in the text or in footnotes. This recommendation also applies to exceptional flights.

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

6 Appendices

6.1 Appendix 1 – Research update

6.1.1 Heat Management in the Middle East

Heat load in sheep exported from Australia to the Middle East continues to have the potential to be a health and welfare concern. The LEP has 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 of the research 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 of the research focused on monitoring environmental conditions and animal responses under different shade types and when different additional measures are applied to cool sheep. Cooling interventions were tested and there was success in demonstrating greater decreases in the rumen temperatures of sheep held under double shade, exposed to fans and where ground wetting was applied (as compared to the control sheep that were kept under single shade structures).

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.

Based on environmental data gathered at several Middle East feedlots, there was a need identified for further evaluation of different shade structures and interventions in different climatic conditions.

This research will continue over 2017–18.

6.1.2 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.

6.1.3 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 is expected to be completed late in 2018.

6.1.4 Backgrounding and feedlotting strategies to reduce inanition in sheep

Inappetence has long been recognized as a problem for sheep in the live export process. Its impact is twofold - as a cause of death from inanition and due to its association with the development of Salmonellosis.

While most inappetent sheep in assembly feedlots will start feeding within a couple of days, it is considered to be an indicator of increased risk of prolonged inappetence during the voyage, with elevated likelihood of inanition and death.

In 2010, a project to explore strategies to reduce the incidence of inanition in sheep was conducted. Sheep were monitored at a pre-embarkation feedlot in Western Australia using RFID tags and specially-designed tracking antennae to determine the time spent at feed and water troughs.

On average, it took five days in the feedlot for more than 95% of sheep to be spending an adequate time at the feed trough. The overall mortality of the monitored sheep was 0.85% with 61.4% of mortalities being due to Salmonella or inanition.

The project also trialled a number of feeding strategies to determine if they sped up the process of feed transition. The strategies tested in sheds were adding oats over pellets and the provision of chaff. Additionally, the project also compared sheep in sheds with pellets to sheep in a paddock with pellets and in a paddock with hay and pellets.

The results of the trials found that housing sheep outside the raised sheds, with access to hay and/or pellets, for a day before entering the sheds did not hasten feed acceptance or increase the number spending an acceptable period at the feed troughs. Provision of oats on top of the pellets did not increase the number of visits or time at the troughs compared to those supplied with pellets only. The addition of chaff did result in more visits to feed troughs than when pellets alone were available. In general, the feeding strategies tested at the feedlot did not appear to increase acceptance and consumption of the pellets.

The report was completed in 2017 and outlines pre-embarkation treatment of sheep to minimise the incidence of inanition and Salmonellosis. The published report can be found at http://www.livecorp.com.au/LC/files/15/15bbe1ed-7336-4792-9c85-ecf4dbd05914.pdf

These guidelines were also produced as a fact sheet, “W.LIV.0412 Best practice guidelines for pre-embarkation treatment of sheep to minimise the incidence of inanition/salmonella”, which can be obtained by request from MLA.

6.1.5 Development and assessment of animal welfare indicators – Quantifying welfare improvements in the live export industry

The effective and transparent monitoring and assessment of animal welfare throughout the livestock export process is essential to support good animal health and welfare outcomes, continuous practice improvements and a sustainable future for the industry. However, animal welfare is complex and multifaceted and it is therefore critical that valid, reliable and practical indicators are identified to underpin monitoring and assessment.

The aim of the initial phase of this research was to identify internationally accepted and current indicators of animal welfare for cattle, sheep and goats that could be used at each point along the livestock export supply chain.

To identify these indicators, the project conducted a literature review of standards and regulations, as well as a stakeholder survey of over 900 people from the general public, animal welfare groups and the industry.

Based on this work, the project has identified 54 potential indicators. Twenty of these are currently monitored by industry and the additional relevant indicators are under assessment for their validity and reliability. The monitoring / assessment of these indicators is in the process of being piloted throughout the supply chain and will ultimately result in a method to benchmark performance and identify areas of improvement.

A smartphone app has also been developed to assist in the capture of relevant data and is being trialled on a number of shipments. Modifications and refinements are ongoing with this phase of the project due for completion in 2021.

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

6.1.6 LGAP implementation background and update

In 2012, the Livestock Export Program initiated research to investigate the potential role of quality assurance (QA) within the livestock export industry to support best practice, achieve ESCAS compliance and promote continuous improvement in animal welfare, control and traceability.

Based on this scoping study, a further project was commissioned which led to the development of a fully implementable conformity assessment and certification program. The program – known as the Livestock Global Assurance Program (LGAP) – was completed in 2016.

Following the completion of the research, ALEC established the LGAP Implementation Steering Committee (LISC) composed of LiveCorp, MLA, exporters, ALEC, Cattle Council of Australia, Sheep Producers Australia (formerly Sheepmeat Council of Australia), the Goat Industry Council of Australia and the Australian Department of Agriculture and Water Resources.

LISC was formed to analyse and report to ALEC on the complex implementation challenges and pathways for LGAP. This was done late in 2017, and industry resolved to move to the implementation stage in April 2018.

A summary to the LGAP final report can be viewed at:
http://www.livecorp.com.au/LC/files/26/26d3c4d5-fd37-4c3d-906a-c2857e9c434b.pdf

6.1.7 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 toward the end of 2018.

6.1.8 Heat Stress Risk Assessment Model 5.0

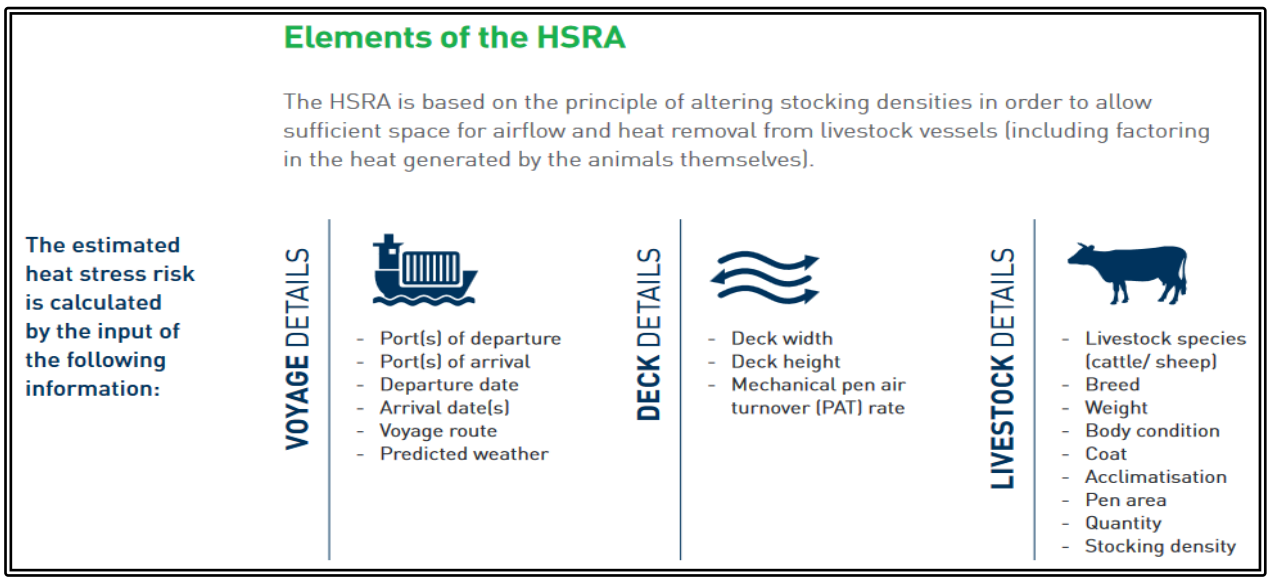
In 2000, research was undertaken to develop a scientific method to determine the risk of heat stress for export voyages to the Middle East. The research focused on ventilation and on-board studies to calculate appropriate stocking densities for various classes of livestock. This resulted in an engineer-developed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

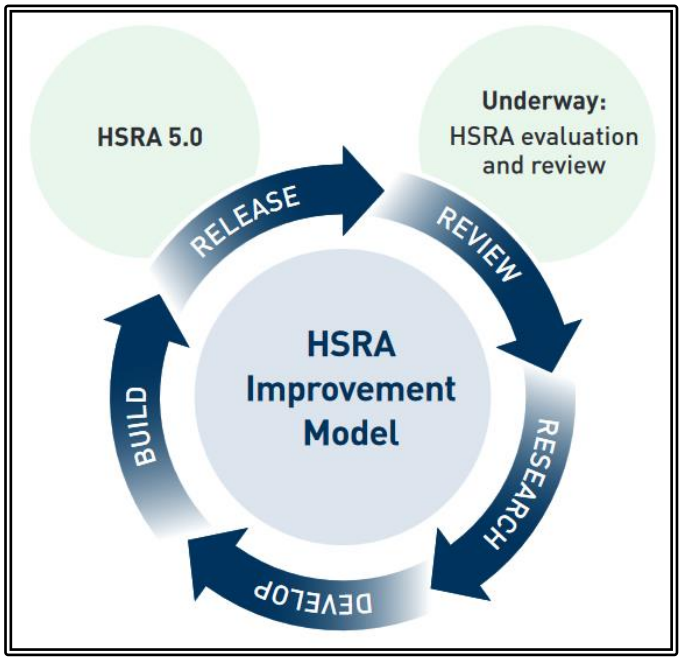


While it is impossible to single out a sole cause, the impact of HSRA since its implementation has been a meaningful reduction in livestock mortality rates during export by sea. The introduction of the Australian Standards for the Export of Livestock (ASEL), improvements in vessels and changes to the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



6.1.9 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.

6.1.9 Identifying opportunities for continued improvements to the on-board live export feed ration

The feed provided to cattle, buffalo, sheep and goats during livestock export is a key element in ensuring their ongoing health and welfare. ASEL sets out the minimum regulatory requirements for ration volume, pellet specifications and chaff provision.

In 2011, the MLA Livestock Export Program engaged a livestock nutritionist and production consultant to perform a review of fodder quality and quantity in the livestock export trade. This project provided recommendations for ASEL and industry best practice.

A further research project is now underway to review the findings of the 2011 report and to confirm the ongoing validity of its recommendations, 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 including exporters, nutritionists, pellet manufacturers, shipboard Australian Accredited Veterinarians and stock people.

6.2 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%
- 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 DAWR 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. 2017 voyage carrying sheep loaded at Fremantle (see sections 4.1.2, p7; 4.1.5, p8; 4.1.5.4, p14; 4.1.5.8, p21):

A consignment of 63,804 sheep and 50 cattle was exported by sea from Fremantle on 1 August 2017 to Qatar, Kuwait and United Arab Emirates (UAE). Unloading was completed on 17, 19 and 24 August 2017 respectively.

A mortality rate of 3.76 per cent (2,400 sheep out of 63,804) was recorded for this voyage in the Master's Report Carriage of Livestock as required by Marine Orders part 43 under subsection 425 (1AA) of the Navigation Act 1912. This exceeds the reportable mortality level of 2 per cent as prescribed by the Australian Standards for the Export of Livestock (ASEL). The majority of the mortalities were caused by heat stress. No cattle mortalities were recorded on the voyage.

The cause of this reportable mortality was heat stress. The peak in mortalities corresponded with extreme heat and humidity experienced in Qatar. The humidity and temperatures experienced from day 5 to day 13 and associated deck conditions, prior to arrival in Qatar is likely to have contributed to the severity of the mortality event. The highest mortality rates were in the 'A' class wethers (69.43 kg), which were the fourth most numerous class of the sheep on board the ship making up 7.51 per cent of the consignment. There was no significant correlation of mortalities with deck position.

http://www.agriculture.gov.au/export/controlled-goods/live-animals/livestock/regulatory-framework/compliance-investigations/investigations-mortalities/sheep-qatar-kuwait-uae-report-69

2. **2013 voyage carrying sheep loaded at two ports (see sections 4.1.5, p8; 4.1.5.2, p11; 4.1.5.4, pp13, 14):**

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

3. **2014 voyage carrying sheep and cattle loaded at Fremantle (see sections 4.1.5, p8; 4.2.3.2, p31):**

During this voyage, 165 of the 6,000 cattle loaded (2.75%) and 1,654 of the 42,550 sheep loaded (3.89%) were recorded as mortalities. This exceeds the reportable mortality level of one per cent for cattle on voyages of 10 days or greater duration and two percent for sheep, as prescribed by the Australian Standards for the Export of Livestock (ASEL).

The ship experienced mechanical failure, which slowed its progress and significantly extended the length of the voyage. Additional fodder of a different composition was loaded en route to ensure sufficient fodder was available for the remainder of the journey.

The investigation determined the cause of the majority of mortalities was ruminal acidosis as the result of a sudden change in fodder. Ruminal acidosis (also referred to as rumen lactic acidosis, grain overload, grain poisoning and acute indigestion) develops in sheep and cattle that have ingested large amounts of unaccustomed feeds rich in ruminally fermentable carbohydrates (RAGFAR 2007).

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

4. **2017 voyage carrying cattle loaded at Darwin (see section 4.2.2, p29; 4.2.4, p33; 4.2.4.1, p33; 4.2.4.2, p34; 4.2.4.3, p35, 36; 4.2.4.4, p36):**

On 27 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 on 3 and 4 May 2017 respectively.

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#conclusions

5. 2009 flight carrying sheep loaded at Perth (see section 4.4.1.2, p44):

There were 138 mortalities of the 1873 sheep loaded 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 DAWR

6. 2013 flight carrying sheep loaded at Perth (see section 4.4.1.2, p44):

On 7 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

7. 2014 flight carrying sheep loaded at Perth (see section 4.4.1.2, p44)

On 2 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

8. 2015 flight carrying sheep loaded at Sydney (see section 4.4.1.2, page 44):

On 8 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#summary

9. 2008 flight carrying cattle loaded at Melbourne (see section 4.4.2.2, page 46):

There were 14 mortalities of the 123 cattle loaded which equates to a mortality rate of 11.3 per cent. There were no mortalities for the sheep and goats that were also loaded on this aircraft.

The factors contributing to the cattle mortalities on board the aircraft were suffocation due to inadequate ventilation in the rear hold of the lower cargo compartment of the aircraft where the cattle were held.

The ventilation appears to have been adequate in the leg of the flight between Melbourne and Brisbane.

Inadequate ventilation in the lower cargo hold is infrequent and unpredictable but when it occurs may cause significant number of mortalities.

This report is no longer presented: it can be obtained by request from DAWR.

10. 2013 flight carrying cattle loaded at Melbourne (see section 4.4.2.2, page 46):

On 27 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

11. 2013 flight carrying cattle loaded at Melbourne (see section 4.4.2.2, page 46):

On 21 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

12. 2015 flight carrying goats loaded at Sydney (see section 4.4.3.2, page 48):

On 8 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#summary

6.3 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, CJC (2013) Microclimatic conditions and their effects on sheep behaviour during a live export shipment from Australia to the Middle East J Anim Sci 91: 4406–4416

Phillips, C (2016) The welfare risks and impacts of heat stress on sheep shipped from Australia to the Middle East Vet J 218: 78-85

The Veterinary Handbook for Cattle, Sheep and Goats Application (2017) 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

The LiveCorp/MLA Livestock Export Program has developed a suite of Livestock Export user guides and manuals including:

“Management of unfit-to-load livestock. Guidelines for persons in charge and veterinarians involved in pre-embarkation live export inspections of cattle and sheep” (available for download at: http://www.livecorp.com.au/LC/files/43/43727f94-7535-41ba-a6d7-8d68a97f1708.pdf)

“Is it fit to load in the Middle East? A guide for the selection of animals fit to transport in the Middle East” (available for download at: http://www.livecorp.com.au/LC/files/a3/a3c32633-97c8-4236-97f6-2eb3504a494a.pdf)

“Is it fit to export? A guide to the supply of livestock for the Australian livestock export industry” (available for download at: http://www.livecorp.com.au/LC/files/12/129d63e8-a979-48b2-abe5-c9c8d30e4871.pdf)

6.4 Appendix 4 - Acknowledgements

The cooperation of ships’ officers in recording details of daily mortalities is gratefully acknowledged.

The cooperation of Exporters, Shipping Agencies and Port Authorities for additional help in collating data is also gratefully acknowledged.

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