



Department of
Agriculture and Food



final report

Project code: **W.LIV.0288**
Prepared by: **Department of Agriculture and
Food, Western Australia
GJ Norman**
Date published: November 2015
ISBN: 9781741919721

PUBLISHED BY
Meat & Livestock Australia Limited
Locked Bag 991
NORTH SYDNEY NSW 2059

National livestock export industry sheep, cattle and goat transport performance report 2014

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government to support the research and development detailed in this publication.

This publication is published by Meat & Livestock Australia Limited ABN 39 081 678 364 (MLA). Care is taken to ensure the accuracy of the information contained in this publication. However MLA cannot accept responsibility for the accuracy or completeness of the information or opinions contained in the publication. You should make your own enquiries before making decisions concerning your interests. Reproduction in whole or in part of this publication is prohibited without prior written consent of MLA.

Executive summary

The objective of this project was to summarise the performance of the livestock export industry in terms of mortality levels of sheep, cattle and goats exported by sea and air from Australia during 2014.

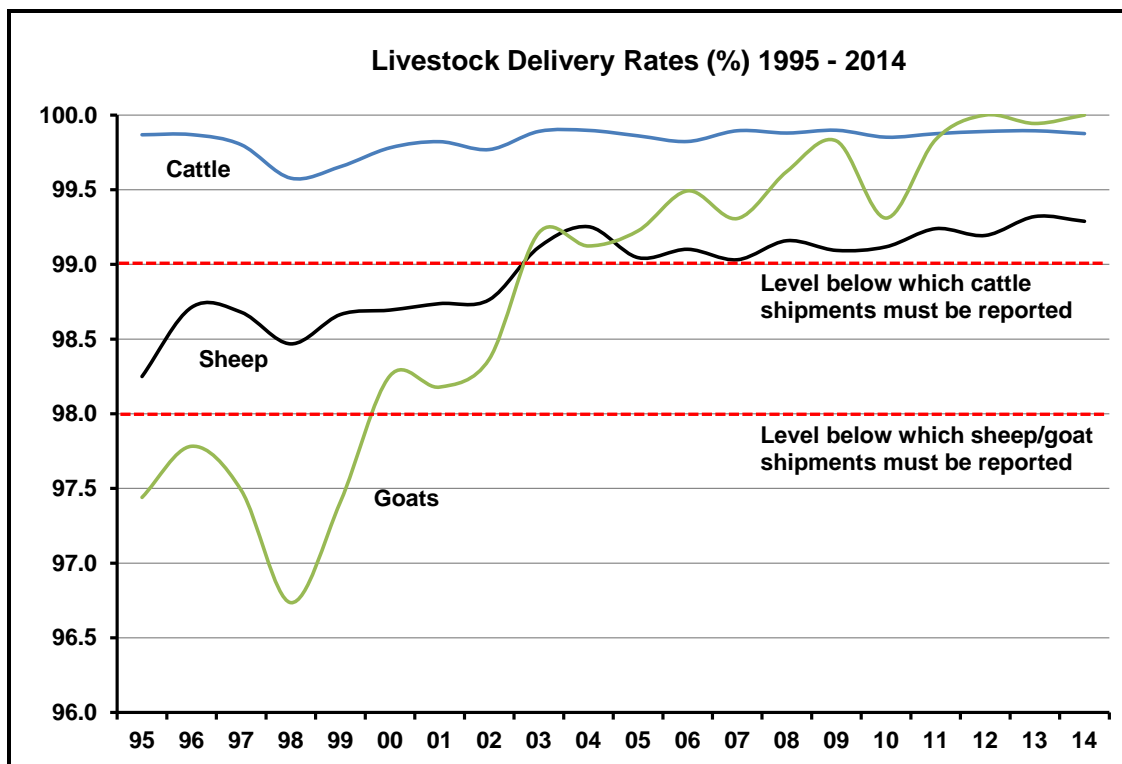
Industry stakeholders, government, animal welfare groups and the general public have a keen interest in monitoring performance in different sectors of the livestock export trade. This summary report provides the only comprehensive breakdown by ship, species, time of year, load ports and major destinations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

The overall mortality rate for sheep during sea transport to all destinations during 2014 was 0.71% (15,899 mortalities in 2.24 million sheep exported). This was slightly higher than the 0.68% mortality rate for 2013. The main port of loading was Fremantle, which exported 1.91 million sheep with a mortality rate of 0.70% (13,360 mortalities), followed by Adelaide exporting 0.27 million sheep with a mortality rate of 0.78% (2,121 mortalities) and Portland which exported 0.06 million sheep with a mortality rate of 0.72% (418 mortalities).

The overall mortality rate for cattle exported from Australia in 2014 was 0.12% (1,592 mortalities in 1.28 million cattle exported). This was higher than the mortality rate observed in 2013. The overall mortality rate on voyages to the Middle East/North Africa was 0.36% (384 mortalities in 0.11 million cattle exported), twice the record low of 0.17% experienced in 2013. The overall mortality rate on voyages to South-East Asia was 0.08% (774 mortalities in 1.00 million cattle exported), equalling that which was observed in 2013. The highest overall mortality rate on a regional basis was 0.47% for exports to South-East Europe (254 mortalities in 0.05 million cattle exported), while the lowest overall mortality rate was 0.07% for the three voyages representing Miscellaneous Destinations.

There were no mortalities among the 154 goats exported by sea from Australia in 2014. All goats exported by sea during 2014 went to South-East Asia.

The graph below shows percentages of sheep, cattle and goats successfully delivered by sea since 1995.



For completeness, summary information regarding the 0.04 million sheep, 9,458 cattle and 0.09 million goats exported by air during 2014 has been included in this report. These experienced overall mortality rates of 0.45% (177 mortalities), 0.00% and 0.01% (11 mortalities) respectively.

Contents

1	BACKGROUND	4
2	PROJECT OBJECTIVES	4
3	METHODOLOGY	4
4	RESULTS AND DISCUSSION	6
4.1	Sheep	6
4.1.1	Performance trend	6
4.1.2	Overview	7
4.1.3	Middle East/North Africa	8
4.2	Cattle	22
4.2.1	Performance trend	22
4.2.2	Overview	23
4.2.3	Middle East/North Africa	24
4.2.4	South-East Asia	27
4.2.5	North-East Asia	31
4.2.6	South-East Europe	34
4.3	Goats	37
4.3.1	Performance trend	37
4.3.2	Overview	38
4.3.3	South-East Asia	38
4.4	Air Transport	39
4.4.1	Air transport of live sheep	39
4.4.2	Air transport of live cattle	40
4.4.3	Air transport of live goats	41
5	CONCLUSION AND RECOMMENDATIONS	42
5.1	Sheep, cattle and goats	42
6	APPENDICES	43
6.1	Appendix 1 – Research update	43
6.1.1	Investigating morbidity and mortality in cattle exported to the Middle East	43
6.1.2	Monitoring and evaluation of the HotStuff model	43
6.1.3	Contingency Planning review	44
6.1.4	Heat load in sheep exported to Middle Eastern feedlots	44
6.1.5	Pinkeye on long haul cattle voyages	45
6.1.6	Further improving the environment on board livestock vessels	45
6.2	Appendix 2 – Federal Department of Agriculture high-mortality investigations	46
6.3	Appendix 3 - Published studies	51
6.4	Appendix 4 - Acknowledgements	52

1 Background

The live export of sheep, cattle and goats makes a significant contribution to the Australian economy, valued at around \$1,500 million in 2014, and provides employment in 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 to monitor mortality trends in these sectors. The report also lists relevant published studies and current research related to the industry.

The Australian Government Department of Agriculture (DA) also presents mortality data, though in a different format, under "Reports to Parliament" at their website:

<http://www.daff.gov.au/biosecurity/export/live-animals/livestock/regulatory-framework/compliance-investigations/investigations-mortalities>.

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 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 2014 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, from other tailored shipboard records and "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.

The shipboard part of the export process is divided into three distinct phases based on dates and times: load; voyage and discharge. The date and time for the end of loading marks the beginning of the voyage phase. The date and time for the beginning of discharge at the first port of discharge marks the end of the voyage phase and the beginning of the discharge phase. If a ship docks at more than one discharge port, all the mortalities after the beginning of discharge at the first port are included in the discharge phase.

Occasionally inordinate periods of time occur between discharge ports or discharge regions. In such cases, where possible, the voyage is split into separate "voyages" to better reflect the actual conditions that occurred for the stock consigned to those destinations.

Often ships load at multiple ports during one passage from Australia (split-load voyages). Where analysis involves split-load voyages, the consignments of livestock from each load port have been considered as separate "voyages".

This current report is for all voyages which departed Australia during the calendar year 2014. Information on the number of sheep exported to various destination countries from ports in Australia was sourced from the Australian Bureau of Statistics. Information for livestock exported by air was provided by DA.

National livestock export industry sheep, cattle and goat transport performance report 2014

In recent years the significant rise in livestock exports to Turkey and the Black Sea caused an imbalance in the Miscellaneous 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 are 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 been included in relevant summary figures in this series of publications. It should be noted that in some instances 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 report, references are made to Federal Department of Agriculture investigations into exceptional voyages and flights mentioned in the report text. It should be noted that these Department of Agriculture reports have been available to the public for a number of years and that parties with an interest in the live export industry have been aware of this availability.

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

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

Summary information was produced using Statistix 10.0 (Analytical software 2000 Tallahassee, Florida USA).

4 Results and discussion

4.1 Sheep

4.1.1 Performance trend

Figures 1 and 2 show the number of sheep exported and the number 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 1.94 million sheep exported in 2013 was the lowest number exported since recording began in 1985. The number of sheep exported annually since 2005 has varied between 4.19 and 1.94 million, and the annual mortality has varied between 0.97 and 0.68%. The trend for numbers of sheep exported and annual mortality has been downward.

Figure 1 Number of sheep exported by sea from Australia to all destinations since 2005

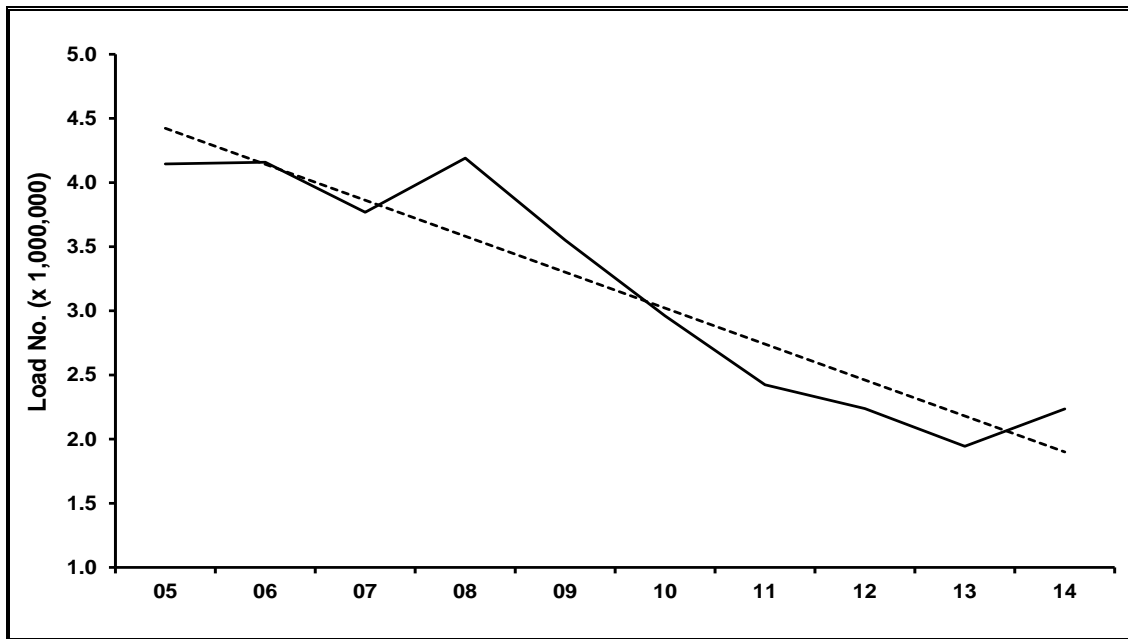
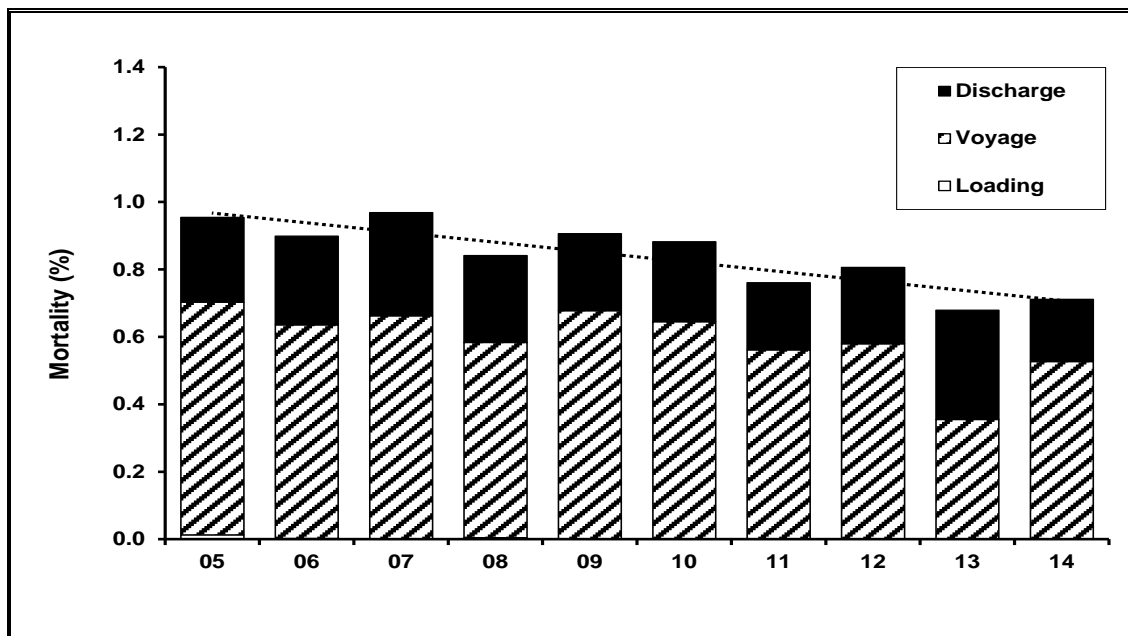


Figure 2 Annual mortality of sheep exported by sea from Australia to all destinations since 2005



National livestock export industry sheep, cattle and goat transport performance report 2014

4.1.2 Overview

All sheep exported live by sea from Australia in 2014 were loaded either at Fremantle (85.3%), Adelaide (12.1%), and Portland (2.6%). Overall average voyage and discharge lengths were 16.54 and 5.38 days respectively (Table 1).

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 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 section of this report for a more detailed explanation of the voyage phases and instances of split-loading and split-discharging.

There were 9 voyages to the Middle East/North Africa in 2014 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 2014. 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 42 "voyages" of sheep to the Middle East/North Africa during 2014. This involved 33 ship journeys, nine of which were split-loaded.

2,227,868 sheep were exported to the Middle East/North Africa (99.7% of all sheep exported) and the average voyage length (voyage to first discharge port) for exports to this region was 17.20 days with 5.92 days for discharge (most voyages had multiple discharge ports). The overall mortality for these sheep was 0.71%.

Malaysia was the destination country for the 7,644 sheep (0.3% of all sheep exported) that were exported to South-East Asia on 5 voyages. The overall mortality rate for these sheep was 1.24% with an average voyage length of 10.97 days and an additional 0.88 days for discharge. These sheep will not be examined further in this report

Table 1 Mortality rates, number of voyages, voyage and discharge days, and number of sheep exported for voyages to major destination regions during 2014

Parameter	ME/N Africa	SE Asia	Total
Voyages (No.)	42	5	47
Sheep (No.)	2,227,868	7,644	2,235,512
Mortality rate overall (%)	0.71	1.24	0.71
Mortality rate range (%)	0.22 – 3.89	0.00 – 1.74	0.00 – 3.89
Voyage days (Ave.)	17.20	10.97	16.54
Discharge days (Ave.)	5.92	0.88	5.38

National livestock export industry sheep, cattle and goat transport performance report 2014

Destination Country

Countries that imported Australian sheep in 2014 are shown in Table 2. The main importing countries were Kuwait (32% of all Australian sheep exports), followed by Qatar (23%) and Jordan (15%). Bahrain and Egypt began imports again in 2014, taking 12% and 3% of our sheep respectively.

Overall export numbers rose by 14% compared to 2013. Exports to all destinations rose except for Kuwait and Qatar, which fell by 18% and 4% respectively. Exports to Israel rose by 43% while those to UAE and Jordan both rose by 15%.

Table 2 Destination country for sheep exported from Australia during 2014

Country	Fremantle	Adelaide	Portland	Other	Total
Bahrain	221,984	42,000	10,881		274,865
Egypt	79,000				79,000
Israel	95,125				95,125
Jordan	329,543	7,052			336,595
Kuwait	639,740	69,279	35,652		744,671
Oman	53,646	4,000	4,000		61,646
Qatar	393,266	139,984	6,000		539,250
UAE	113,298	3,500	1,207	38	118,005
S.E. Asia	8,150			35,321	43,471
Other				5,789	5,789
Total	1,933,752	265,815	57,740	41,148	2,298,455

SOURCE – Australian Bureau of Statistics, March 2014

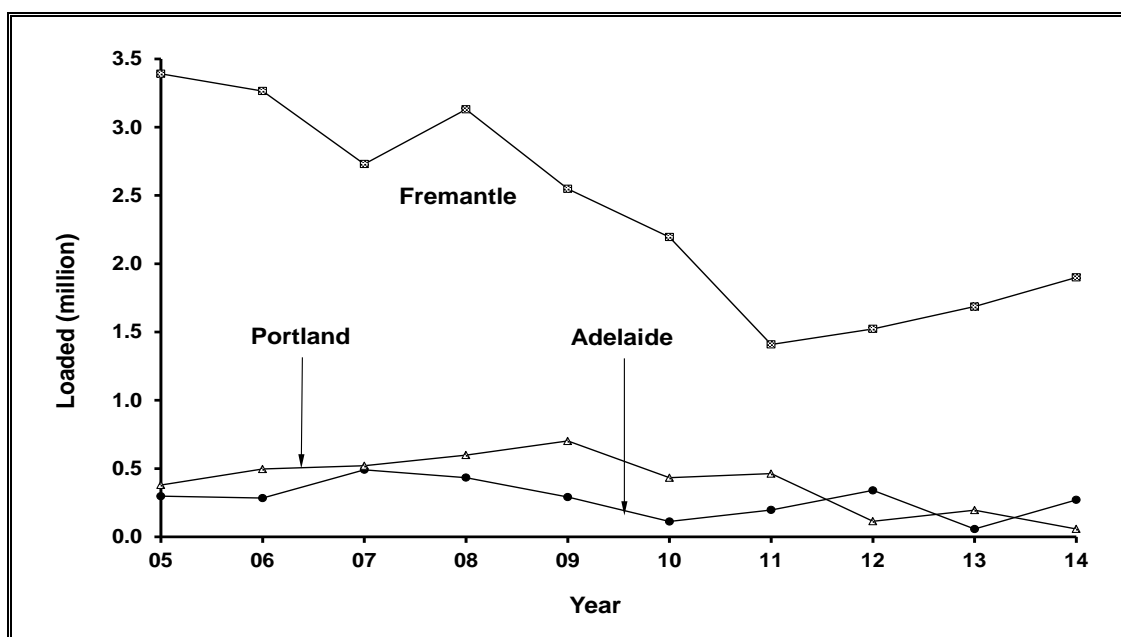
Note: As ABS figures include exports by air; figures in Table 2 may not reflect those in Table 3.

4.1.3 Middle East/North Africa

4.1.3.1 Port of loading

Most sheep exported by sea from Australia to the Middle East/North Africa during 2014 were loaded at Fremantle (85.3% of all sheep, Figure 3) with smaller numbers loaded at Adelaide (12.1%), and Portland (2.6%).

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 2005



National livestock export industry sheep, cattle and goat transport performance report 2014

The number and class of sheep exported by sea to the Middle East/North Africa from Fremantle, Adelaide and Portland during 2014 are shown in Table 3. Overall numbers exported to the region in 2014 rose by 1.0% compared to 2013, which saw the lowest numbers exported since recording began in 1985. Exports from Fremantle and Adelaide rose by 12.7% and 370.7% respectively, while exports from Portland fell by 70.5%.

The main changes in 2014 compared to 2013 were increases in exports of adult wethers (23%) and wether hoggets (79%). The increase in adult wethers comprised rises for Adelaide and Fremantle of 404% and 17% respectively, while Portland experienced a 70% decrease.

Other than a small rise in wether lambs and a single shipment of ewe hoggets, all other class numbers fell during 2014.

Table 3 The numbers and classes of sheep exported by sea to the Middle East/North Africa from Fremantle, Adelaide and Portland during 2014

Livestock		Fremantle	Adelaide	Portland	Total
Wethers	adults	1,024,855	249,854	42,341	1,317,050
	hoggets	165,793	16,936		182,729
	lambs	497,474			497,474
Rams	adults	33,072	3,386	1,799	38,257
	hoggets	32,053	307		32,360
	lambs	60,507		13,486	73,993
Ewes	adults	68,525			68,525
	hoggets	367			367
	lambs	16,999		114	17,113
Total	sheep	1,899,645	270,483	57,740	2,227,868

National livestock export industry sheep, cattle and goat transport performance report 2014

4.1.3.2 Mortality rates

The total mortality rate for all sheep exported to all destination regions during 2014 was 0.71% (Table 4), an increase from the record low of 0.68% observed in 2013.

Fremantle voyage and overall mortality rates rose by 47% and 34 % respectively compared to 2013 levels, while Portland voyage, discharge and overall mortality rates rose by 17%, 191% and 53% respectively (Table 4 and Figure 4). These rises were offset by the fall in Adelaide discharge and overall mortalities when compared to the 2013 figures. It should be noted that the 2013 Adelaide figures included one exceptional high-mortality voyage.

One high-mortality voyage each for 2013 and 2014 will not be included in some analyses as the mortality was incurred under exceptional circumstances, and would distort the study of long term trends. Where this exclusion applies, text, tables and figures are appropriately annotated. Federal Department of Agriculture investigation summaries regarding these voyages are referred to in 6.2 Appendix 2.

If one high mortality voyage mentioned above was not included, the overall mortality rate for all sheep in 2014 would have been a further record low of 0.65%.

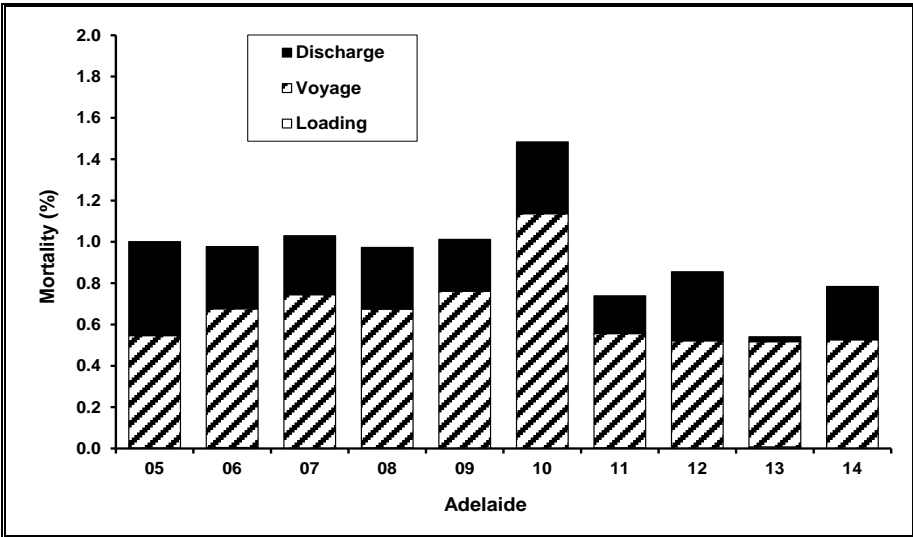
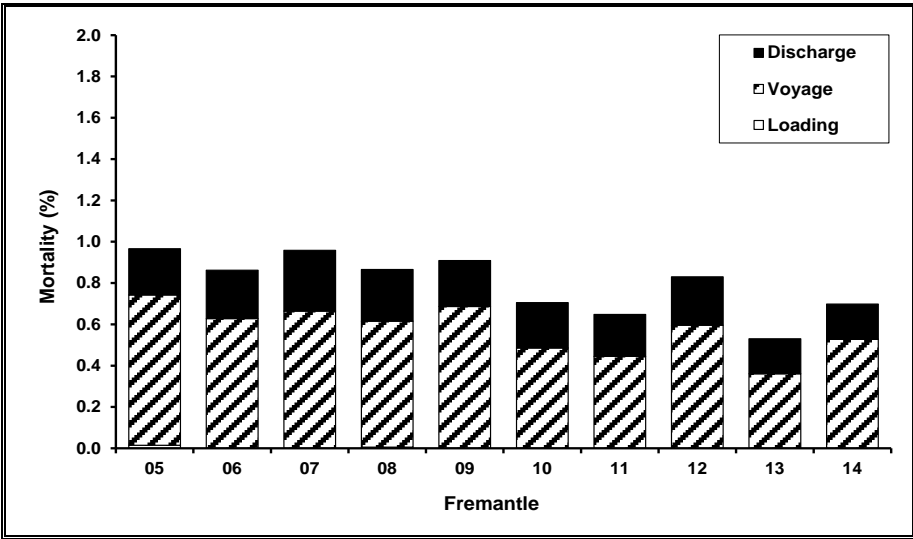
Table 4 Annual shipboard mortality rates for all sheep exported from Fremantle, Adelaide and Portland to the Middle East/North Africa, and Total mortality rate for all sheep exported to all destinations

	Year	Mortality rate (%)			
		Load	Voyage	Discharge	Total
Fremantle*	2010	0.00	0.48	0.22	0.71
	2011	0.00	0.44	0.20	0.65
	2012	0.00	0.60	0.23	0.83
	2013	0.00	0.36	0.17	0.53
	2014	0.00	0.53	0.17	0.71
Adelaide*	2010	0.00	1.14	0.35	1.48
	2011	0.00	0.55	0.18	0.74
	2012	0.00	0.52	0.33	0.86
	2013	0.00	0.17	5.61	5.79
	2013	0.00	0.53	0.26	0.78
Portland*	2010	0.00	1.17	0.32	1.49
	2011	0.00	0.83	0.21	1.05
	2012	0.00	0.31	0.12	0.42
	2013	0.00	0.35	0.11	0.47
	2014	0.00	0.41	0.32	0.72
Total**	2010	0.00	0.64	0.24	0.88
	2011	0.00	0.55	0.20	0.75
	2012	0.00	0.58	0.23	0.81
	2013	0.00	0.35	0.32	0.68
	2014	0.00	0.53	0.18	0.71

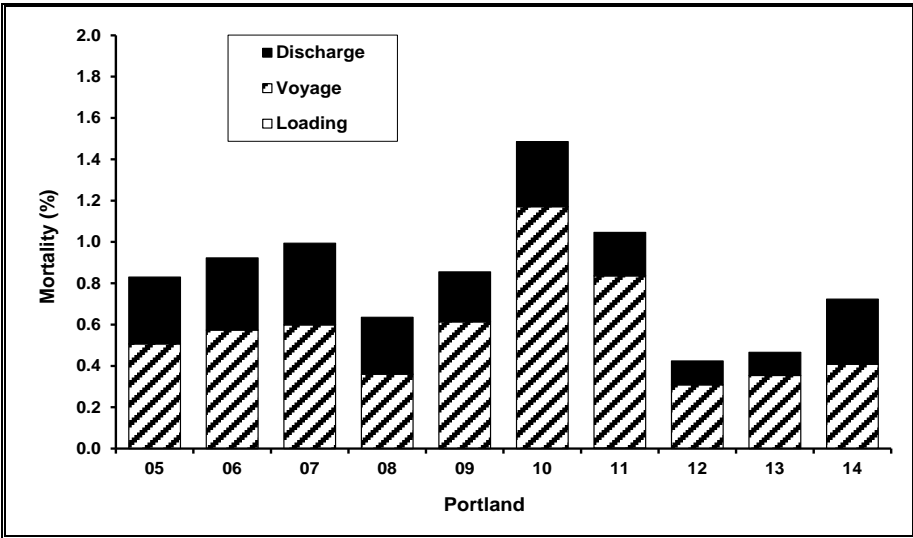
* Middle East/North Africa only

** 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 2005 to 2014.



Note – one exceptional voyage excluded for 2013



National livestock export industry sheep, cattle and goat transport performance report 2014

4.1.3.3 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 for 2013 were in adult and hogget rams, and ewe lambs (1.46%, 1.05% and 1.02% 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 4.1.3.7 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 2014

Class of sheep		Fremantle	Adelaide	Portland	Total
Wethers	adult	0.60	0.76	0.78	0.64
	hogget	0.38	1.03	n/a	0.44
	lamb	0.93	n/a	n/a	0.93
Rams	adult	1.50	1.42	0.89	1.46
	hogget	1.05	1.95	n/a	1.05
	lamb	0.87	n/a	0.54	0.81
Ewes	adult	0.46	n/a	n/a	0.46
	hogget	0.27	n/a	n/a	0.27
	lamb	1.03	n/a	0.00	1.02

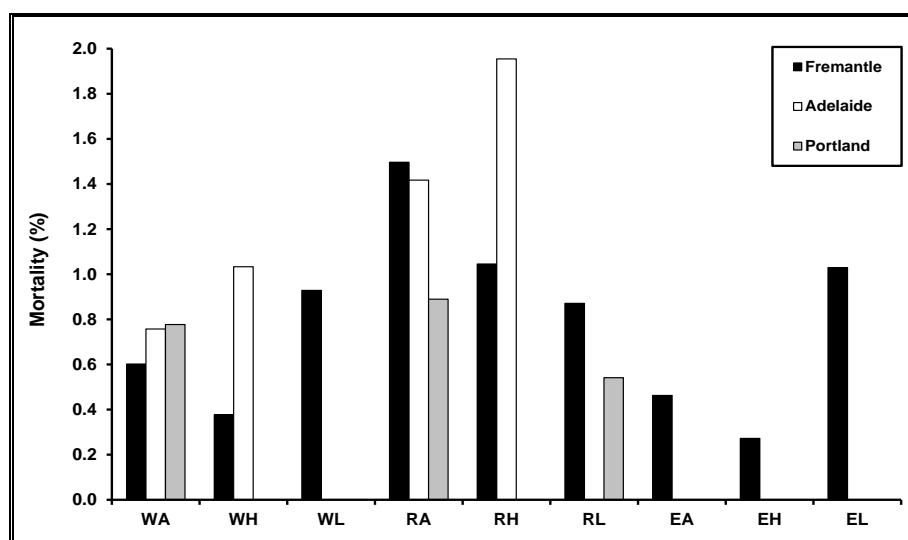
n/a - not applicable (no sheep of this class were loaded)

Figure 5 Overall mortality (%) for classes of sheep exported from Fremantle, Adelaide and Portland to the Middle East/North Africa in 2014

WA = wether adults
RA = ram adults
EA = ewe adults

WH = wether hoggets
RH = ram hoggets
EH = ewe hoggets

WL = wether lambs
RL = ram lambs
EL = ewe lambs

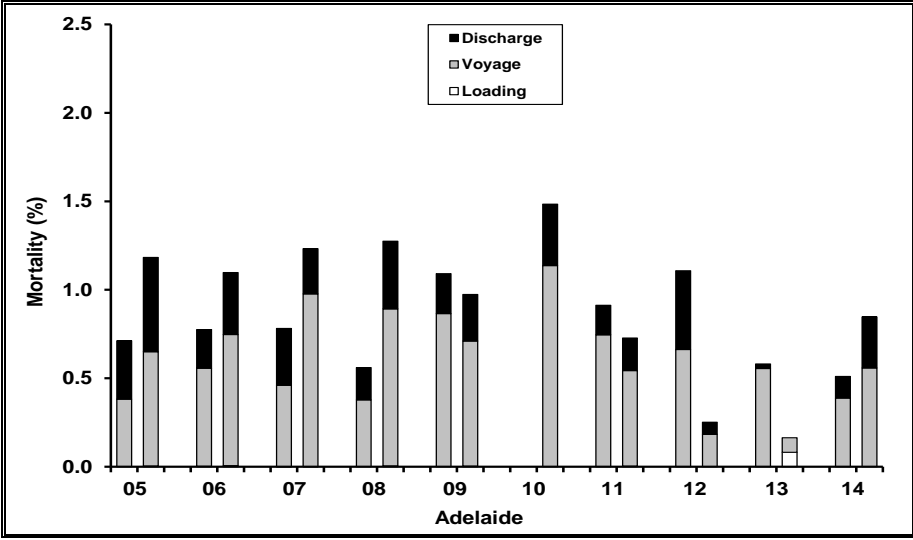
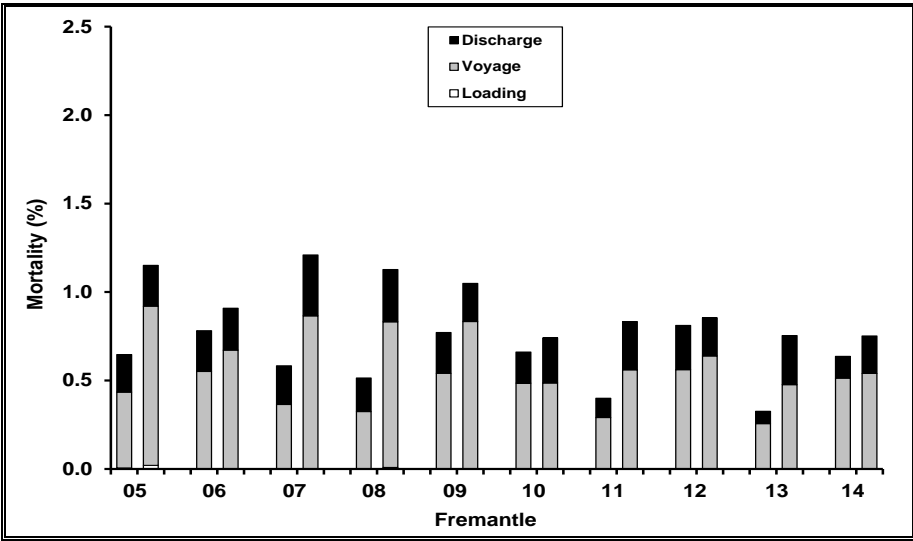


4.1.3.4 Time of year

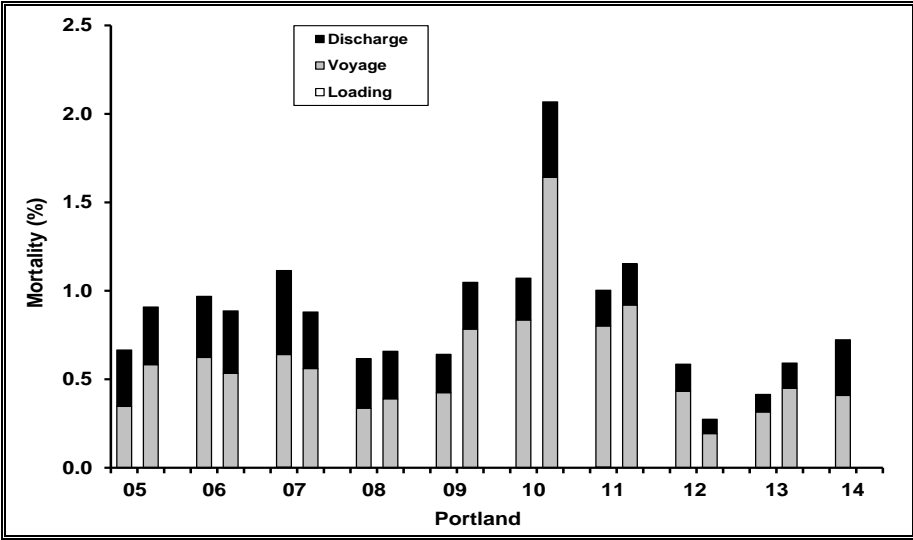
After the surprising reversal of the long-term trend in 2012, the overall half-yearly mortality rates for sheep exported to the Middle East / North Africa returned to the expected pattern in 2013 and on to 2014, being higher ($P < 0.05$) in the second half of the year compared with the first half.

Sheep exported from Fremantle and Adelaide had significantly different ($P < 0.05$) mortality rates for the first and second halves of the year (Fremantle 0.64% and 0.75% respectively; Adelaide 0.51% and 0.85%; Figure 6). Portland exported sheep only in the first 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 2005 to 2014



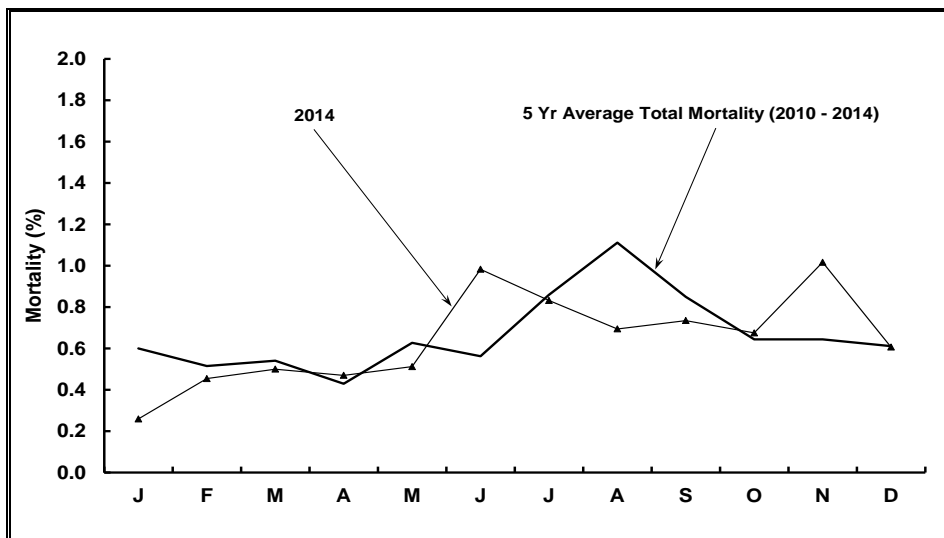
Note – one exceptional voyage excluded in 2013



National livestock export industry sheep, cattle and goat transport performance report 2014

In 2014, 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, being substantially lower in August but higher in January, June and November (Figure 7)

Figure 7 Monthly mortality rates for shipments from Fremantle to the Middle East/North Africa in 2014 and the 5-year monthly averages for the period 2010 to 2014



4.1.3.5 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 2005 to 2014. 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 2005 to 2014. 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 and hogget wethers in 2006, and adult wethers in 2011, 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 first 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. As noted above (and at 4.1.3.4), the return to the expected pattern in 2013 and continuing so in 2014 has been quite definite.

The results shown in Figures 8 and 9 in 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 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 4.1.3.7 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 2005 to 2014 (note - one exceptional voyage each for 2013 and for 2014 excluded; see 6.2 Appendix 2).

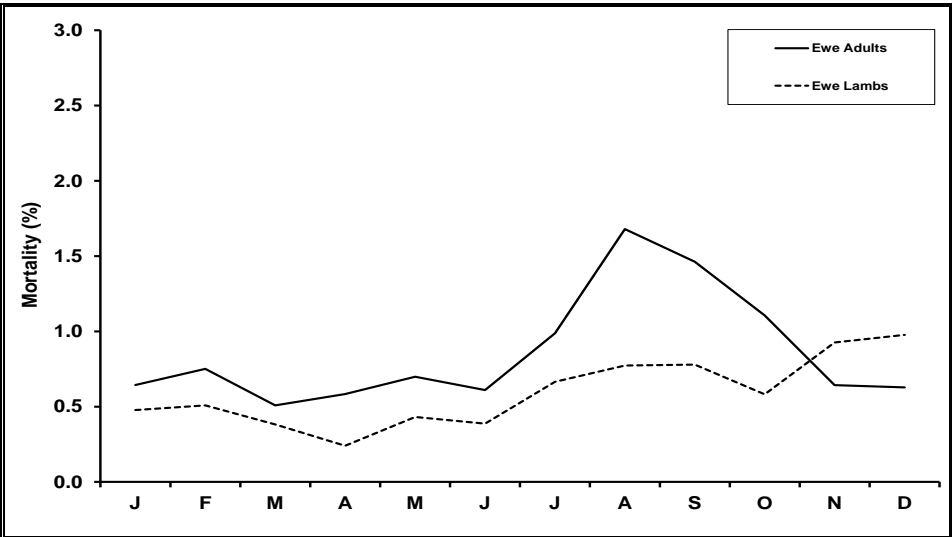
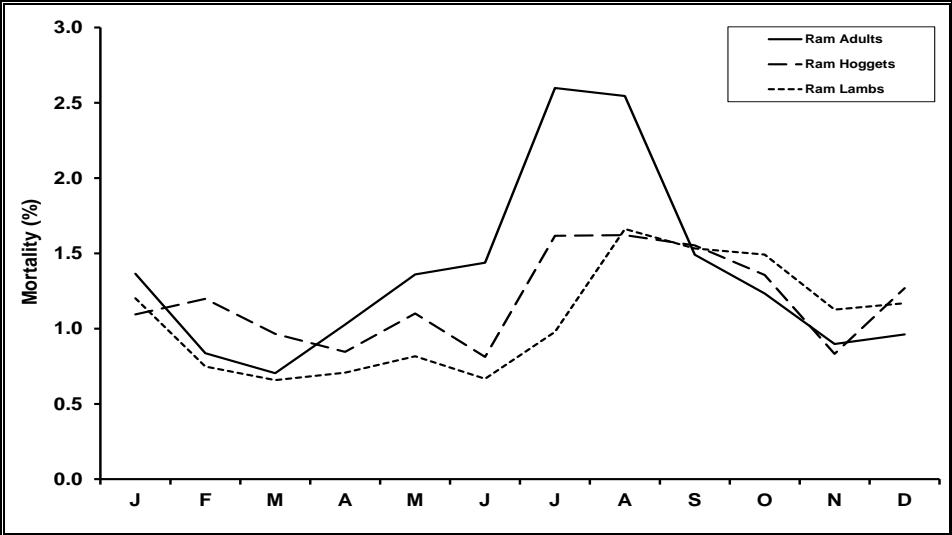
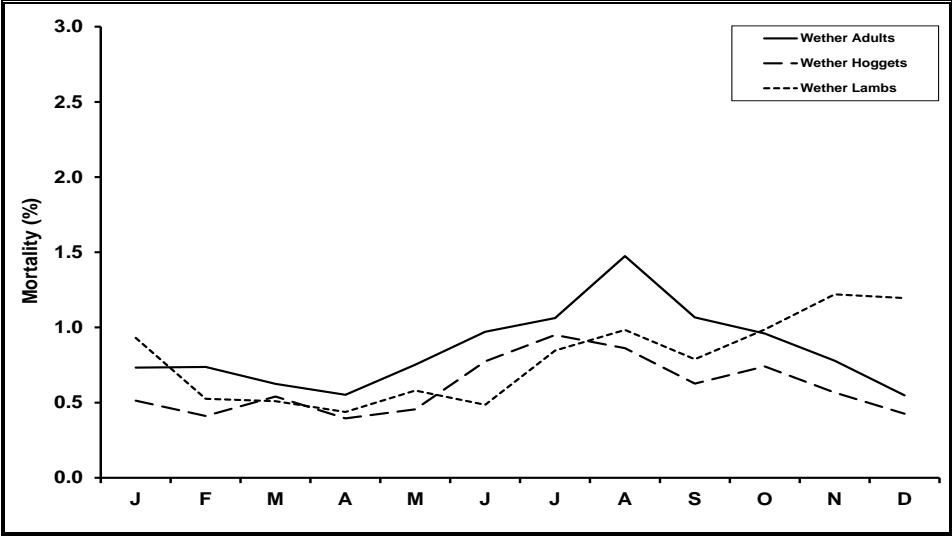
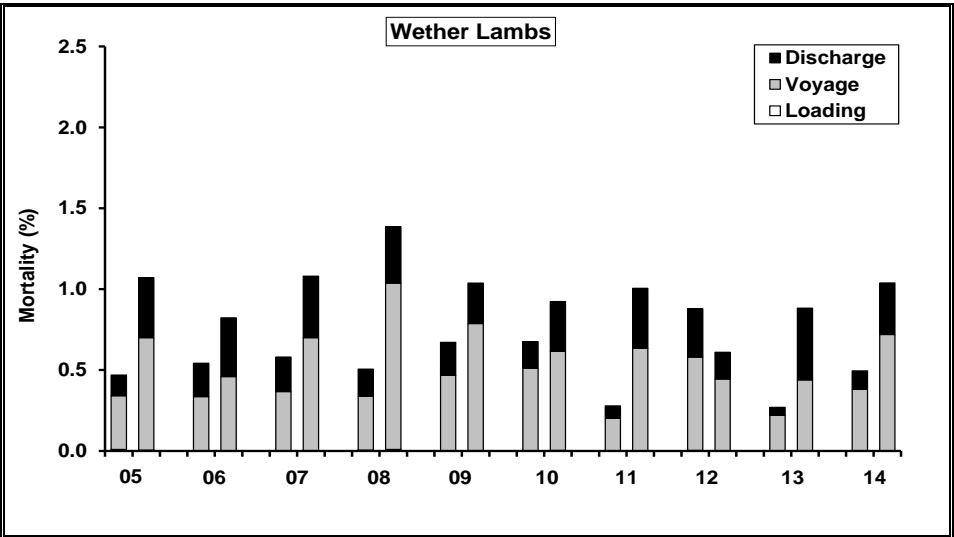
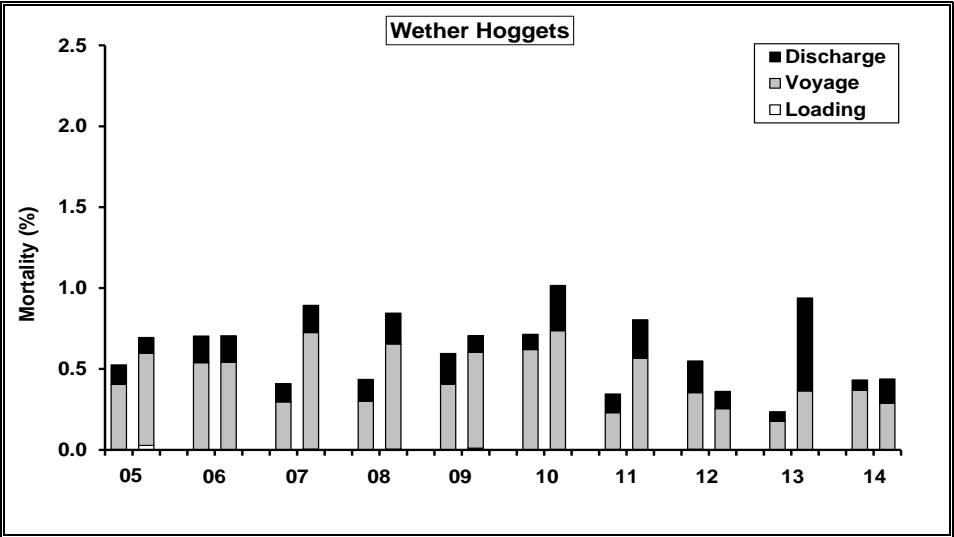
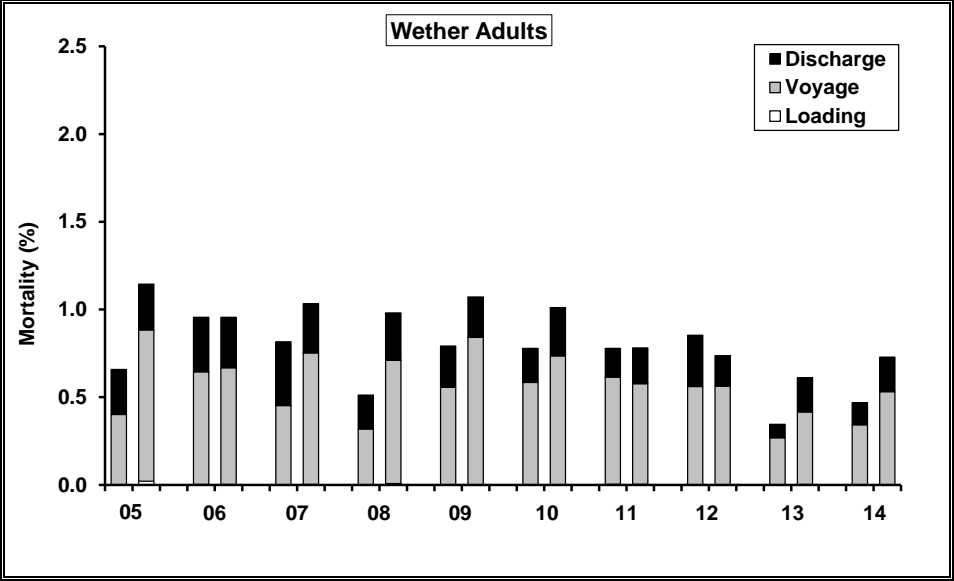


Figure 9 Mortality (%) for wether adults, hoggets and lambs exported by sea from Australia to the Middle East/North Africa for the first and second half of each year from 2005 to 2014 (note – one exceptional voyage each for 2013 and for 2014 excluded; see 6.2 Appendix 2).



4.1.3.6 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 2014

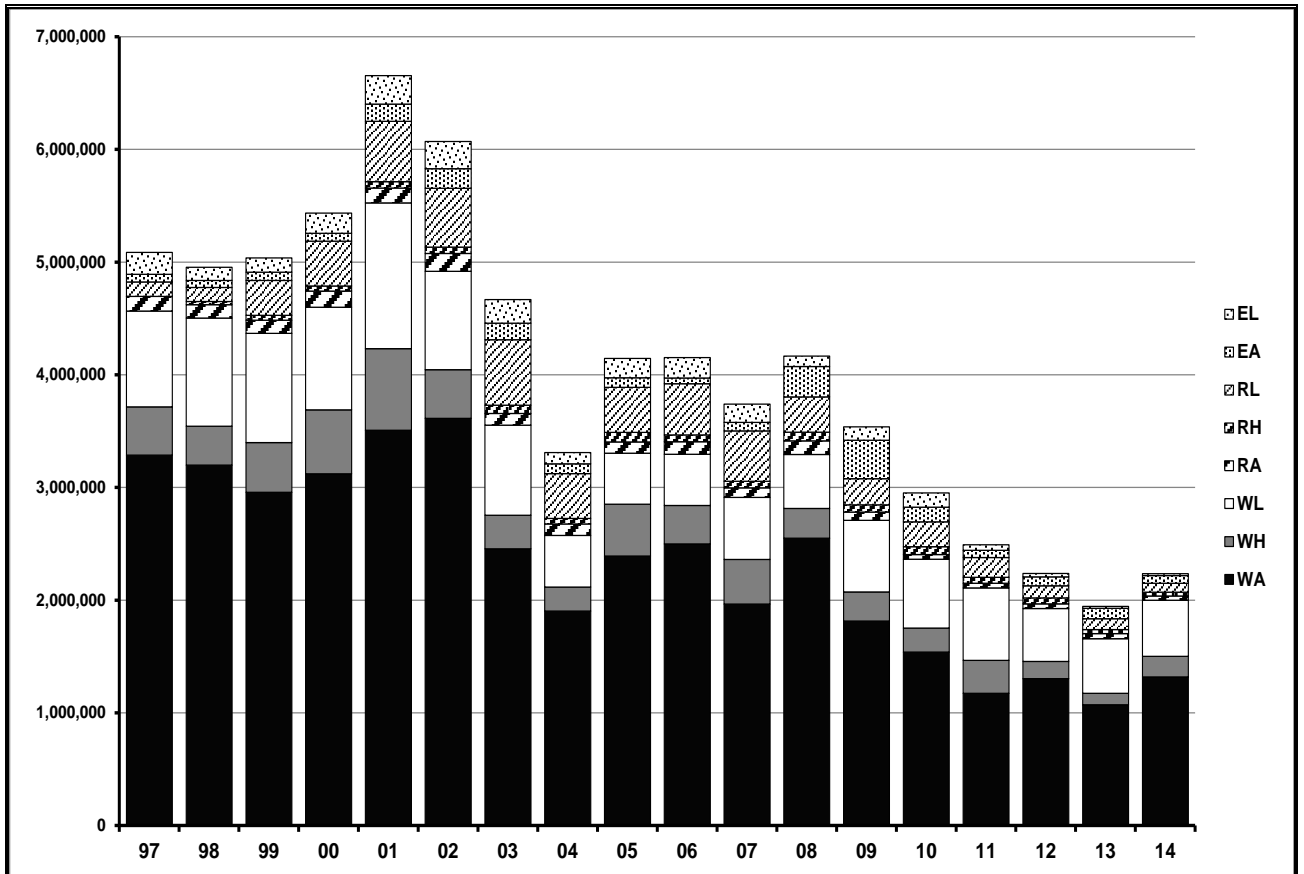


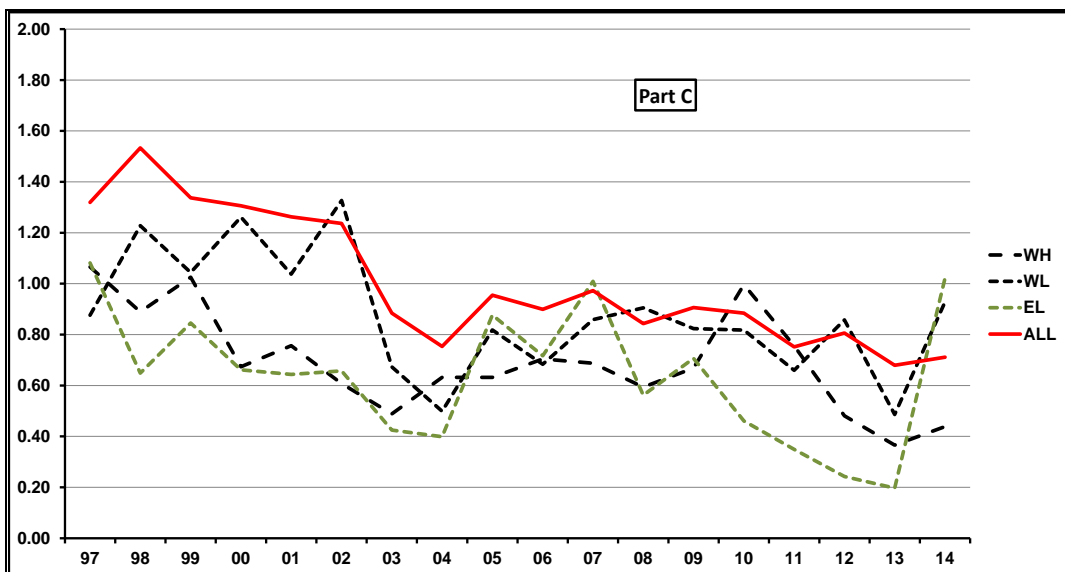
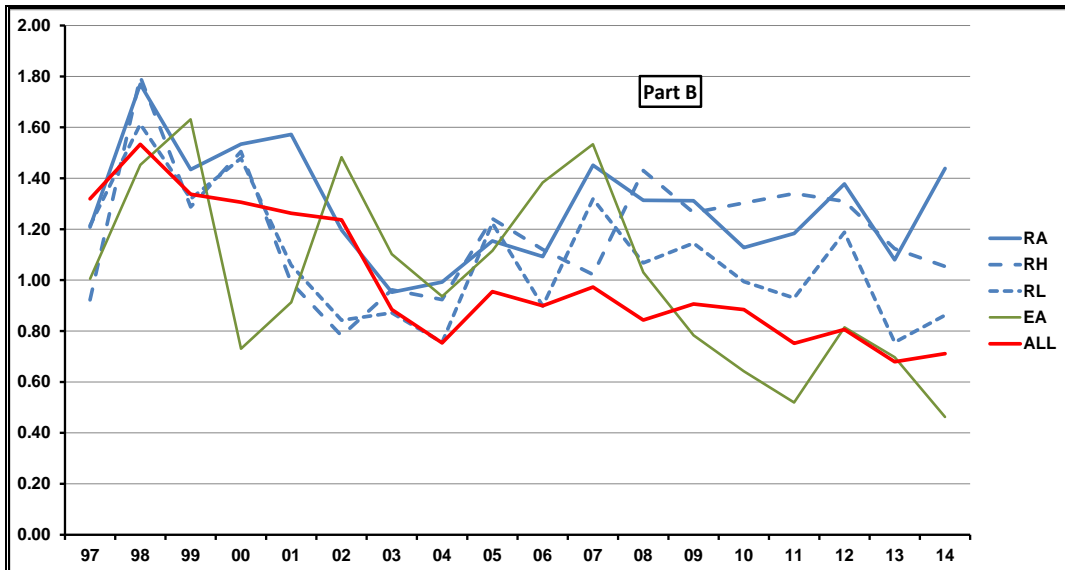
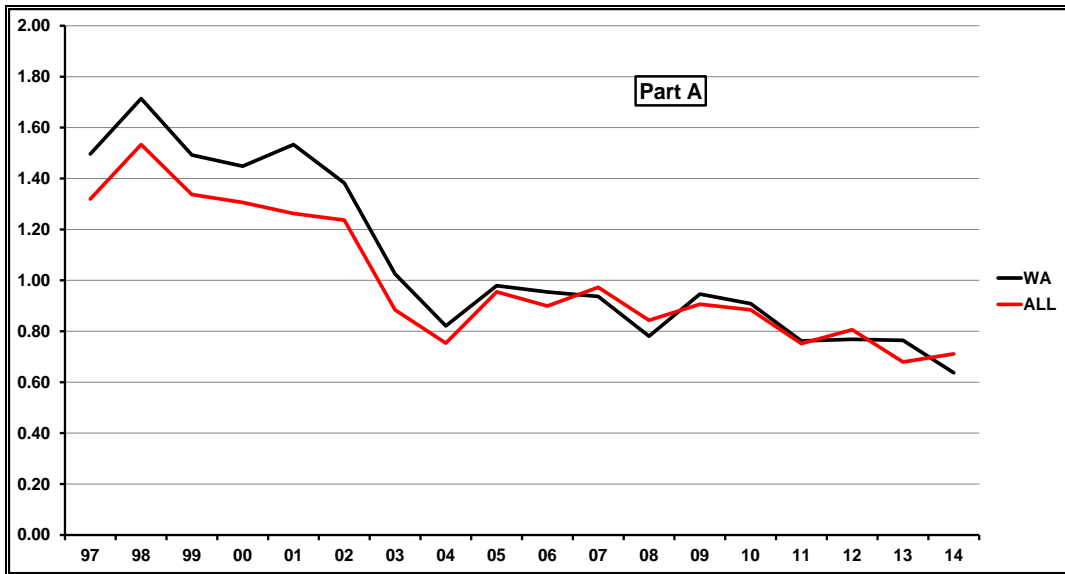
Figure 11, below, shows that the overall mortality rate is closely linked to the Adult Wether mortality (part A). It can also be seen that ram classes have had consistently high mortality rates over time, with Ram Adults (RA) nearly always highest (Part B).

The Adult Ewes (EA) mortality rate has swung wildly over the time, but the three ram classes have remained alone the highest from 2008 onward.

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

National livestock export industry sheep, cattle and goat transport performance report 2014

Figure 11 Mortality rate (%) by class of sheep exported from Australia, 1997 to 2014



4.1.3.7 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, 1997-2014, 2005-2014 and 2014, for Adult Wethers and Adult rams respectively. While the overall pattern for Adult Wethers has reduced 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

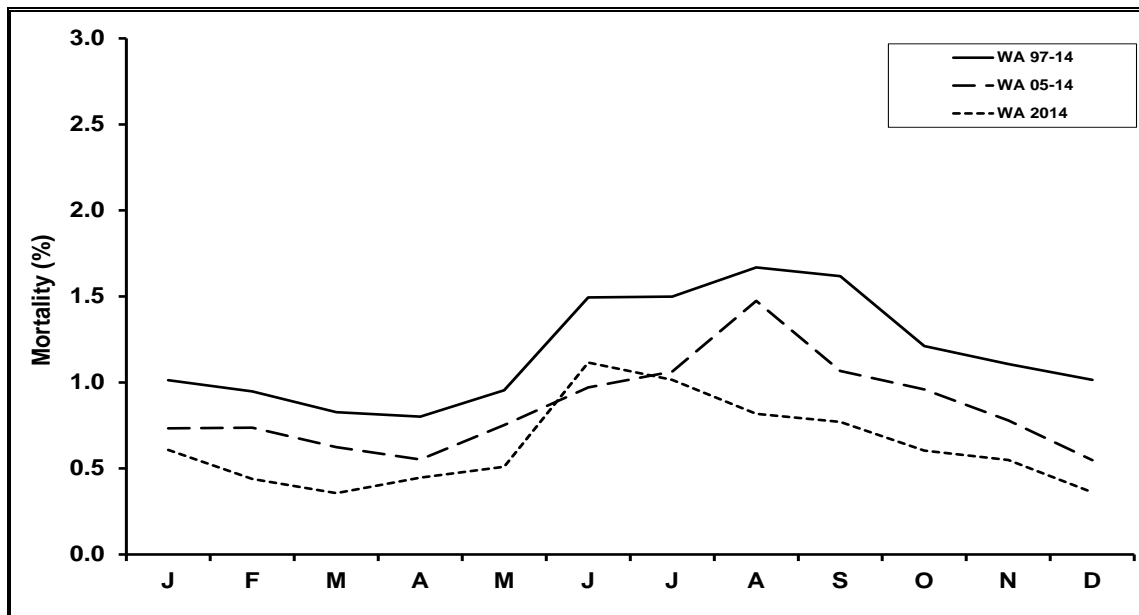
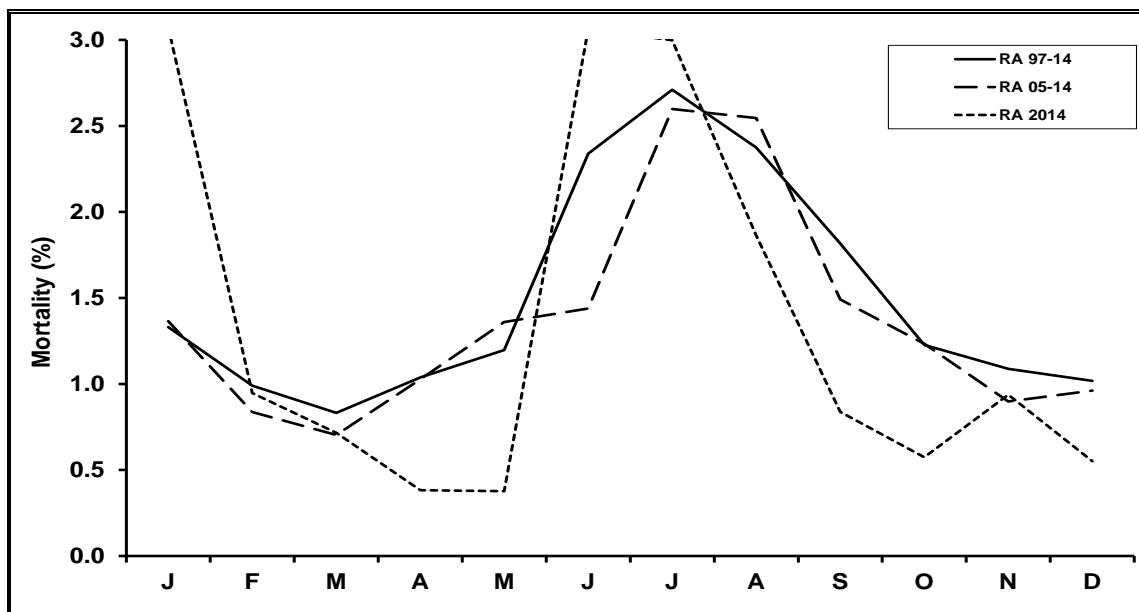


Figure 13 Average monthly mortality rate (%) for Adult Rams for three periods



National livestock export industry sheep, cattle and goat transport performance report 2014

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 (late September in 2015) 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.

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. 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 the tendency towards exporting younger wethers to meet the changing market requirements, as well as improved ship design and management.

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 in "flattening" the overall reverse tilde pattern, or servicing the trade in a way that compensates for the peak mortality period of the year.

National livestock export industry sheep, cattle and goat transport performance report 2014

4.1.3.8 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), Adelaide (6b) and Portland (6c).

There was only one voyage in the “high” category in 2014, featuring ship 43. Approximately 85% of voyages from Fremantle, 71% from Adelaide and 50% from Portland were in the “low” category.

Table 6a Number of voyages in low, medium and high mortality categories for ships loaded at Fremantle in 2014

Ship (code)	Mortality rate			Total
	Low <1.0%	Medium 1.0–2.0%	High >2.0%	
32	7	1	0	8
33	5	1	0	6
34	8	0	0	8
35	4	1	0	5
43	1	0	1	2
46	2	1	0	3
50	1	0	0	1
Total	28	4	1	33

Table 6b Number of voyages in low, medium and high mortality categories for ships loaded at Adelaide in 2014

Ship (code)	Mortality rate			Total
	Low <1.0%	Medium 1.0–2.0%	High >2.0%	
32	1	1	0	2
33	1	1	0	2
35	3	0	0	3
Total	5	2	0	7

Table 6c Number of voyages in low, medium and high mortality categories for ships loaded at Portland in 2014

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

4.2 Cattle

4.2.1 Performance trend

The number of cattle shipped from all ports in Australia to all destinations since 2005 as well as the trend line (linear regression) across those years is shown in Figure 10. Figure 11 shows the number of cattle mortalities during sea transport since 2005. The number of cattle exported annually has varied from approximately 560,000 to 1,280,000, and the annual mortality has varied between 0.10 and 0.18%. The overall trend for numbers of cattle exported is upwards whereas the trend for annual mortality is slightly downward.

Figure 14 Number of cattle exported by sea from Australia to all destinations since 2005

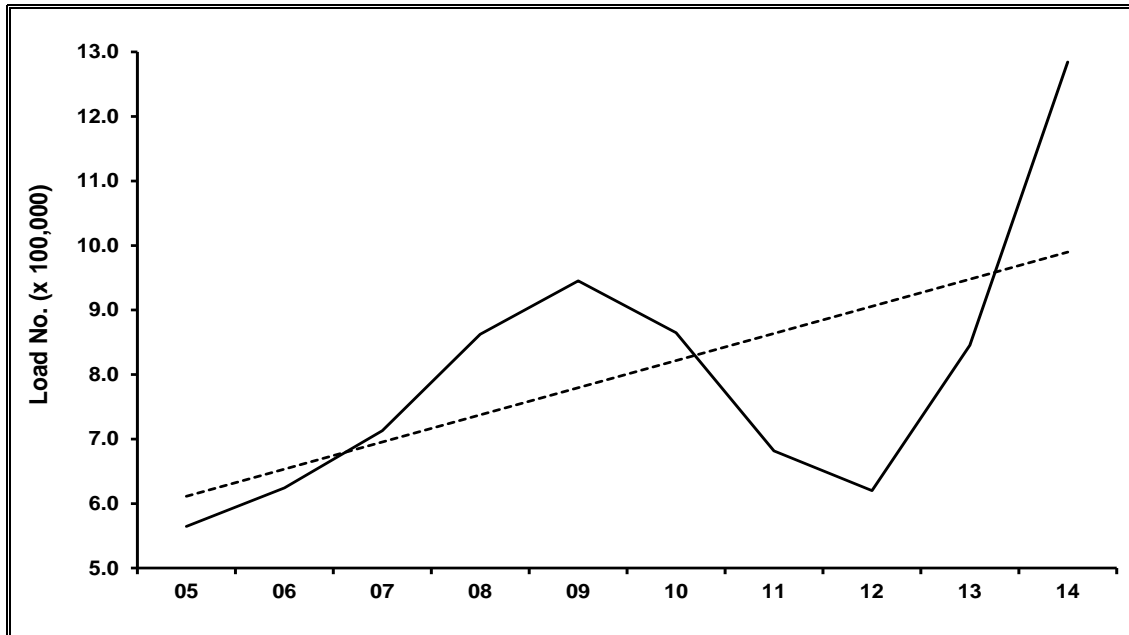
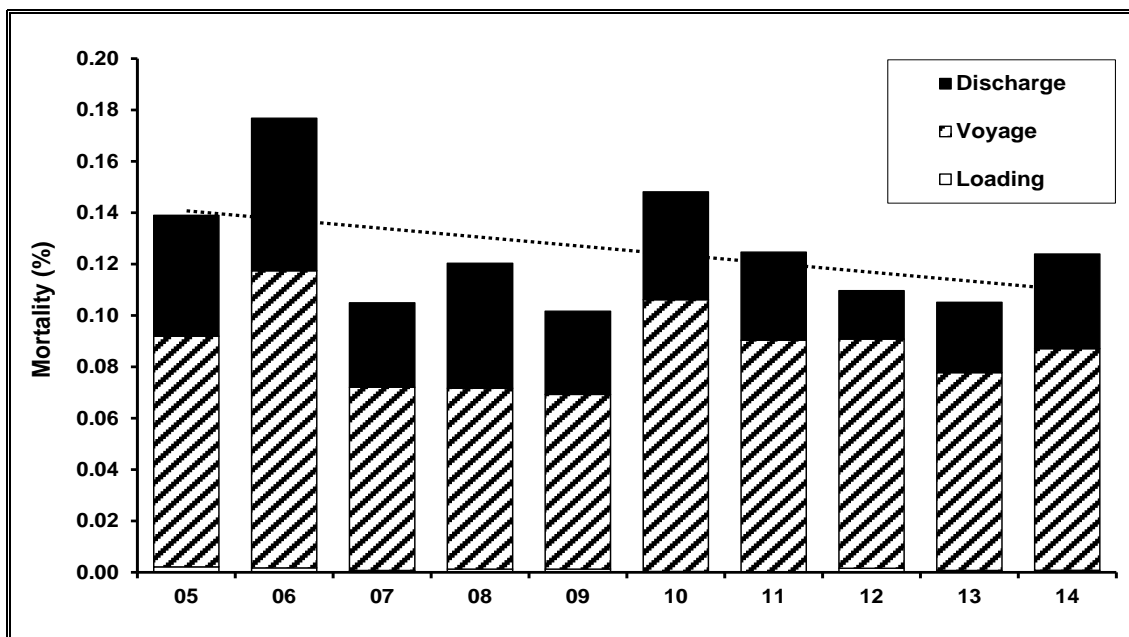


Figure 15 Annual mortality of cattle exported by sea from Australia to all destinations since 2005



National livestock export industry sheep, cattle and goat transport performance report 2014

4.2.2 Overview

The live cattle trade from Australia in 2014 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 where there were only three ports of loading, and nearly all sheep were shipped to the Middle East/North Africa.

There were 9 voyages in 2014 for which cattle were loaded at more than one port in Australia. Mortalities for split-load voyages were attributed to the port of loading for all voyages in 2014. Where analysis involving split-load voyages has been performed, the consignments of cattle from each load port have been considered as separate "voyages".

A further three single-port loaded voyages were split for destination where the separated voyage times fell below and above the ten-day AMSA definition for short and long-haul voyages.

Using the above definition of voyage, there were 339 "voyages" of cattle during 2014. This involved 327 ship journeys, which was 40% more than in 2013. The overall number of cattle exported rose by 52% in 2014 compared to 2013.

The overall number of cattle exported from Australia in 2014 rose by 52% compared to 2013, to a record of 1.28 million (Table 7). The overall mortality rate in 2014 was 0.12%, slightly higher than the figure observed in 2013. The highest overall mortality rate on a regional basis was for exports to South-East Europe (0.47%).

The lowest overall mortality rate was for exports on three voyages to a miscellaneous destination (0.07%). These three voyages comprised 5,714 cattle and incurred 4 mortalities. They will not be examined further in this report.

The number of cattle exported to the Middle East/North Africa in 2014 fell by 13% compared to 2013, while the number of voyages fell by 24%. The mortality rate to the region doubled, from 0.17% in 2013 to 0.36% in 2014.

Exports to South-East Asia rose by 67% in 2014 compared to 2013, while the number of voyages rose by 50% (266 and 177 respectively). Trade to South-East Asia accounted for 78% of all cattle exported in 2014 (up from 70% in 2013) and the majority of the overall rise in numbers for the year.

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 2014 these larger vessels accounted for 48% of the cattle and 23% of the voyages to South-East Asia. This included four split-loaded voyages to the region.

Exports to North-East Asia in 2014 rose by 51% compared to 2013, while those to South-East Europe rose by 21%. The mortality rate to South-East Europe rose from 0.18% in 2013 to 0.47% in 2014.

During 2014, 35% of all cattle voyages returned a nil mortality rate.

Table 7 Mortality rates, number of voyages, voyage and discharge days, and number of cattle exported for voyages to major destination regions during 2014

Parameter	ME/N Africa	SE Asia	NE Asia	Misc	SE Europe	Total
Voyages (No.)	25	266	39	3	5	338
Cattle (No.)	106,065	995,138	123,583	5,714	54,006	1,284,506
Mortality rate o/all (%)	0.36	0.08	0.14	0.07	0.47	0.12
Mortality rate range (%)	0.00 – 2.75	0.00 – 3.52	0.00 – 2.04	0.05 – 0.11	0.34 – 0.60	0.00 – 3.52
Voyage days (Ave.)	19.21	7.66	17.47	14.51	25.61	9.97
Discharge days (Ave.)	4.72	1.55	0.76	0.63	3.88	1.72
Voyages with nil mortalities (No.)	11	96	10	0	0	117

National livestock export industry sheep, cattle and goat transport performance report 2014

4.2.3 Middle East/North Africa

The number of live cattle exported to the Middle East/North Africa during 2014 fell by 13% compared to 2013 (Table 8). Overall mortality rates have remained at or below 0.5% over the last decade. In 2014 the mortality rate was 0.36%, doubling the 2013 rate of 0.17%.

Table 8 Mortality rates, number of voyages, average voyage and discharge length, and number of cattle exported to the Middle East/North Africa from 2005 to 2014

Year	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days	Nil mortality voyages (No.)
2005	36	85,209	0.34	0.00 – 1.04	15.60	5.17	11
2006	43	119,297	0.52	0.00 – 4.27	16.05	4.42	13
2007	41	74,256	0.19	0.00 – 0.54	16.43	4.23	16
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

4.2.3.1 Port of loading

There were 3 ports of loading for voyages to the Middle East/North Africa in 2014, with most cattle exported from Fremantle (Table 9). Mortality rates in 2014 were highest from Fremantle, followed by Broome and Adelaide.

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 loading in Fremantle. No mortalities occurred on 50% and 45% of the voyages from Adelaide and Fremantle respectively.

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 2014

Port	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days
Fremantle	22	91,913	0.38	0.00 – 2.75*	18.52	4.66
Broome	1	8,110	0.26	n/a	23.84	3.78
Adelaide	2	6,042	0.20	0.00 – 0.21	24.52	5.91

* exceptional voyage; see 6.2 Appendix 2

National livestock export industry sheep, cattle and goat transport performance report 2014

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 2014

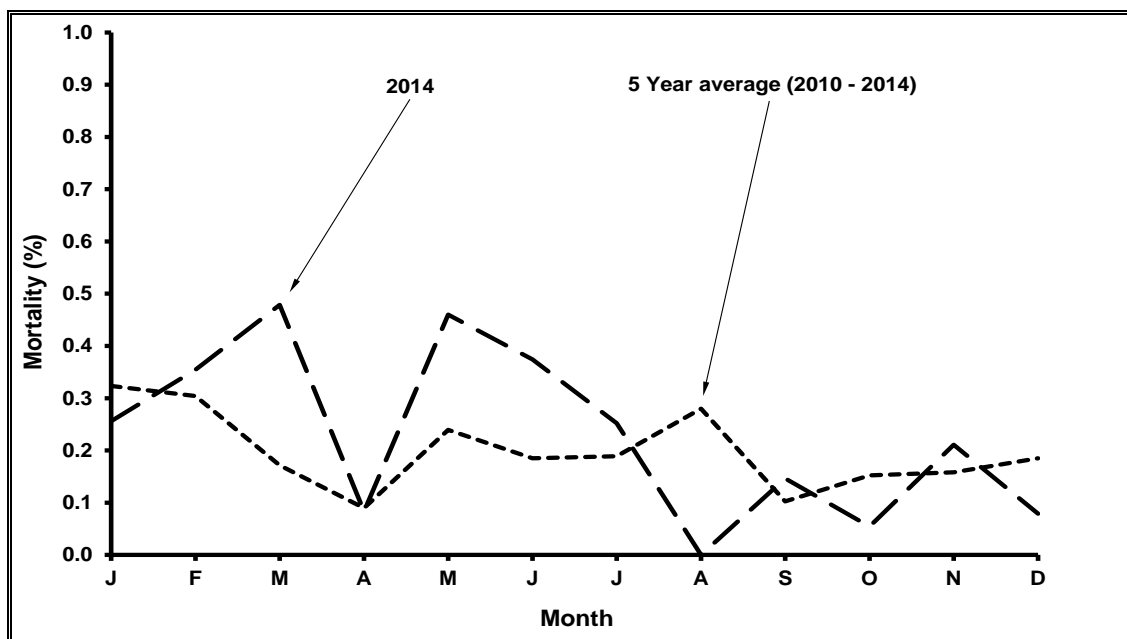
Port	Mortality rate				Total
	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	
Fremantle	10	10	1	1	22
Adelaide	1	1	0	0	2
Broome	0	1	0	0	1
Total	11	12	1	1	25

4.2.3.2 Time of year

In 2014, 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 0.5% throughout the year (Figure 12). The monthly mortality rate profile for 2014 approximated the 5 year average except for the months March, May and June, when it was somewhat higher, and August, when it was well below.

Note that one 2014 and one 2010 exceptional voyages have been excluded from the data. If the 2010 voyage was included, the February percentage would have been 0.89% for the 5 year average profile. If the 2014 voyage was included, the January percentage for the 2014 and the 5 year average profiles would have been 1.56% and 0.66% respectively. Federal Department of Agriculture investigation summaries regarding these voyages are referred to in 6.2 Appendix 2

Figure 16 Monthly mortality rates of cattle on voyages from all ports to the Middle East/North Africa for 2014 and the 5-year monthly rates for the period 2010 to 2014



4.2.3.3 Ship

The voyages of each ship sailing 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 33 and 43. 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 2014

Ship (code)	Mortality rate				Total
	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	
32	2	1	0	0	3
33	2	3	1	0	6
34	3	0	0	0	3
35	4	3	0	0	7
43	0	1	0	1	2
46	0	2	0	0	2
49	0	1	0	0	1
128	0	1	0	0	1
Total	11	12	1	1	25

4.2.3.4 Class of cattle

In 2014, the highest overall class mortality rate occurred in adult steers (1.36%; Table 12). Bull classes made up 88% of all cattle shipped to Middle East/North Africa in 2014.

Table 12 Mortality rates, number of voyages and number of cattle in various classes exported to the Middle East/North Africa in 2014

Class	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)
Bull adult*	23	61,121	0.33	0.00 – 2.68**
Bull weaner	8	32,009	0.17	0.00 – 0.37
Heifer beef	9	7,471	0.95	0.00 – 2.69**
Steer adult*	8	3,839	1.36	0.00 – 2.94**
Heifer dairy	1	627	0.48	n/a
Cow beef	1	622	0.00	n/a
Steer weaner	1	376	0.53	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

National livestock export industry sheep, cattle and goat transport performance report 2014

4.2.4 South-East Asia

Almost a million cattle were exported to South-East Asia in 2014 (Table 13), representing an increase of 67% compared to 2013. The mortality rate for voyages to the region remained at 0.08% while the number of voyages rose by 50%. 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.

Table 13 Mortality rates, number of voyages, average voyage and discharge length, and number of cattle exported to South-East Asia from 2005 to 2014

Year	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days	Nil mortality voyages (No.)
2005	169	403,819	0.10	0.00 – 0.80	6.06	0.97	73
2006	166	452,516	0.09	0.00 – 1.04	6.24	1.38	66
2007	205	573,729	0.09	0.00 – 4.01	6.47	1.10	92
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

4.2.4.1 Port of loading

Most cattle exported to South-East Asia in 2014 were loaded at Darwin (54%) followed by Townsville (26%) and Broome (9%, Table 14). The mortality rate was highest for cattle exported from Mourilyan (0.57%) followed by Adelaide (0.46%) and Geraldton (0.45%).

The voyages from each port were classified into various mortality categories as shown in Table 15. 98% of voyages were in the nil or low categories in 2014. There were three voyages in the medium and three in the high category involving the ports of Darwin, Geraldton and Mourilyan.

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 2014

Port	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days
Darwin	153	537,068	0.07	0.00 – 2.09*	6.73	1.40
Townsville	38	256,139	0.08	0.00 – 0.25	9.76	2.36
Broome	28	92,590	0.10	0.00 – 0.44	6.30	1.70
Fremantle	16	39,331	0.09	0.00 – 0.21	10.40	2.25
Wyndham	9	28,765	0.05	0.00 – 0.36	6.23	1.02
Karumba	12	22,420	0.02	0.00 – 0.07	9.87	0.61
Geraldton	8	15,060	0.45	0.04 – 3.52**	10.45	0.77
Adelaide	1	2,369	0.46	n/a	20.94	1.51
Mourilyan	1	1,396	0.57	n/a	15.05	0.64

* exceptional voyage; see 6.2 Appendix 2

** exceptional voyage; see 6.2 Appendix 2

National livestock export industry sheep, cattle and goat transport performance report 2014

Table 15 Number of voyages in nil, low, medium and high mortality categories for shipments from various ports to South-East Asia for 2014

Port	Mortality rate				Total
	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	
Darwin	65	84	2	2	153
Townsville	4	34	0	0	38
Broome	10	18	0	0	28
Fremantle	7	9	0	0	16
Wyndham	2	7	0	0	9
Karumba	8	4	0	0	12
Geraldton	0	7	0	1	8
Adelaide	0	1	0	0	1
Mourilyan	0	0	1	0	1
Total	96	164	3	3	266

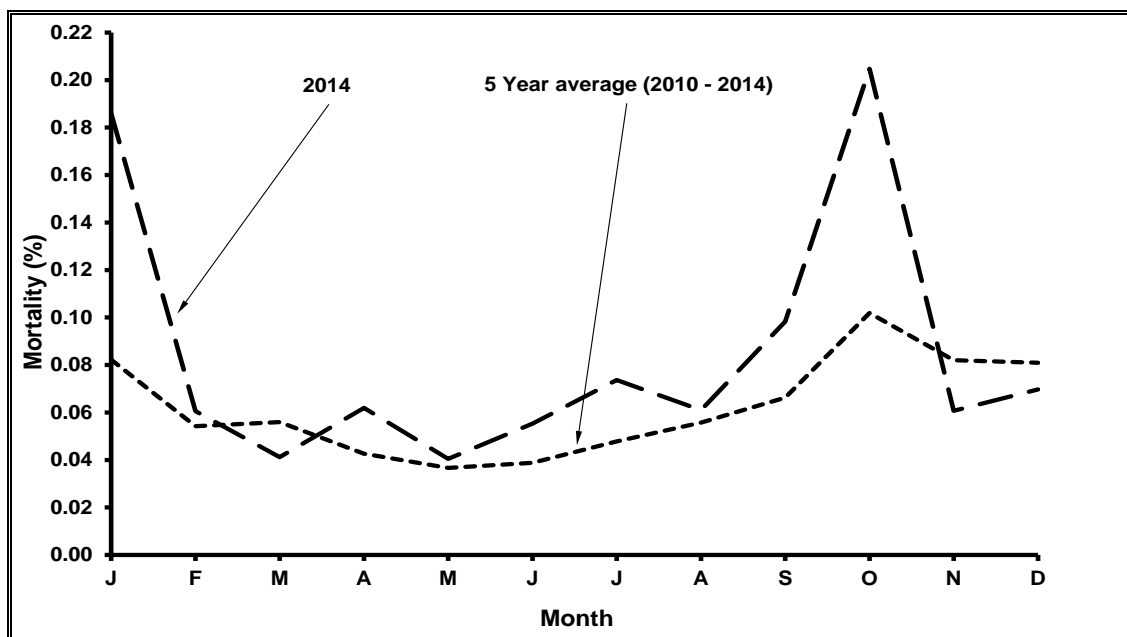
4.2.4.2 Time of year

Monthly mortality rates (total mortality as a proportion of total loaded for each month) for voyages to South-East Asia in 2014 were below 0.10% for the year except for the months of January and October (Figure 17).

While some voyages were higher than average in January and October, all were well below the reportable levels of 0.5% for voyages under 10 days duration and 1.0% for voyages of 10 days duration and over.

The monthly mortality rate profile for 2014 approximated that of the 5-year average except for the months mentioned above.

Figure 17 Monthly mortality rates of cattle on voyages from all ports to South-East Asia for 2014 and the 5-year monthly rates for the period 2010 to 2014



National livestock export industry sheep, cattle and goat transport performance report 2014

4.2.4.3 Ship

The voyages of each ship from Australia to South-East Asia were classified into various mortality categories as shown in Table 16. All voyages except six were in the nil or low mortality categories. There were three voyages in the medium and three in the high category involving ships 117, 123 and 124.

The number of voyages to the region increased by 50% in 2014 compared to 2013.

Ships with a carrying capacity of 6,000 or more head accounted for 23% of voyages to South-East Asia in 2014. They also accounted for 48% of cattle exported, 50% of mortality, 25% of voyage days and 50% of discharge days. The convergence of load number and mortality percentages indicates that the larger ships performed around the average in 2014 despite the extended loading and/or discharge times.

Table 16 Number of voyages in nil, low, medium and high mortality categories for shipments to South East Asia for 2014

Ship (code)	Mortality rate				Total
	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	
33	0	2	0	0	2
35	1	0	0	0	1
43	0	5	0	0	5
44	2	8	0	0	10
45	3	8	0	0	11
46	1	5	0	0	6
47	3	5	0	0	8
48	0	3	0	0	3
49	1	7	0	0	8
50	1	5	0	0	6
59	4	5	0	0	9
77	11	6	0	0	17
95	11	7	0	0	18
103	5	5	0	0	10
114	8	10	0	0	18
117	7	11	0	1	19
120	7	8	0	0	15
121	4	3	0	0	7
122	4	17	0	0	21
123	3	14	1	1	19
124	6	8	2	1	17
125	2	8	0	0	10
126	8	6	0	0	14
127	4	3	0	0	7
128	0	3	0	0	3
129	0	2	0	0	2
Total	96	164	3	3	266

National livestock export industry sheep, cattle and goat transport performance report 2014

4.2.4.4 Class of cattle

In 2014 all cattle exported to South-East Asia were able to be identified by class.

Adult steers and beef heifers comprised 56% and 25% respectively of all classes exported to the region in 2014 (Table 17).

The highest mortality rates occurred in beef cows (0.34%) followed by adult bulls (0.13%). Note that high values for mortality rate ranges not included in voyage investigations mentioned at 6.2 Appendix 2, involved 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 2014

Class	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)
Steer adult*	256	559,085	0.07	0.00 – 4.75 [†]
Heifer beef	207	248,062	0.05	0.00 – 2.38 [†]
Bull adult*	135	79,513	0.13	0.00 – 2.73
Steer weaner	20	54,193	0.05	0.00 – 0.21
Cow beef	84	38,505	0.34	0.00 – 6.08**
Bull weaner	16	10,470	0.06	0.00 – 0.44
Heifer dairy	7	5,310	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

[†] exceptional voyage; see 6.2 Appendix 2

National livestock export industry sheep, cattle and goat transport performance report 2014

4.2.5 North-East Asia

The number of cattle exported to North-East Asia in 2014 rose by 52% compared to 2013 while the number of voyages rose by 26% (Table 18). The mortality rate has remained under 0.2% over the last decade.

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 2014.

Table 18 Mortality rates, number of voyages, average voyage and discharge length, and number of cattle exported to North-East Asia from 2005 to 2014

Year	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days	Nil mortality voyages (No.)
2005	39	58,164	0.09	0.00 – 0.36	16.48	1.74	15
2006	26	37,963	0.12	0.00 – 1.29	17.09	1.28	11
2007	21	34,837	0.06	0.00 – 0.20	16.60	1.71	10
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

4.2.5.1 Port of loading

All cattle exported to North-East Asia in 2014 departed from Portland, Geelong and Brisbane (Table 19). All cattle loaded at Brisbane were exported to Japan with the rest being exported to China.

The voyages from each port were classified into various mortality categories as shown in Table 20. During 2014 there was one high mortality voyage departing from Portland, while 92% 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 2014

Port	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days
Portland	27	97,555	0.14	0.10 – 2.04*	17.76	0.90
Geelong	3	16,909	0.08	0.00 – 0.11	17.82	1.18
Brisbane	9	9,119	0.25	0.00 – 0.83	16.49	0.21

* exceptional voyage; see 6.2 Appendix 2

National livestock export industry sheep, cattle and goat transport performance report 2014

Table 20 Number of voyages in nil, low, medium and high mortality categories for shipments from various ports to North-East Asia for 2014

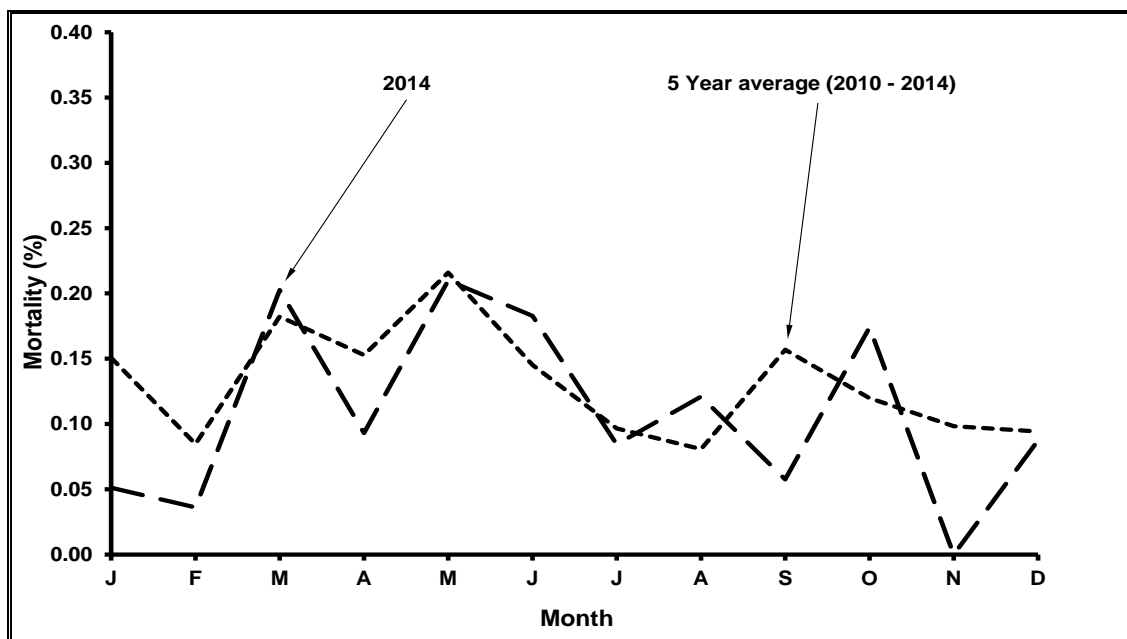
Port	Mortality rate				Total
	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	
Portland	6	20	0	1	27
Geelong	1	2	0	0	3
Brisbane	3	4	2	0	9
Total	10	26	2	1	39

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 2014 were at or below 0.25% throughout the year, and approximated the five year average (Figure 18).

One exceptional 2014 voyage has been excluded from the analysis. If this voyage is included, the February figures for 2014 and the 5 year average would be 2.04% and 0.49% respectively. A Federal Department of Agriculture investigation summary regarding this voyage is referred to in 6.2 Appendix 2.

Figure 18 Monthly mortality rates of cattle on voyages from all ports to North-East Asia for 2014 and the 5-year monthly rates for the period 2010 to 2014



National livestock export industry sheep, cattle and goat transport performance report 2014

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 2014 there was one high mortality voyage involving ship 121. For the remainder, 92% 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 2014

Ship (code)	Mortality rate				Total
	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	
44	1	1	0	0	2
47	1	2	0	0	3
50	1	1	0	0	2
59	1	5	0	0	6
77	1	0	0	0	1
95	0	1	0	0	1
103	0	4	0	0	4
115	3	4	2	0	9
120	0	1	0	0	1
121	0	0	0	1	1
126	0	2	0	0	2
127	1	1	0	0	2
128	1	2	0	0	3
129	0	2	0	0	2
Total	10	26	2	1	39

4.2.5.4 Class of cattle

Mortality rates for classes of cattle exported to North-East Asia during 2014 are presented in Table 22.

The North-East Asian cattle trade comprised mainly steers exported to Japan and heifers exported to China.

The highest mortality rates occurred in adult steers (0.25%) followed by beef cows (0.17%). Note that the high value in the dairy heifer mortality rate range is the subject of the Federal Department of Agriculture investigation mentioned in 6.2 Appendix 2.

Table 22 Mortality rate, number of voyages and number of cattle in the classes exported to North-East Asia in 2014

Class	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)
Heifer dairy	29	111,563	0.13	0.00 – 2.04
Steer adult*	9	9,119	0.25	0.00 – 0.83
Cow beef	2	2,401	0.17	0.00 – 0.34
Heifer beef	1	500	0.00	n/a

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

4.2.6 South-East Europe

In recent years the significant rise in livestock exports to Turkey and the Black Sea had the effect of excessively boosting the miscellaneous category. 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 at 0.5% or less over the nine years surveyed (Table 23).

The mortality rate in cattle exported to South-East Europe was 0.47% in 2014. Numbers exported rose by 21%.

Table 23 Mortality rates, number of voyages, average voyage and discharge length, and number of cattle exported to South-East Europe from 2006 to 2014

Year	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days	Nil mortality voyages (No.)
2006	1	3,382	0.09	n/a	19.18	1.98	0
2007	6	7,062	0.18	0.00 – 0.24	26.99	1.18	1
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

4.2.6.1 Port of loading

Cattle exported to South-East Europe in 2014 were all from the southern ports of Adelaide, Portland and Fremantle (Table 24). Most cattle were loaded at Adelaide (62%) followed by Portland (29%). The mortality rate was highest for cattle exported from Adelaide (0.55%).

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 2014

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 2014

Port	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days
Adelaide	2	33,578	0.55	0.46 – 0.60	29.34	4.42
Portland	1	15,788	0.35	n/a	30.48	5.28
Fremantle	2	4,640	0.35	0.34 – 0.35	19.45	2.65

National livestock export industry sheep, cattle and goat transport performance report 2014

Table 25 Number of voyages is nil, low, medium and high mortality categories for shipments from various ports to South-East Europe for 2014

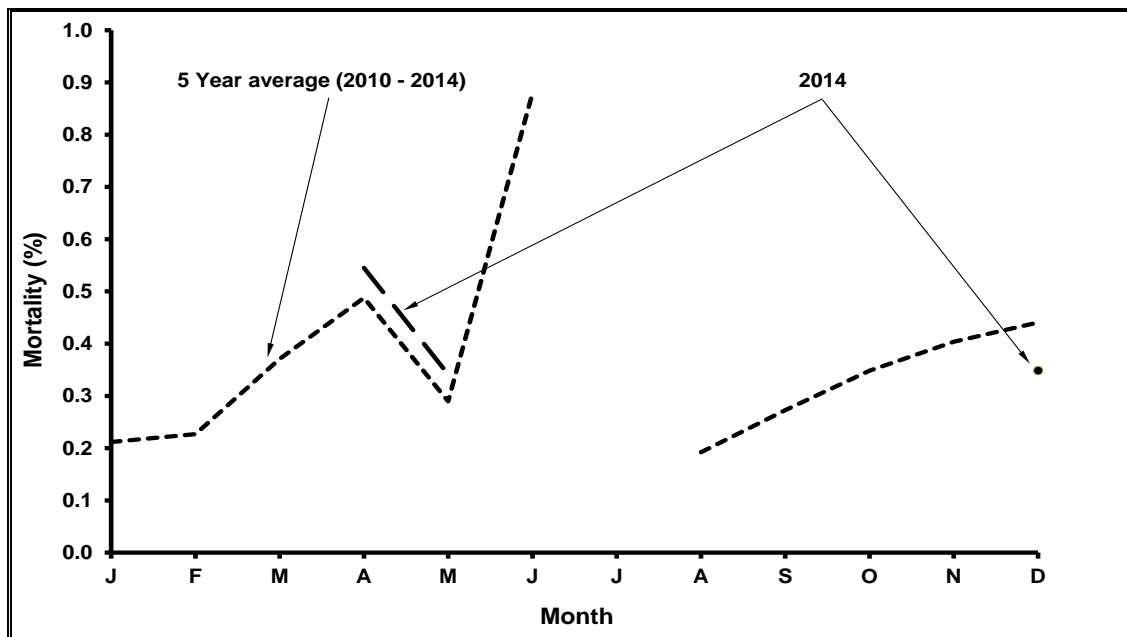
Port	Mortality rate				Total
	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	
Adelaide	0	1	1	0	2
Portland	0	1	0	0	1
Fremantle	0	2	0	0	2
Total	0	4	1	0	5

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 2014 were below 0.6% throughout the year (Figure 15).

For the three months on which voyages occurred during 2014, the monthly mortality profile approximated the five year average. Note that one exceptional voyage in 2011 has been excluded from the 5 year average data. If this voyage were included, the June percentage would have been 1.18% for the 5 year average profile. A Federal Department of Agriculture investigation regarding this voyage is referred to in 6.2 Appendix 2.

Figure 19 Monthly mortality rates of cattle on voyages from all ports to South-East Europe for 2014 and the 5-year monthly rates for the period 2010 to 2014



National livestock export industry sheep, cattle and goat transport performance report 2014

4.2.6.3 Ship

The voyages of each ship taking cattle from Australia to South-East Europe were classified into various mortality categories as shown in Table 26. There were no voyages in the high category in 2014.

Table 26 Number of voyages in nil, low, medium and high mortality categories for shipments to South-East Europe for 2014

Ship (code)	Mortality rate				Total
	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	
46	0	1	0	0	1
48	0	3	1	0	4
Total	0	4	1	0	5

4.2.6.4 Class of cattle

Mortality rates for each class of cattle exported to South-East Europe during 2014 are presented in Table 27. Cattle to South-East Europe comprised steers (10%) and bulls (13%) exported to Turkey, and dairy cattle (75%) and bulls (2%) exported to Russia.

In 2014 the highest mortality rates occurred in beef heifers (0.82%) followed by adult bulls (0.45%).

Table 27 Mortality rate, number of voyages and number of cattle in the classes exported to South-East Europe in 2014

Class	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)
Steer adult*	4	43,329	0.44	0.00 – 0.60
Heifer beef	2	4,612	0.82	0.54 – 2.36
Steer weaner	1	3,380	0.41	n/a
Bull adult*	3	2,685	0.45	0.00 – 1.14

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

4.3 Goats

4.3.1 Performance trend

Figures 16 and 17 show the number of goats exported and the mortality rates 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 number of goats exported annually has varied between approximately 200 and 26,000, and the annual mortality has varied between 0.00 and 0.79%. The trend for exports and annual mortality has continued downward.

Figure 20 Number of goats exported by sea from Australia to all destinations since 2005

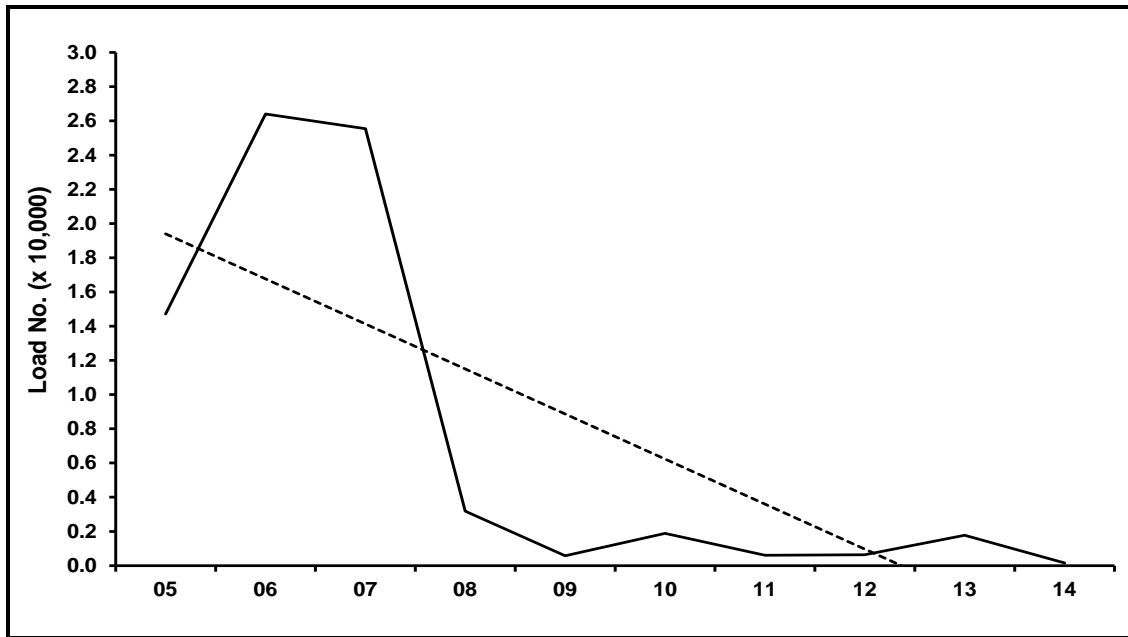
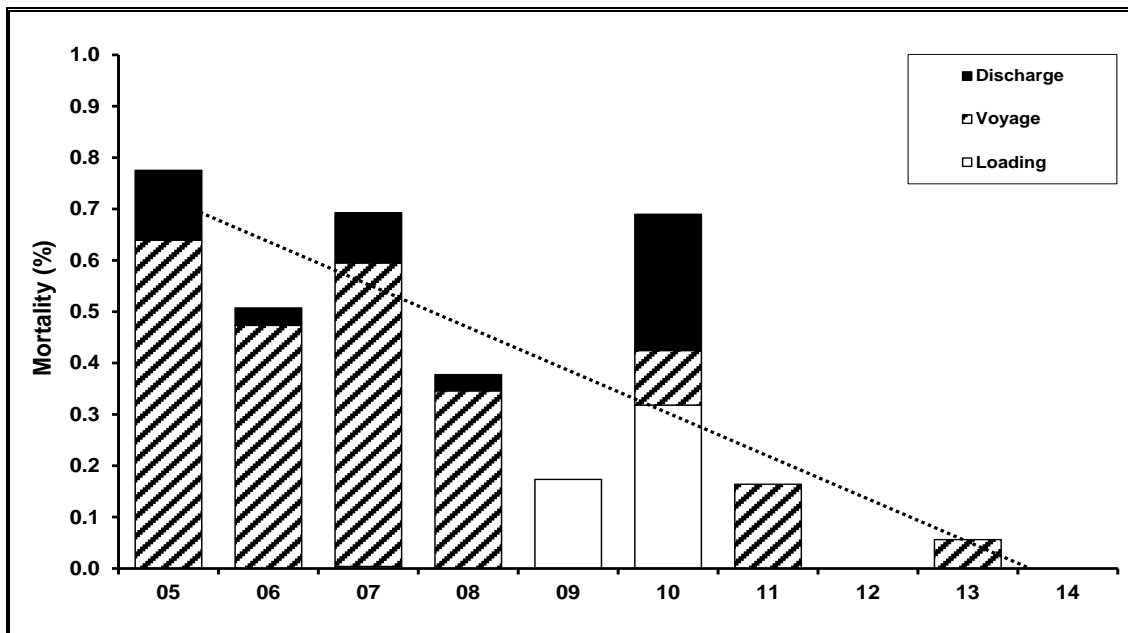


Figure 21 Annual mortality of goats exported by sea from Australia to all destinations since 2005



National livestock export industry sheep, cattle and goat transport performance report 2014

4.3.2 Overview

The number of goats exported live by sea has remained very low since 2008, making it difficult to present any meaningful analysis of trends. The few graphs / tables shown for this section of the report simply document the ongoing numbers and mortalities experienced.

There were 154 goats exported by sea from Australia in 2014. They were carried to Brunei on one voyage which was loaded in Darwin. The overall mortality rate was 0.00%.

4.3.3 South-East Asia

The number of goats exported by sea to South-East Asia has fallen substantially since peaking in 2002. The mortality rate fell to 0.00% in 2012 (Table 28), the first time this figure has been achieved since recording began in 1993. The mortality rate for 2014 was again 0.00%.

Table 28 Mortality rates, number of voyages, average voyage and discharge length, and number of goats exported to South-East Asia from 2005 to 2014

Year	Voyages (No.)	Goats (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days	Nil mortality voyages (No.)
2005	26	14,706	0.78	0.00 – 2.03	7.92	1.35	10
2006	26	26,408	0.51	0.00 – 3.04	7.67	1.89	6
2007	25	25,546	0.69	0.00 – 12.50	9.17	2.01	5
2008	8	3,180	0.75	0.00 – 5.14	9.08	0.72	3
2009	2	577	0.17	0.00 – 0.25	9.78	0.75	1
2010	5	1,885	0.69	0.00 – 1.25	8.44	0.40	3
2011	1	610	0.16	n/a	10.02	0.35	0
2012	1	635	0.00	n/a	7.68	1.08	1
2013	3	1,776	0.06	0.00 – 0.14	7.76	1.69	2
2014	1	154	0.00	n/a	8.36	0.84	1

4.4 Air Transport

4.4.1 Air transport of live sheep

Air transport of live sheep comprises a mix of breeding and slaughter types. In 2014 82% of air-transported sheep were for slaughter.

During 2014 air transport accounted for the 1.72% of live sheep exports (39,227 out of 2,274,739 sheep exported). The number of sheep exported by air in 2014 rose by 9.3% compared to 2013.

4.4.1.1 Load point / destination

The loading points and destination countries for sheep transported by air from Australia in 2014 are shown in Table 29.

The majority of these sheep were loaded at Sydney and Perth airports, accounting for 34% and 30% respectively.

The main importing countries for sheep exported by air in 2014 were Malaysia (82.5%), China (11%) and Singapore (5.5%).

Table 29 Load point and destination country for sheep exported by air from Australia during 2014

Country	Adelaide	Melbourne	Perth	Sydney	Total
Malaysia	9,604		9603	13,156	32,363
China		4,305			4,305
Singapore			2,200		2,200
Other		59		300	359
Total	9,604	4,364	11,803	13,456	39,227

SOURCE – Department of Agriculture

Other includes Argentina, Chile, Kazakhstan, New Zealand, Philippines, Sarawak, UAE 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%), one in 2013 (38.39%) and one in 2014 (7.91%). If these flights were excluded, the mortality rates for those years would have been 0.05%, 0.01%, and 0.01% respectively. Note that references to Federal Department of Agriculture investigation reports into mortalities over 2% are included in 6.2 Appendix 2.

All mortalities for sheep transported by air from 2008 to 2014 occurred in slaughter types and in the second half of the year. Mortalities occurred on 2.5% of flights (17 out 753).

Sheep exported by air experienced 0.45% mortalities during 2014 (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 2014

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

SOURCE – Department of Agriculture

National livestock export industry sheep, cattle and goat transport performance report 2014

4.4.2 Air transport of live cattle

Air transport of live cattle is almost exclusively confined to breeding types. During 2014 air transport accounted for the 0.73% of live cattle exports (9,458 out of 1,293,964 cattle exported). The number of cattle exported by air in 2014 fell by 2.4% compared to 2013.

4.4.2.1 Load point / destination

The loading points and destination countries for cattle transported by air from Australia in 2014 are shown in Table 31.

All of these cattle were loaded at Melbourne and Sydney airports, accounting for 68% and 32% respectively.

The main importing countries for cattle exported by air in 2014 were China (31%), Vietnam (22%), Indonesia (18%) and Malaysia (13%).

Table 31 Load point and destination country for cattle exported by air from Australia during 2014

Country	Melbourne	Sydney	Total
China	2,923		2,293
Vietnam	1,413	637	2,050
Indonesia	1,281	408	1,689
Malaysia	151	1,103	1,254
Thailand		528	528
Taiwan	373		373
Japan		348	348
Other	276	17	293
Total	6,417	3,041	9,458

SOURCE – Department of Agriculture
Other includes Bangladesh, New Caledonia, Sabah and UAE

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 0.00% mortalities during 2014 (Table 32). Expected level of mortality is nil.

Table 32 Mortality rates and number of cattle exported by air to all destinations from 2008 to 2014

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

SOURCE – Department of Agriculture

National livestock export industry sheep, cattle and goat transport performance report 2014

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 2014 accounted for the 99.8% of live goat exports (86,705 out of 86,859 goats exported).

Air transport of live goats comprises a mix of breeding and slaughter types, the majority of which are for slaughter. In 2014 97% of air-transported goats were for slaughter.

The number of goats exported by air in 2014 rose by 16.6% compared to 2013.

4.4.3.1 Load point / destination

The loading points and destination countries for goats transported by air from Australia in 2014 are shown in Table 33.

The majority of these goats were loaded at Sydney and Adelaide airports, accounting for 51% and 46% respectively.

The main importing country for goats exported by air in 2014 was Malaysia, which took 97% of the numbers exported.

Table 33 Load point and destination country for goats exported by air from Australia during 2014

Country	Adelaide	Brisbane	Melbourne	Perth	Sydney	Total
Malaysia	39,078	47		1,584	43,716	84,425
UAE			998		46	1,044
Sabah			483			483
China			250			250
Sarawak					225	225
Other		60	3		215	278
Total	39,708	107	1,734	1,584	44,202	86,705

SOURCE – Department of Agriculture

Other includes New Zealand, Philippines, Sabah, Thailand and Vietnam

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. There have been no flights with reportable mortality levels for the years 2008 to 2014.

All mortalities for goats transported by air from 2008 to 2014 occurred in slaughter types, but these comprise the vast majority of goats exported. Mortalities occurred on 1.5% of flights (15 out 1008).

Goats exported by air experienced 0.013% mortalities during 2014 (Table 34). The expected level of mortality is nil.

Table 34 Mortality rates and number of goats exported by air to all destinations from 2008 to 2014

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

SOURCE – Department of Agriculture

5 Conclusion and recommendations

5.1 Sheep, cattle and goats

This report successfully summarises the mortalities of sheep, cattle and goats exported live for the 2014 calendar year. Mortality trends were analysed and the overall mortalities for sheep, cattle and goats exported by sea were 0.71%, 0.12% and 0.00%, while overall mortalities for sheep, cattle and goats exported by air were 0.45%, 0.00% and 0.01% respectively.

It is recommended that this project continue to be funded and reported 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. 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, data held would allow a broader range of analyses than those currently presented.

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 Master's Report. In 2014, 100% of cattle exported to South-East Asia could be identified by class, and the Industry cooperation facilitating this outcome is laudable.

Analysis covering the past five years for sheep, cattle and goats exported by air was introduced for the first time in 2013. The continuation of this information in 2014 completes the coverage of live exports for these species, allowing comparison between the sea and air export industries and analysis of air exports over time.

In this report, graphs and tables presenting long-term overviews were 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.

In this report, the markets of Turkey and the Black Sea have been included in the new destination region South-East Europe, first introduced in 2012. This reflects the fact that they are no longer minor, "miscellaneous" destinations, and that they don't fit the Middle East / North Africa region because of geographical and climatic differences.

It is recommended that the graph of "delivery success rates", first presented in the 2013 Executive Summary, be included on an ongoing basis.

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

It is recommended that 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.

A formatting update has been introduced in this current report. Where mortality rate range data is presented in tables, the numbers shown have been extended to the second decimal place. This will illustrate differences that may be real but not apparent with numbers shown to one decimal place. It is recommended that this format be maintained in future reports.

6 Appendices

6.1 Appendix 1 – Research update

6.1.1 Investigating morbidity and mortality in cattle exported to the Middle East

This project was initiated in response to concerns regarding elevated mortalities in some cattle voyages to the Middle East that were attributed to bovine respiratory disease (BRD). The project aimed to describe the causes of death in cattle exported from Australia to the Middle East and to develop systems that can be used by industry to describe causes of death in future.

A new Veterinary Export Handbook was developed that included a detailed description of how to perform a necropsy, common findings, sample collection and protocols for numbers of animals to be sampled. (The Handbook has been published in a limited print edition, but is also available electronically at <http://www.veterinaryhandbook.com.au/>)

Voyages were enrolled if they met the following criteria: 3,000 or more cattle; long haul voyages (greater than 10 days duration), destined for Middle East / North African or South-East European countries.

From July 2010 to the end of the shipboard phase in October 2013, the project enrolled 31 voyages from a total of 57 eligible voyages. 28% of all mortalities on enrolled voyages were sampled.

A number of scientific papers and a PhD thesis have derived from the project. These can be found at the following internet sites:

<http://vdi.sagepub.com/content/27/1/6.long>

<http://vdi.sagepub.com/content/26/2/252.long>

<http://researchrepository.murdoch.edu.au/24046/> (thesis).

The project findings were also submitted for publication in a scientific journal in May 2014, which can be found at the following internet site: <http://onlinelibrary.wiley.com/enhanced/doi/10.1111/avj.12355/>.

The project Final report has been submitted to the research committee for consideration.

The cooperation from exporters and AA Veterinarians is gratefully acknowledged.

6.1.2 Monitoring and evaluation of the HotStuff model

Cattle and sheep being shipped to ports north of the equator can be exposed to conditions that impose thermoregulatory challenges. The maintenance of homeostasis in these animals can be aided by setting limits to the wet-bulb temperature on the animal decks. The wet-bulb temperature on the animal decks is, in turn, influenced by the ambient conditions and the stocking density.

A heat stress risk assessment model (named 'HotStuff') was developed for MLA / LiveCorp for use on long haul live export voyages to the Middle East. The HotStuff model restricts the stocking density on live export ships based on expected ambient conditions and the ship characteristics (especially the ventilation rate, or 'pen air turnover' on the animal decks).

In 2009 a technical review was undertaken by a panel of experts to examine the scientific basis, methodology and assumptions of the core elements that underpin HotStuff. Overall, the panel concluded that the methodology and assumptions underpinning HotStuff were sound, reasonable and supported by scientific literature, and that the model developers had followed well-defined and logical principles of adaptive management in the presence of uncertainty. The Review findings and a link to the Project Report can be found at the internet site - <http://www.mla.com.au/Research-and-development/Search-RD-reports/RD-report-details/Live-Export/Review-of-the-Livestock-Export-Heat-Stress-Risk-Assessment-Model-HotStuff/796>

The objectives of the current Monitoring and Evaluation Project are:

National livestock export industry sheep, cattle and goat transport performance report 2014

1. Review the HotStuff model and information that has been made available by industry in order to establish a framework and methodology that will form the basis for ongoing assessment and performance of the model.
2. Based on findings from objective one, implement and maintain a data collection system that can be used to validate the HotStuff model over a two year period.
3. Based on the data collected over the two year period, evaluate the HotStuff model predictions and provide recommendations for model enhancement.

The project completed the review of data and established the data collection system over the years 2012-2013. During this time research officers deployed loggers measuring dry bulb temperature and relative humidity on board the animal decks of ships carrying livestock across the equator.

Evaluation of data gathered for 35 voyages led to the following recommendations:

1. That the Project data be first discussed with the HotStuff developers to resolve some issues identified. From this discussion a consensus should be formed on the most appropriate measures of
 - (i) 'on-deck maximum temperatures', which would then be compared against the '5%-mortality' temperatures assumed in HotStuff for different classes of animal
 - (ii) 'heat rise due to animals' so that estimation of 'effective' deck ventilation can be made. These statistics would then be checked against the values used in the HotStuff model, and perhaps cause ventilation values to be changed.
2. Once the first recommendation has been resolved, Project methods and results will be presented and discussed at an Exporters seminar. Further monitoring to 'audit' the ventilation rate of each deck of current livestock vessels can be decided upon.

The Project was completed in 2013 but release of the findings is pending completion of recommendation 1, the further evaluation of findings with the HotStuff developers.

6.1.3 Contingency Planning review

While a Consignment Risk Management Plan (CRMP) and associated contingency plan is an Australian Government requirement for all live exports, recent incidents have demonstrated the need to review the adequacy of the contingency plans and institute changes where necessary.

Contingency planning is a necessary process to prepare for emergencies or disasters which may occur in the live export trade. The purpose of the project is to review and identify consignment risks and develop contingency planning options during the export of livestock.

The key objectives are:

1. To critically and technically assess the key emergency situations which could possibly occur during the export of livestock, and to identify all of the potential contingency options. For each of the potential contingency responses identified, the benefits, costs and associated risks will be clearly identified and described. To assist the process, an Advisory Group and a Research Group will be established to guide discussions, assist drafting and provide technical advice.
2. An Operations and Governance Manual will be prepared which outlines the available contingencies for managing emergencies and which can be used to guide optimal contingency selection.
3. A model template for developing a contingency risk management plan (CRMP) will be provided.

The project commenced in December 2012, with a draft report delivered in September 2013. The operations and governance manual and a model template for developing a contingency risk management plan (CRMP) is available for industry to trial and there is an opportunity to provide feedback (manual and template available from the LEP R&D Manager). The project is closed.

6.1.4 Heat load in sheep exported to Middle Eastern feedlots

The objectives of this project are:

1. To record the internal temperatures of sheep and their environmental conditions as they undergo transition from Australia into Middle Eastern feedlots, during 5 shipments (2 winter and 3 summer).

National livestock export industry sheep, cattle and goat transport performance report 2014

2. Gather data on the pathophysiology of any sheep clinically affected by disease during shipment and at the post-shipment feedlot, along with blood and pathology sample analysis, recorded clinical signs and the history of individual animals.
3. Gather data on other stressors (such as feeding, management, infectious disease) during the process, by tracking individual sheep through the pre-embarkation feedlot, during road transport to the port, on-board during the voyage to the Middle East, and then during their stay at the feedlot prior to slaughter.
4. To examine causes of morbidity and mortality by relating any sheep morbidity / mortality to the gathered internal / environmental data.
5. Use findings to improve risk management and to make recommendations that limit compromise to the health and welfare of the sheep, and that help minimise losses.

50 sheep per shipment for two summer-to-winter, and four winter-to-summer shipments have been monitored. Two of the winter-to-summer shipments and a follow-up summer-to-winter shipment specifically targeted a higher-humidity Middle Eastern port.

The data is currently being analysed, with a final report expected to be available later in 2015.

6.1.5 Pinkeye on long haul cattle voyages

The objectives of this project are:

1. To review current literature and gather epidemiological data from recent outbreaks of pinkeye
2. To identify microorganisms associated with the current syndrome and develop strategies for prevention

Scheduled Outcomes for the project are:

Defining the problem

Reviewing cattle eye-disease literature

Identifying the causes of pink-eye in exported cattle

Identifying environmental factors and husbandry practices that contribute to or mitigate severe eye-disease syndrome in export cattle

Test proposed solutions

The project will examine outbreaks of eye disease in pre-embarkation feedlots and on board vessels, with a focus on long-haul voyages.

Experiments to test the optimal use of immuno-therapeutic treatments and to better define the pathogen load of animals suffering eye-disease have been planned, but with options for suitable long-haul voyages being limited so far, the on-board testing has been delayed.

The Project began in May 2014, but the proposed September 2015 finish date may have to be reviewed.

6.1.6 Further improving the environment on board livestock vessels

The objectives of this project are:

1. To undertake a literature review to identify any innovations or developments that may direct research to improve environmental conditions within livestock vessels and facilities
2. Review the current best practice guidelines

The literature review has been performed with the major focus being on air quality and bedding management.

The project began in March 2014 and the final report is expected to be released later in 2015.

6.2 Appendix 2 – Federal Department of Agriculture 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 DA investigations, and so provides no comments on any findings or recommendations made.

Any internet address provided was current at the date of publication.

1. 2013 voyage carrying sheep loaded at two ports (see sections 4.1.3.2, pp10, 11; 4.1.3.3, p13; 4.1.3.5, pp15, 16):

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/biosecurity/export/live-animals/livestock/regulatory-framework/compliance-investigations/investigations-mortalities/report-46>

2. 2014 voyage carrying sheep and cattle loaded at Fremantle (see sections 4.1.3.2, p10; 4.1.3.5, pp15, 16; 4.2.3.1, p24; 4.2.3.2, p25; 4.2.3.4.p26):

This mortality incident is undergoing investigation and the summary will be published on the DA website once it is completed

3. 2010 voyage carrying cattle loaded at Fremantle (see section 4.2.3.2, p 25):

There were 16,460 cattle loaded on the vessel in Fremantle on 23 February 2010. There were 295 mortalities in the cattle which equates to a mortality percentage of 1.79%. The cattle are the subject of the investigation.

Pneumonia was the most important cause of mortality and was associated with 73.2% of the diagnosed mortalities. There are a number of factors that can contribute to the development of pneumonia in cattle. In this case breed, lack of immunity to infectious pathogens (from either background vaccination or prior exposure to pathogens), heat stress, deck conditions, stress of co-mingling, environment and transport are likely to have contributed to the development of pneumonia in these cattle.

National livestock export industry sheep, cattle and goat transport performance report 2014

Other causes of mortality included inanition, bloat, rumenal indigestion, peritonitis, enteritis, misadventure and septicaemia. Twenty five cattle were euthanased in the last three days of the voyage.

The available information indicates that on the lower decks, wet bulb temperatures were higher and the cattle on these decks experienced moderate to severe heat stress. The lack of deck washing on these decks may have contributed to this. There is insufficient information available to determine if the deck conditions had a significant effect on mortality. However, failure to clean decks when indicated, as the crew was diverted to other tasks, may suggest that there was too low a ratio of stockmen and crew to animals on this voyage.

This report is no longer available from the DA website.

4. 2014 voyage carrying cattle loaded at Geraldton (see sections 4.2.4.1, p27; 4.2.4.4, p30)

On 8 January 2014, a consignment of cattle was exported from Australia to Vietnam.

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

The main cause of mortality was euthanasia due to injuries sustained as a result of bad weather during the voyage. Mortality was highest in the steers which were loaded on decks 3, 4 and 5. This is likely due to the cattle on the higher decks experiencing more vessel rolling during the period of bad weather than the cattle on the lower decks.

<http://www.daff.gov.au/export/live-animals/livestock/regulatory-framework/compliance-investigations/investigations-mortalities/cattle-vietnam-report-50>

5. 2014 voyage carrying cattle loaded at Darwin (see section 4.2.4.1, p27; 4.2.4.4, p30)

On 13 October 2014, a consignment of cattle was exported from Darwin to the Philippines. There were 53 mortalities in this consignment of 2534 cattle, a mortality rate of 2.09 per cent. This exceeds the reportable mortality level of 0.5 per cent for cattle on voyages of less than ten days as prescribed by the *Australian Standards for the Export of Livestock (ASEL)*.

The investigation did not find any information to link the mortalities to the preparation of the cattle in the registered premises. AMSA did not identify any deficiencies with the vessel. The cattle were prepared and loaded in accordance with ASEL requirements.

Based on; the history, clinical signs, post-mortem findings and histopathological findings, shipping fever (BRD) due to an infection with *Pasteurella/Mannheimia spp* is considered the cause of the mortalities.

<http://www.daff.gov.au/export/live-animals/livestock/regulatory-framework/compliance-investigations/investigations-mortalities/cattle-philippines-report-54?wasRedirectedByModule=true>

6. 2014 voyage carrying cattle loaded at Portland (see sections 4.2.5.1, p31; 4.2.5.2, p32; 4.2.5.4, p33):

On 20 February 2014, a consignment of 2,400 cattle were exported by sea from Portland to Tianjin (China). There were 49 mortalities on the voyage, a mortality rate of 2.04 per cent. This exceeds the reportable mortality level of 1.0 per cent for cattle on voyages of ten days or greater as prescribed by the *Australian Standards for the Export of Livestock (ASEL)*.

National livestock export industry sheep, cattle and goat transport performance report 2014

The mortalities in this consignment were a result of rough weather and high seas resulting in injuries to the cattle. These cattle were initially treated by the AAV on board and those that did not respond to treatment were euthanased. Eighteen cattle were responding to treatment but were rejected from discharge in Tianjin and were euthanised at that time.

<http://www.daff.gov.au/export/live-animals/livestock/regulatory-framework/compliance-investigations/investigations-mortalities/cattle-china-report-52?wasRedirectedByModule=true>

7. 2011 voyage carrying cattle loaded at Portland (see section 4.2.6.2, p35):

On 14 and 15 June 2011, 5,022 cattle and 2,914 sheep were loaded in Portland, Victoria. On 21 and 22 June 2011, a further 3,978 cattle and 43,596 sheep were loaded in Fremantle, Western Australia. During the voyage to Turkey, 72 deaths occurred in the Portland cattle and 29 deaths occurred in the Portland sheep, equating to mortality percentages of 1.43% and 1.0% respectively. There were 35 deaths in the Fremantle cattle and 342 deaths in the Fremantle sheep, equating to mortality percentages of 0.88% and 0.78% respectively.

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

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

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

This report is no longer available from the DA website.

8. 2009 flight carrying sheep loaded at Perth (see section 4.4.1.2, p39):

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 available from the DA website.

9. 2013 flight carrying sheep loaded at Perth (see section 4.4.1.2, p39):

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.

National livestock export industry sheep, cattle and goat transport performance report 2014

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

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

10. 2014 flight carrying sheep loaded at Perth (see section 4.4.1.2, p39)

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.daff.gov.au/export/live-animals/livestock/regulatory-framework/compliance-investigations/investigations-mortalities/sheep-singapore-report-53>

11. 2008 flight carrying cattle loaded at Melbourne (see section 4.4.2.2, page 40):

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 available from the DA website.

12. 2013 flight carrying cattle loaded at Melbourne (see section 4.4.2.2, page 40):

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/biosecurity/export/live-animals/livestock/regulatory-framework/compliance-investigations/investigations-mortalities/report-47>

13. 2013 flight carrying cattle loaded at Melbourne (see section 4.4.2.2, page 40):

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/biosecurity/export/live-animals/livestock/regulatory-framework/compliance-investigations/investigations-mortalities/report-48>

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 inappetent 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

National livestock export industry sheep, cattle and goat transport performance report 2014

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

The Veterinary Handbook for Cattle, Sheep and Goats Application (2014) is available for download 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

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.

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

The cooperation of the Australian Government Department of Agriculture for provision of data regarding air transport of livestock is gratefully acknowledged.

Special thanks to R.T. Norris for reviewing this publication.

This work was funded by Meat and Livestock Australia, LiveCorp and the Department of Agriculture and Food, Western Australia.