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National livestock export industry sheep, cattle and goat transport performance report 2013

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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 2013.

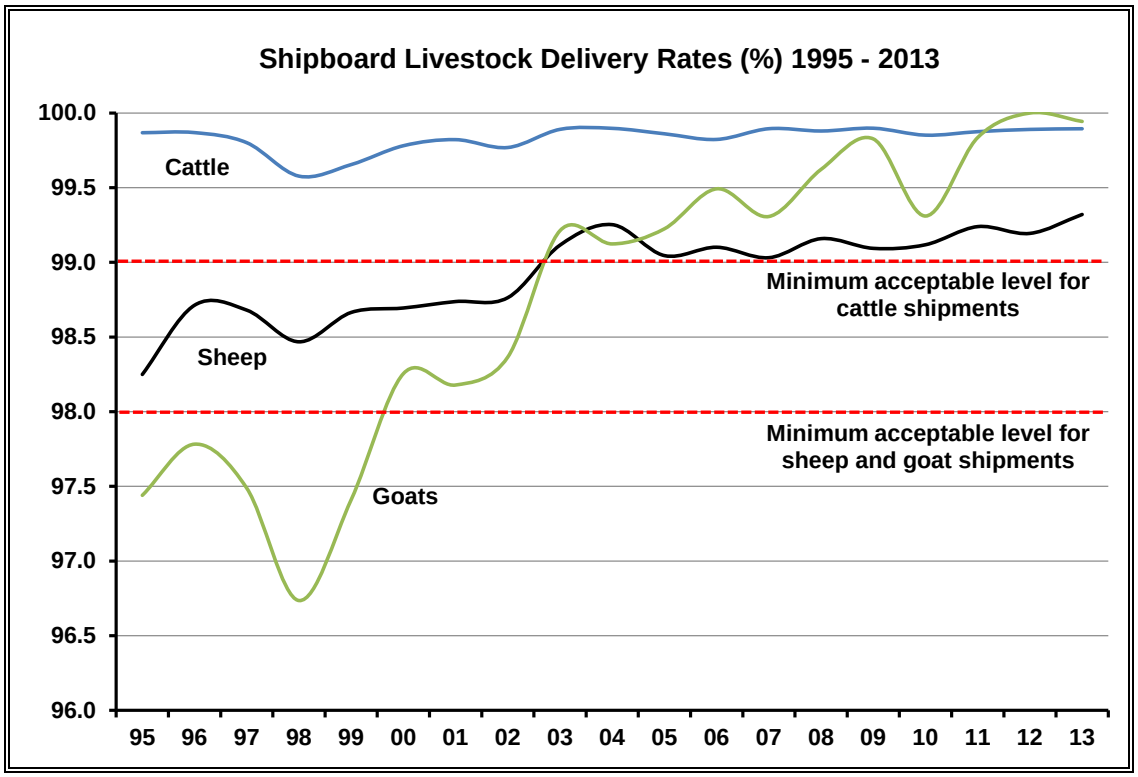
Industry stakeholders, government, animal welfare groups and the general public have a keen interest in monitoring performance in different sectors of the livestock export trade. This summary report provides the only comprehensive breakdown by ship, species, time of year, load ports and major destinations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

The overall mortality rate for sheep during sea transport to all destinations during 2013 was a record low 0.68% (13,204 mortalities in 1.94 million sheep exported). This was significantly lower than the 0.81% mortality rate for 2012. The main port of loading was Fremantle, which exported 1.69 million sheep with a mortality rate of 0.53% (8,965 mortalities), followed by Portland exporting 0.20 million sheep with a mortality rate of 0.47% (914 mortalities) and Adelaide which exported 0.06 million sheep with a mortality rate of 5.79% (3,325 mortalities).

The overall mortality rate for cattle exported from Australia in 2013 was 0.11% (888 mortalities in 0.84 million cattle exported). This was equal to the mortality rate observed in 2012. The overall mortality rate on voyages to the Middle East/North Africa was 0.17% (205 mortalities in 0.12 million cattle exported), slightly up from the record low of 0.16% experienced in 2012. The overall mortality rate on voyages to South-East Asia was 0.08% (478 mortalities in 0.59 million cattle exported), double that which was observed in 2012. The highest overall mortality rate on a regional basis was 0.18% for exports to the newly examined region of South-East Europe (80 mortalities in 0.04 million cattle exported), while the lowest overall mortality rate was 0.00% for the one voyage representing Miscellaneous Destinations.

The overall mortality rate among the 1,776 goats exported by sea from Australia in 2013 was 0.06% (1 mortality). All goats exported by sea during 2013 went to South-East Asia.

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



For completeness, summary information regarding the 0.04 million sheep, 9,624 cattle and 0.07 million goats exported by air during 2013 has been included in this report. These experienced overall mortality rates of 0.13% (45 mortalities), 0.69% (67 mortalities) and 0.01% (9 mortalities) respectively.

Contents

1 Background

The live export of sheep, cattle and goats makes a significant contribution to the Australian economy 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, 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 report refers only to voyages for which data was *received* during the calendar year, in contrast to the 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 2013 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, and also from "Yellow Books". "Yellow Books" record more detailed information about numbers of livestock mortalities (daily mortality by type-age-sex category and port of loading 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 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 docks at more than one discharge port, all the mortalities after arrival at the first port are included in the discharge phase.

The current report is for all voyages which departed Australia during 2013. 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.

In recent years the significant rise in livestock exports to Turkey and the Black Sea has boosted 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. North-East Asia includes ports in China, Japan, Korea and eastern Russia.

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 inclusion of such voyages, usually resulting from exceptional circumstances (not representing usual trade conditions, such as mechanical failure or trade dispute), would distort consideration of long-term trends. Where such voyages have been excluded from analysis of trends, there is explanatory text or footnotes to 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 7.0 (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 2004 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 2004

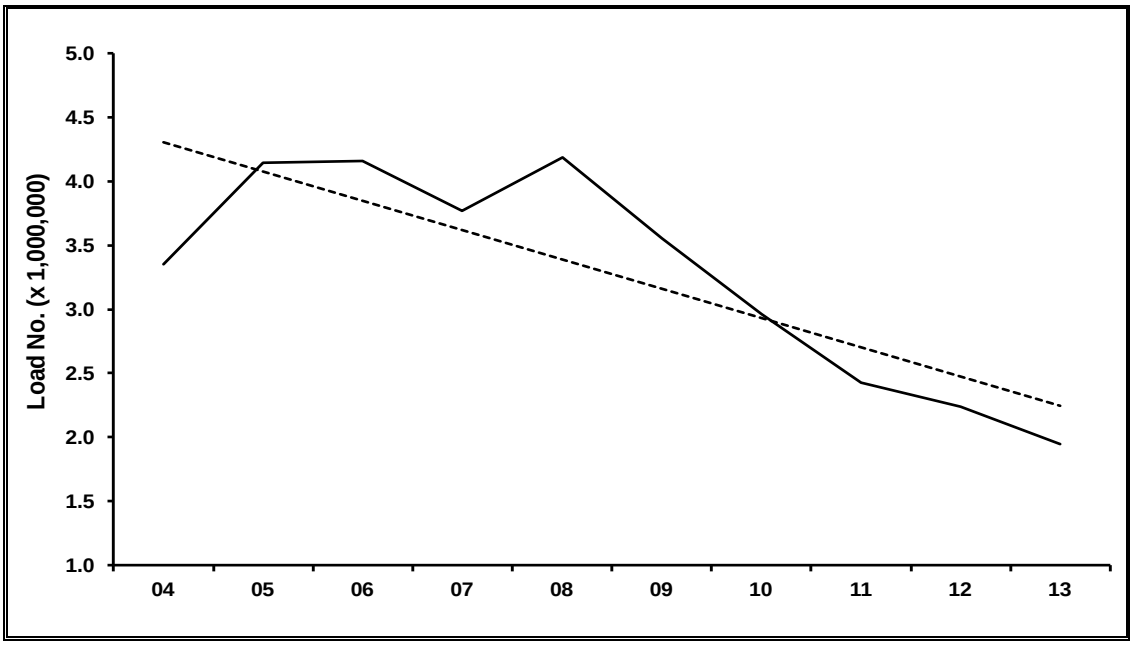
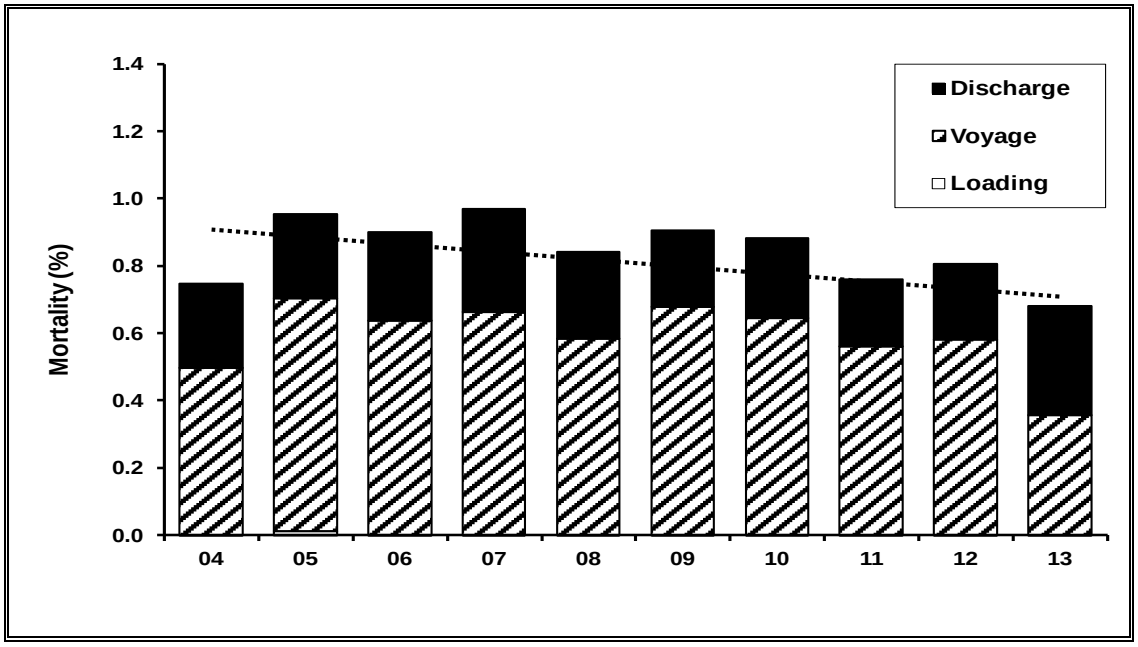


Figure 2 Annual mortality of sheep exported by sea from Australia to all destinations since 2004



4.1.2 Overview

All sheep exported live by sea from Australia in 2013 were loaded either at Fremantle (87.0%), Portland (10.1%), and Adelaide (3.0%). Overall average voyage and discharge lengths were 16.06 and 5.98 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.

There were 8 voyages to the Middle East/North Africa in 2013 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 2013. 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 37 "voyages" of sheep to the Middle East/North Africa during 2013. This involved 21 ship journeys, eight of which were split-loaded.

Approximately 1,939,000 sheep were exported to the Middle East/North Africa (99.8% of all sheep exported) and the average voyage length (voyage to first discharge port) for exports to this region was 16.31 days with 6.25 days for discharge (most voyages had multiple discharge ports). The overall mortality for these sheep was 0.68%. If one exceptional high-mortality voyage was excluded, the overall mortality would have been 0.48%

Malaysia was the destination country for the 4,440 sheep (0.2% of all sheep exported) that were exported to South-East Asia. The overall mortality rate for these sheep was 0.52% with an average voyage length of 11.46 days and an additional 1.16 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 2013

Parameter	ME/N Africa	SE Asia	Total
Voyages (No.)	37	3	40
Sheep (No.)	1,939,501	4,440	1,943,941
Mortality rate overall (%)	0.68	0.52	0.68
Mortality rate range (%)	0.2 – 7.3	0.1 – 0.7	0.1 – 7.3
Voyage days (Ave.)	16.31	11.46	15.95
Discharge days (Ave.)	6.25	1.16	5.87

Destination Country

The countries that imported Australian sheep in 2013 are shown in Table 2. With no exports of Australian live sheep to Bahrain and Saudi Arabia, the main importing countries were Kuwait (44% of all Australian sheep exports in 2013), followed by Qatar (28%) and Jordan (15%).

Overall export numbers fell by 15% compared to 2012. Exports to UAE, Oman and Kuwait rose by 67%, 66% and 19% respectively, while Turkey, Israel and Jordan fell by 100%, 18% and 14% respectively.

Table 2 Destination country for sheep exported from Australia during 2013

Country	Fremantle	Adelaide	Portland	Other	Total
Israel	54,164				54,164
Jordan	274,532	13,260			287,792
Kuwait	786,413		89,591		876,004
Oman	54,476		4,000		58,476
Qatar	375,865	45,000	139,897		560,762
Turkey				120	120
UAE	69,356		30,439		99,765
S.E. Asia	4,875			27,866	32,741
Other				3,564	3,564
Total	1,619,681	58,260	263,927	31,550	1,973,418

SOURCE – Australian Bureau of Statistics, March 2013

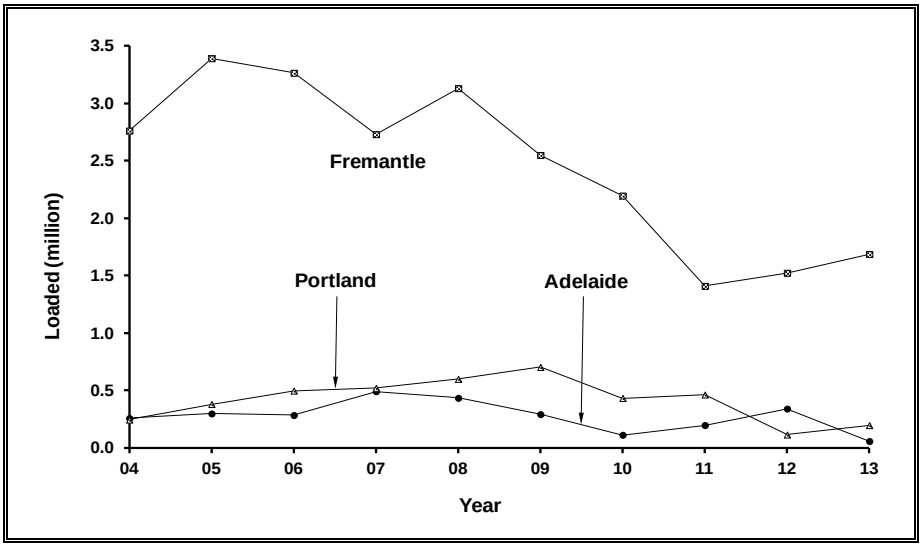
Note: As ABS figures include exports by air; figures in Table 2 may not reflect those in Table 3.

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 2013 were loaded at Fremantle (87.0% of all sheep, Figure 3) with smaller numbers loaded at Portland (10.1%), and Adelaide (3.0%).

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 2004



The number and class of sheep exported by sea to the Middle East/North Africa from Fremantle, Adelaide and Portland during 2013 are shown in Table 3. Overall numbers exported to the region in 2013 fell by 1.9% compared to 2012. Exports from Fremantle and Portland rose by 11% and 72% respectively, while exports from Adelaide fell by 83%. Exports to the region were the lowest since recording began in 1985.

The main changes in 2013 compared to 2012 were decreases in exports of adult wethers (-10%) and wether hoggets (-33%), and an increase in exports of wether lambs (31%). The decrease in adult wethers comprised an 80% fall for Adelaide, with rises from Fremantle and Portland of 5% and 38% respectively. For wether hoggets, a small rise in numbers from Portland was overwhelmed by falls of 30% and 100% from Fremantle and Adelaide respectively. The increase in wether lambs comprised a 53% rise in exports from Fremantle and falls of 100% and 96% from Adelaide and Portland.

Table 3 The numbers and classes of sheep exported by sea to the Middle East/North Africa from Fremantle, Adelaide and Portland during 2013

Livestock		Fremantle	Adelaide	Portland	Total
Wethers	adults	878,739	49,575	140,307	1,068,621
	hoggets	82,664		19,547	102,211
	lambs	482,337	1,422		483,759
Rams	adults	34,723	1,158	8,770	44,651
	hoggets	32,509		2,483	34,992
	lambs	65,564	5,313	24,820	95,697
Ewes	adults	92,281			92,281
	hoggets				
	lambs	17,289			17,289
Total	sheep	1,686,106	57,465	195,927	1,939,501

4.1.3.2 Mortality rates

The total mortality rate for all sheep exported to all destination regions during 2013 was 0.68% (Table 4), a decrease from 0.81% observed in 2012.

There were some remarkable mortality figures for sheep exported to the Middle East/North Africa in 2013 (Table 4 and Figure 4). Fremantle had record low voyage (0.36%), discharge (0.17%) and total (0.53%) mortality rates while Portland had a record low discharge mortality rate (0.11%). Adelaide had a record low voyage mortality rate (0.17%), but also a record high discharge mortality rate (5.61%), resulting in a record high total mortality rate of 5.79%. This was offset by the Fremantle and Portland results to deliver a record low overall voyage mortality of 0.35% and a record low overall total mortality rate of 0.68%.

One high-mortality voyage 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 will be appropriately annotated. A Federal Department of Agriculture investigation summary regarding this voyage is referred to in Appendix 6.2.

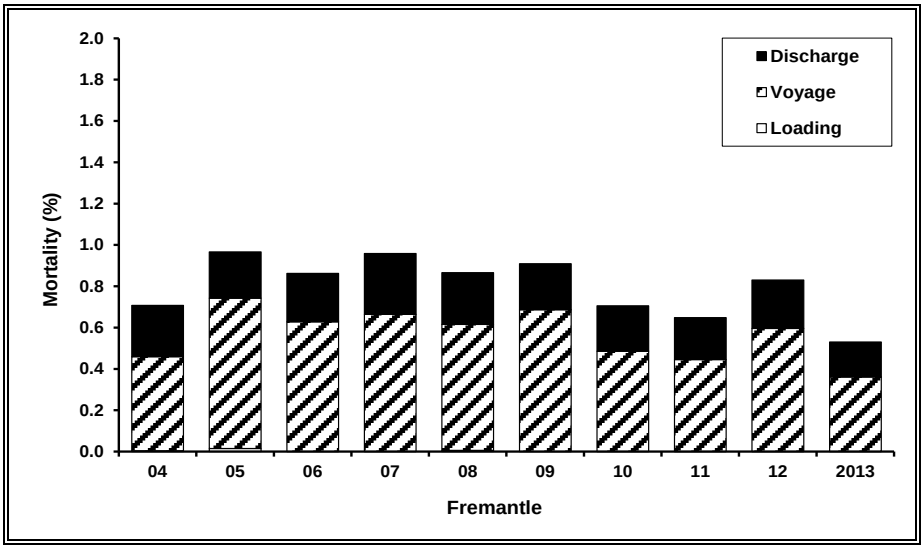
Table 4 Annual shipboard mortality rates for all sheep exported from Fremantle, Adelaide and Portland to the Middle East/North Africa, and Total mortality rate for all sheep exported to all destinations

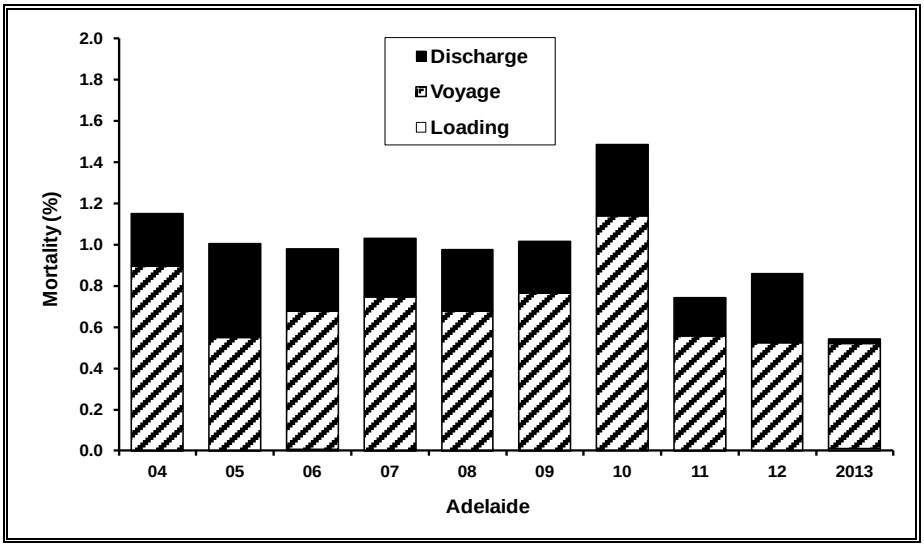
		Mortality rate (%)			
	Year	Load	Voyage	Discharge	Total
Fremantle*	2009	0.00	0.68	0.22	0.91
	2010	0.00	0.48	0.22	0.71
	2011	0.00	0.44	0.20	0.65
	2012	0.00	0.60	0.23	0.83
	2013	0.00	0.36	0.17	0.53
Adelaide*	2009	0.00	0.76	0.25	1.01
	2010	0.00	1.14	0.35	1.48
	2011	0.00	0.55	0.18	0.74
	2012	0.00	0.52	0.33	0.86
	2013	0.00	0.17	5.61	5.79
Portland*	2009	0.00	0.61	0.24	0.86
	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
Total**	2009	0.00	0.68	0.23	0.91
	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

* Middle East/North Africa only

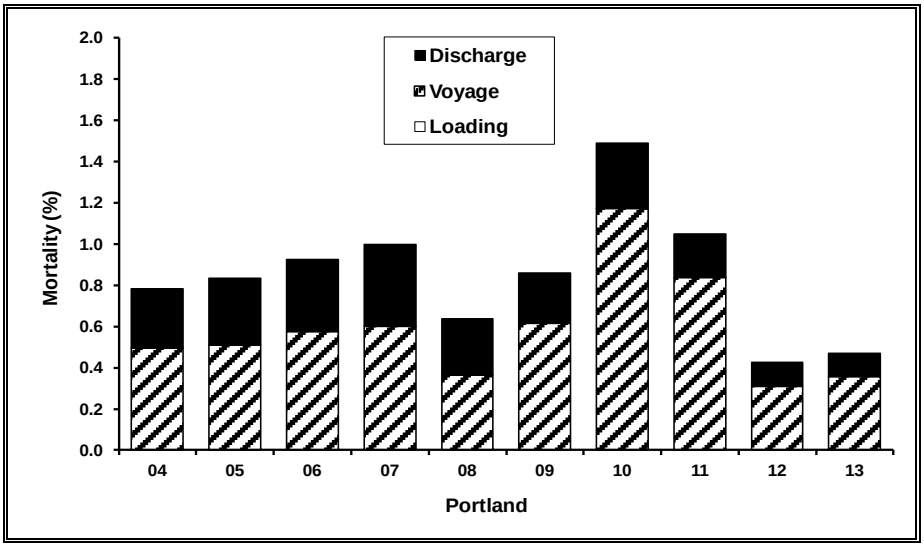
** Total includes all sheep exported by sea from Australia to all destinations

Figure 4 Annual mortality for sheep exported from Fremantle, Adelaide and Portland to the Middle East/North Africa since 2004.





Note – one exceptional voyage excluded for 2013



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 (note – one exceptional voyage caused the high Adelaide adult wether mortality; see Appendix 6.2). The highest total mortality rates for 2013 were in hogget, adult and lamb rams (1.12%, 1.09% and 0.76% respectively; refer to Table 3 for numbers loaded).

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

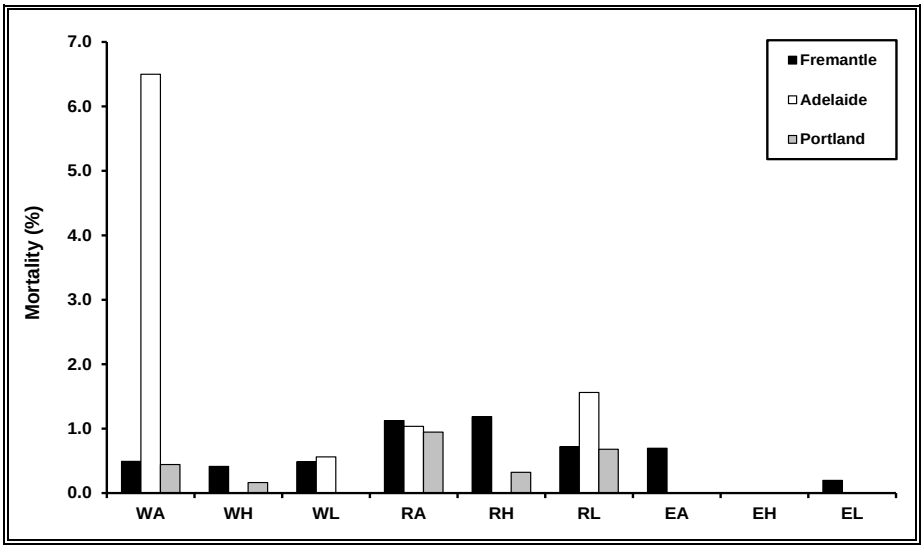
Table 5 Overall mortality (%) for classes of sheep exported from Fremantle, Adelaide and Portland to the Middle East/North Africa in 2013

Class of sheep		Fremantle	Adelaide	Portland	Total
Wethers	adult	0.49	6.50	0.44	0.76
	hogget	0.41	n/a	0.16	0.37
	lamb	0.49	0.56	n/a	0.49
Rams	adult	1.13	1.04	0.95	1.09
	hogget	1.18	n/a	0.32	1.12
	lamb	0.72	1.56	0.68	0.76
Ewes	adult	0.70	n/a	n/a	0.70
	hogget	n/a	n/a	n/a	n/a
	lamb	0.20	n/a	n/a	0.20

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 2013

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

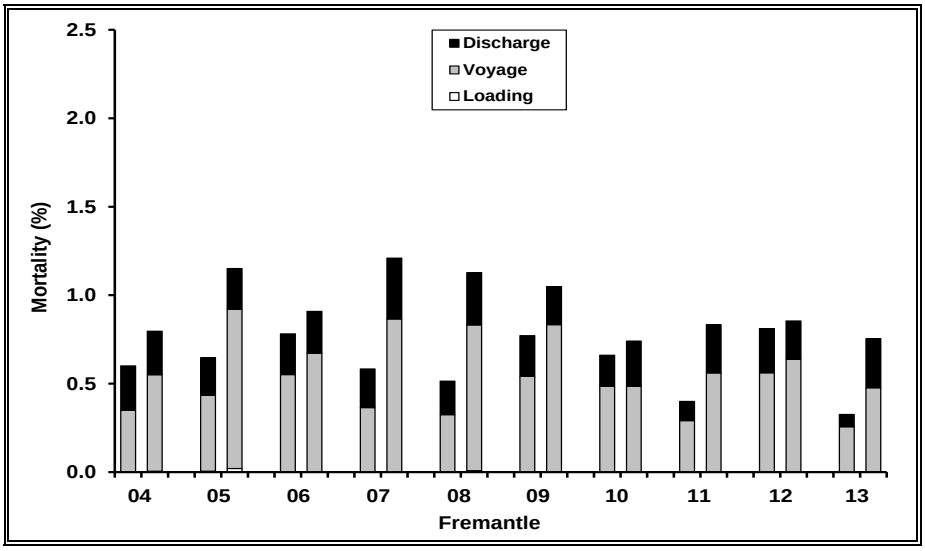


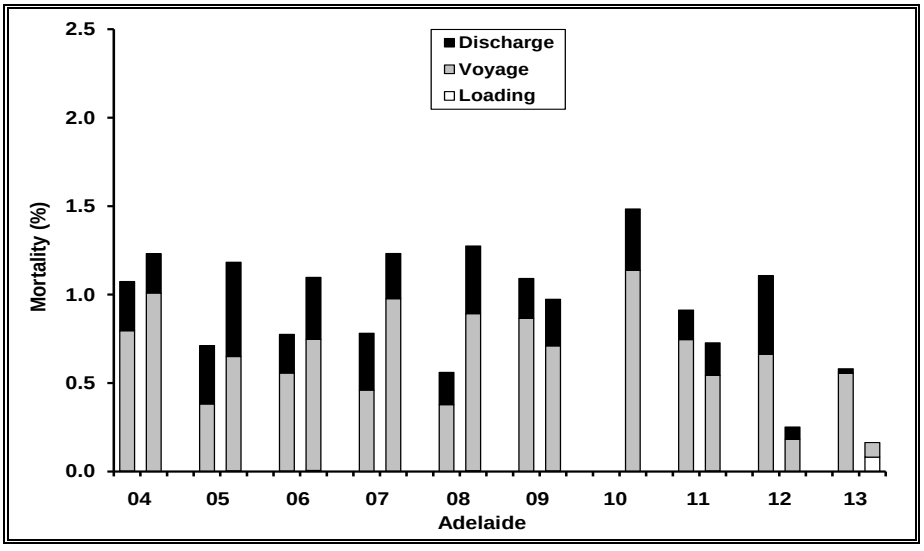
4.1.3.4 Time of year

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, being higher ($P < 0.05$) in the second half of the year compared with the first half.

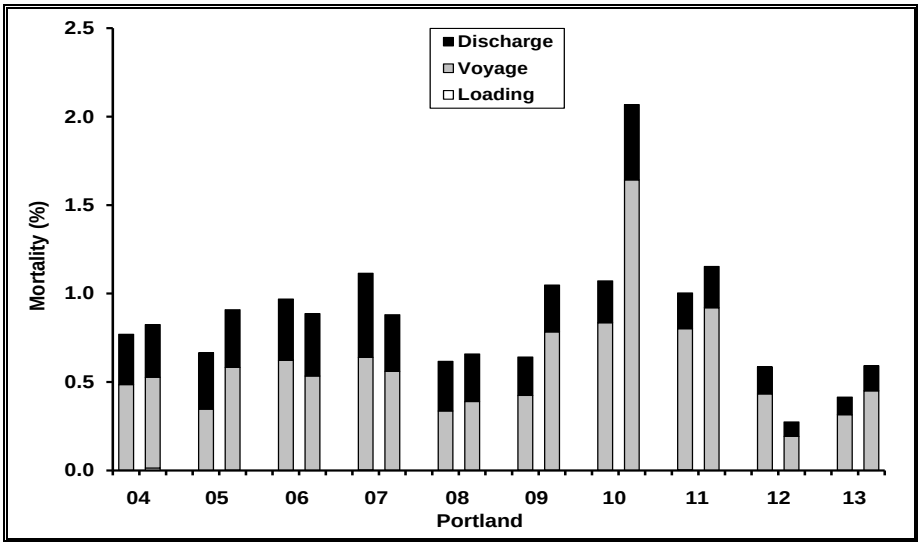
Sheep exported from Fremantle and Portland had significantly different ($P < 0.05$) mortality rates for the first and second halves of the year (Fremantle 0.33% and 0.67% respectively; Portland 0.42% and 0.59%), while half-year mortality rates for Adelaide were not significantly different (Figure 6).

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 2004 to 2013



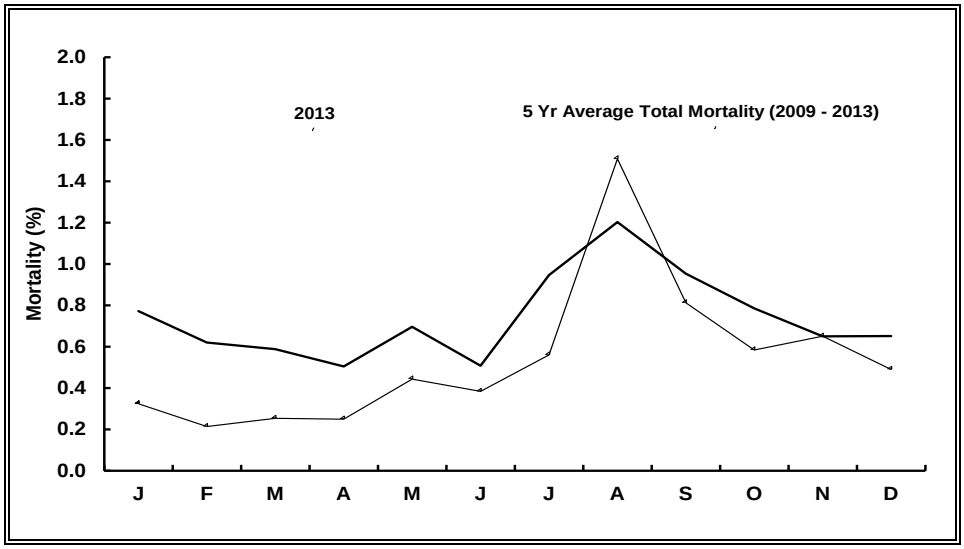


Note – one exceptional voyage excluded in 2013



In 2013, monthly mortality rates (total mortality as a proportion of total loaded for each month) in sheep exported from Fremantle followed the 5-year average profile, and were lower throughout the year except for August and November (Figure 7). The unusually low 2012 November-December figures continued on through January to May of 2013, before drawing back near the 5-year profile in June.

Figure 7 Monthly mortality rates for shipments from Fremantle to the Middle East/North Africa in 2013 and the 5-year monthly averages for the period 2009 to 2013



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 2004 to 2013. Results for ewe hoggets are not presented because of the paucity of data.

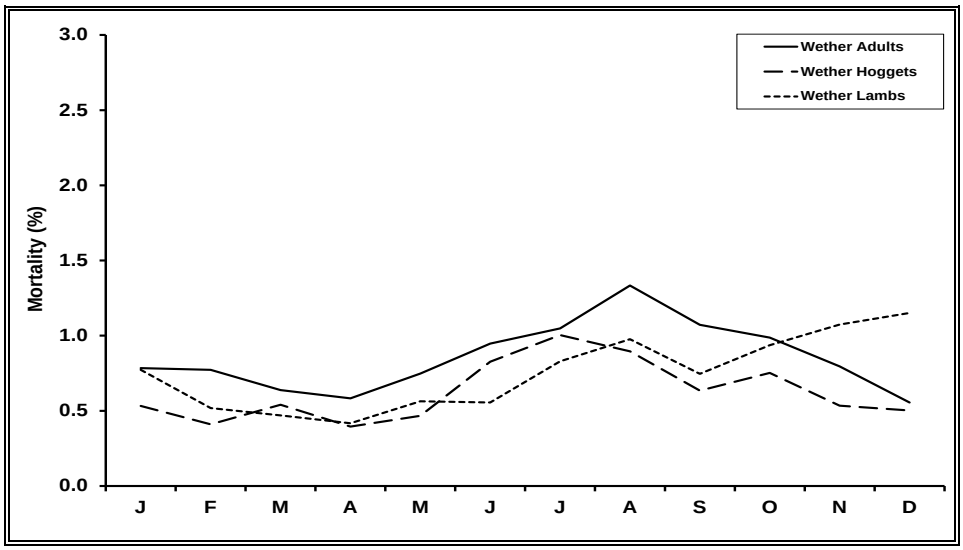
Figure 9 shows the mortality rates in the first and second half of the year for the wether classes from 2004 to 2013. There were significantly more deaths ($P < 0.05$) in the second half of the year than in the first half for each year and each age category of wethers, with the following exceptions: adult and hogget wethers in 2006, and adult wethers in 2011, and all three wether classes in 2012.

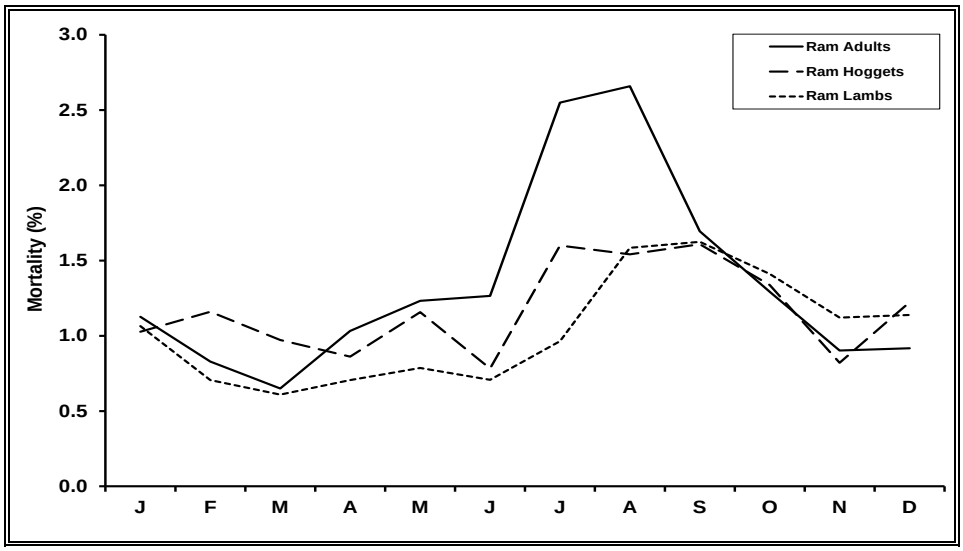
The return to the expected pattern for all wether classes in 2013 was also evident in all three ram classes and in adult ewes (results not presented). Ewe lambs showed higher mortalities in the first half of the year, but the difference was not significant.

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 has been quite definite.

Higgs et al (1991) identified a seasonal difference in mortality for adult wethers but not for wether hoggets and lambs. However, their data for this analysis was limited to 1989 only. The results shown in Figures 8 and 9 in this current report and in previous reports 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, the paucity of data in most years made conclusions unreliable.

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 2004 to 2013 (note - one exceptional voyage excluded for 2013; see Appendix 6.2).





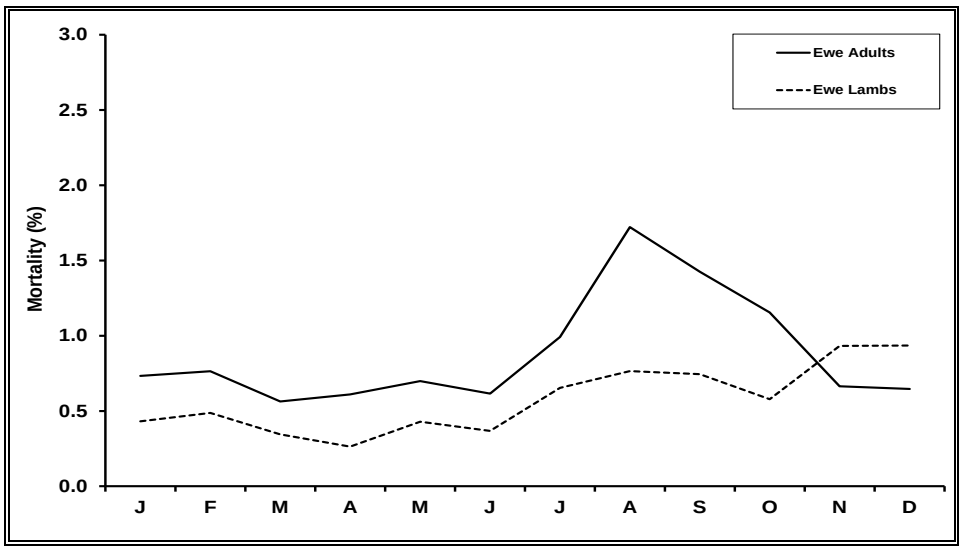
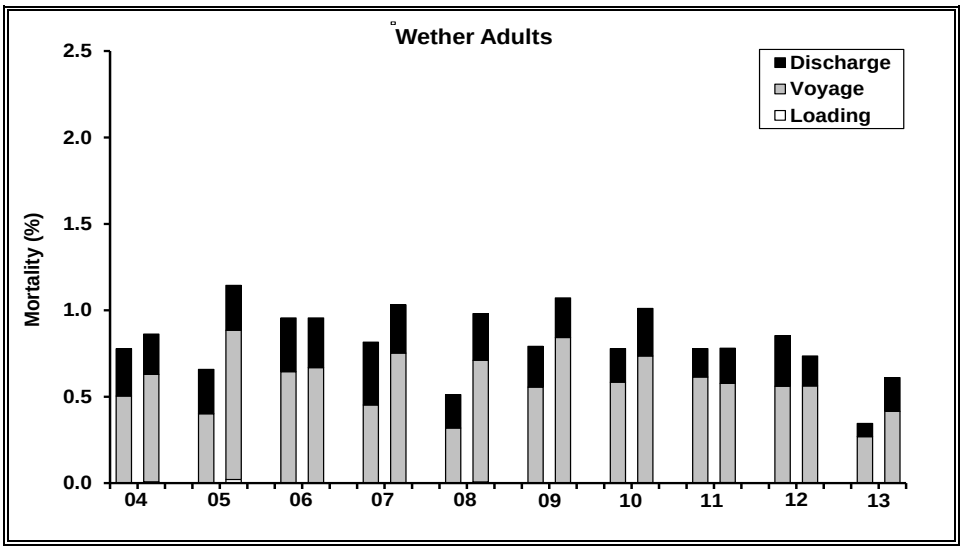
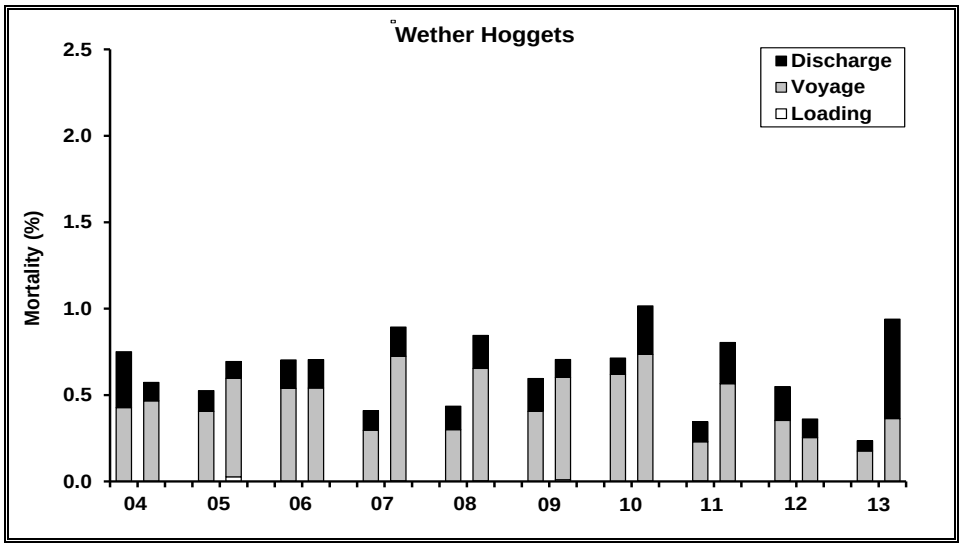
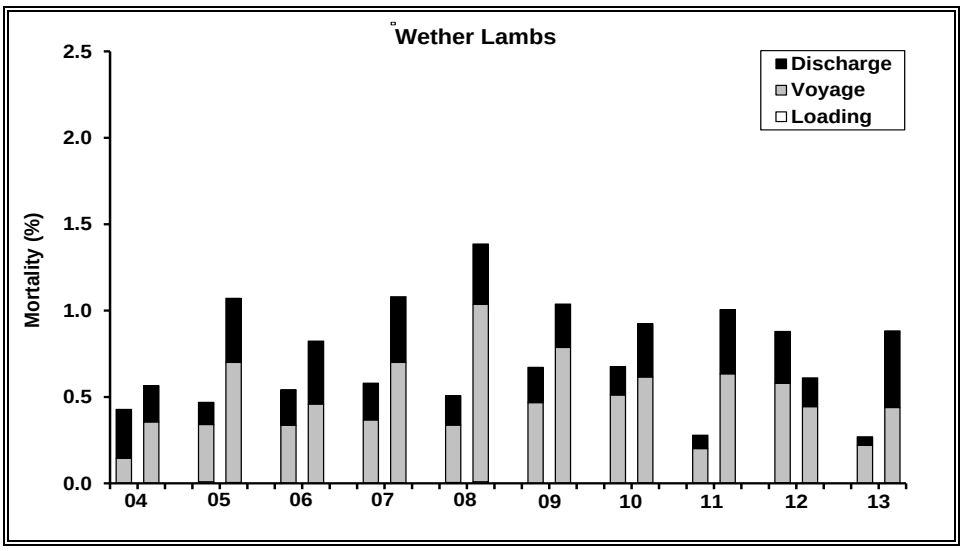


Figure 9 Mortality (%) for wether adults, hoggets and lambs exported by sea from Australia to the Middle East/North Africa for the first and second half of each year from 2004 to 2013 (note – one exceptional voyage excluded for 2013; see Appendix 6.2).







4.1.3.6 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 were only two voyages in the "high" category in 2013, both featuring ship 33. Approximately 93% of voyages from Fremantle, 67% from Adelaide and 100% 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 2013

	Mortality rate			
Ship (code)	Low <1.0%	Medium 1.0–2.0%	High >2.0%	Total
32	8	0	0	8
33	3	0	1	4
34	8	0	0	8
35	4	0	0	4
43	3	0	0	3
46	1	1	0	2
Total	27	1	1	29

Table 6b Number of voyages in low, medium and high mortality categories for ships loaded at Adelaide in 2013

	Mortality rate			
Ship (code)	Low <1.0%	Medium 1.0–2.0%	High >2.0%	Total
33	1	0	1	2
46	1	0	0	1
Total	2	0	1	3

Table 6c Number of voyages in low, medium and high mortality categories for ships loaded at Portland in 2013

	Mortality rate			
Ship (code)	Low <1.0%	Medium 1.0–2.0%	High >2.0%	Total
32	3	0	0	3
34	2	0	0	2
Total	5	0	0	5

4.2 Cattle

4.2.1 Performance trend

The number of cattle shipped from all ports in Australia to all destinations since 2004 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 2004. The number of cattle exported annually has varied from approximately 560,000 to 950,000, 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 10 Number of cattle exported by sea from Australia to all destinations since 2004

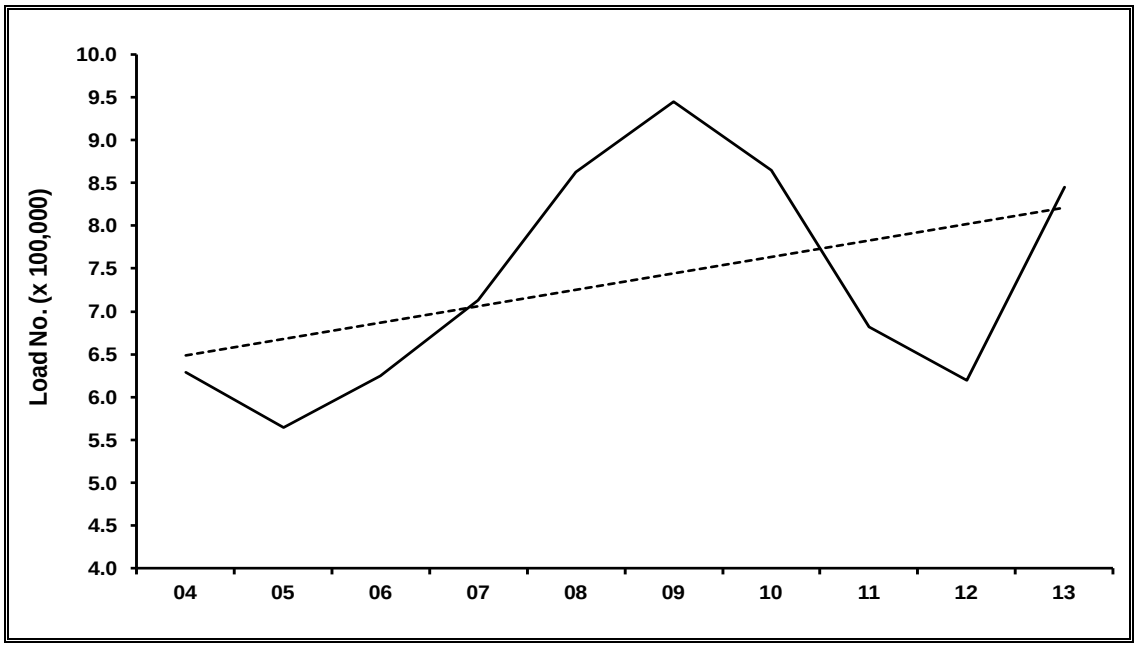
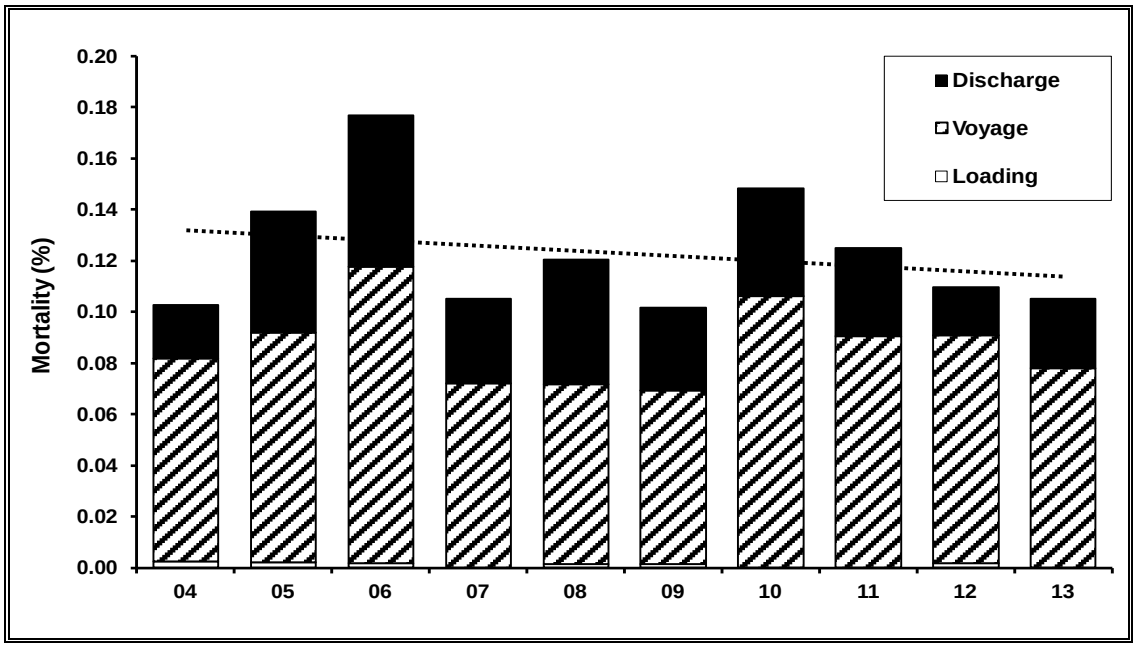


Figure 11 Annual mortality of cattle exported by sea from Australia to all destinations since 2004



4.2.2 Overview

The live cattle trade from Australia in 2013 was characterised by the large number of ports of loading in Australia and the regions to which the animals were shipped. This is in contrast to the live sheep trade where there were only three main ports of loading, and nearly all sheep were shipped to the Middle East/North Africa.

There were 14 voyages in 2013 for which cattle were loaded at more than one port in Australia. Mortalities for split-load voyages were attributed to the port of loading where possible. Where analysis involving split-load voyages has been performed, the consignments of cattle from each load port have been considered as separate “voyages”.

Using the above definition of voyage, there were 247 "voyages" of cattle during 2013. This involved 233 ship journeys, which was 22% more than in 2012. The overall number of cattle exported rose by 36% in 2013 compared to 2012.

The overall mortality rate among the 0.85 million cattle exported from Australia in 2013 was 0.11% (Table 7), matching the figure observed in 2012. The highest overall mortality rate on a regional basis was for exports to South-East Europe (0.18%), while the lowest overall mortality rate was for exports on the single voyage to a miscellaneous destination (0.00%). This single voyage of 2,000 cattle will not be examined further in this report.

The number of cattle exported to the Middle East/North Africa in 2013 rose by 24% compared to 2012, while the number of voyages rose by 6%. The mortality rate to the region remained almost the same, being 0.17% in 2013 compared to 0.16% in 2012.

The number of cattle exported to South-East Asia rose by 65% in 2013 compared to 2012, while the number of voyages to the region rose by 39% (177 and 127 respectively). Trade to South-East Asia accounted for 70% of all cattle exported in 2013, up from 58% in 2012.

In previous years, exports to South-East Asia involved small consignments on short voyages, but since 2004, larger ships have been introduced which load and/or discharge at more than one port. In 2013 these larger vessels accounted for 43% of the trade and 20% of the voyages to South-East Asia. This included four split-loaded voyages to the region.

Exports to North-East Asia in 2013 rose by 9% compared to 2012, while those to South-East Europe fell by 41%.

During 2013, 36% 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 2013

Parameter	ME/N Africa	SE Asia	NE Asia	Misc	SE Europe	Total
Voyages (No.)	33	177	31	1	5	247
Cattle (No.)	121,780	594,457	81,521	2,000	44,560	844,318
Mortality rate overall (%)	0.17	0.08	0.15	0.00	0.18	0.11
Mortality rate range (%)	0.0 – 0.4	0.0 – 0.7	0.0 – 1.2	n/a	0.1 – 0.3	0.0 – 1.2
Voyage days (Ave.)	19.28	7.27	17.63	13.05	24.59	10.55
Discharge days (Ave.)	3.99	1.92	0.68	0.60	3.87	2.08
Voyages with nil mortalities (No.)	12	71	5	1	0	89

4.2.3 Middle East/North Africa

The number of live cattle exported to the Middle East/North Africa during 2013 rose by 24% compared to 2012 (Table 8). Overall mortality rates have remained at or below 0.5% over the last decade. In 2013 the mortality rate was 0.17%, a slight rise from the record low of 0.16% set in 2012.

Table 8 Mortality rates, number of voyages, average voyage and discharge length, and number of cattle exported to the Middle East/North Africa from 2004 to 2013

Year	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days	Nil mortality voyages (No.)
2004	31	61679	0.44	0.0 – 1.3	16.10	5.55	9
2005	36	85,209	0.34	0.0 – 1.0	15.60	5.17	11
2006	43	119,297	0.52	0.0 – 4.3	16.05	4.42	13
2007	41	74,256	0.19	0.0 – 0.5	16.43	4.23	16
2008	46	120,122	0.29	0.0 – 0.8	17.09	5.02	19
2009	41	98,183	0.33	0.0 – 1.8	15.37	4.62	13
2010	37	163,869	0.40	0.0 – 1.6	17.57	3.75	14
2011	28	80,180	0.17	0.0 – 0.7	17.91	3.14	10
2012	31	98,236	0.16	0.0 – 0.9	18.53	2.74	11
2013	33	121,780	0.17	0.0 – 0.4	19.28	3.99	12

4.2.3.1 Port of loading

There were 4 ports of loading for voyages to the Middle East/North Africa in 2013, with most cattle exported from Fremantle and Adelaide (Table 9). Mortality rates in 2013 were highest from Port Hedland, followed by Adelaide and Fremantle.

The voyages from each port were classified into various mortality categories as shown in Table 10. There were no voyages in the medium or high categories. No mortalities occurred on 60% and 39% of the voyages from Portland 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 2013

Port	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days
Fremantle	23	87,939	0.17	0.0 – 0.4	18.23	4.48
Adelaide	4	16,791	0.19	0.1 – 0.3	26.45	2.92
Portland	5	9,397	0.04	0.0 – 0.1	18.27	2.42
Port Hedland	1	7,653	0.24	n/a	20.01	4.97

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 2013

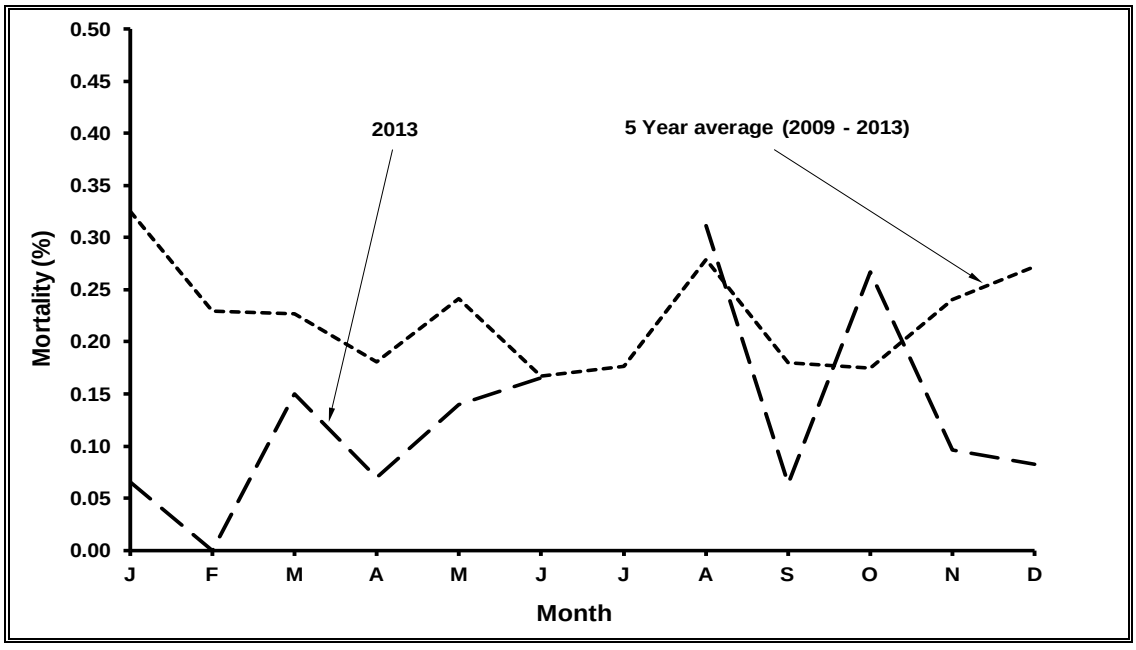
Port	Mortality rate				Total
	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	
Fremantle	9	14	0	0	23
Adelaide	0	4	0	0	4
Portland	3	2	0	0	5
Port Hedland	0	1	0	0	1
Total	12	21	0	0	33

4.2.3.2 Time of year

In 2013, monthly mortality rates (total mortality as a proportion of total loaded for each month) in cattle exported from all ports to the Middle East/North Africa remained at or below 0.3% throughout the year (Figure 12). The only months of 2013 in which the mortality rate rose above the 5 year average were August and October.

Note that one exceptional voyage in 2010 has been excluded from the 5 year average data. If this voyage were included, the February percentage would have been 0.63% for the 5 year average profile. A Federal Department of Agriculture investigation summary regarding this voyage is referred to in Appendix 6.2.

Figure 12 Monthly mortality rates of cattle on voyages from all ports to the Middle East/North Africa for 2013 and the 5-year monthly rates for the period 2009 to 2013



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. All 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 2013

	Mortality rate				
Ship (code)	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	Total
32	0	2	0	0	2
33	1	3	0	0	4
34	4	0	0	0	4
35	3	1	0	0	4
43	2	1	0	0	3
46	0	4	0	0	4
47	0	4	0	0	4
49	0	4	0	0	4
59	0	1	0	0	1
95	0	1	0	0	1
120	2	0	0	0	2
Total	12	21	0	0	33

4.2.3.4 Class of cattle

In 2013, the highest overall class mortality rate occurred in adult and weaner bulls (both 0.19%; Table 12). Bull classes made up 77% of all cattle shipped to Middle East/North Africa in 2013.

Table 12 Mortality rates, number of voyages and number of cattle in various classes exported to the Middle East/North Africa in 2013

Class	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)
Bull weaner	14	52,941	0.19	0.0 – 0.4
Bull adult*	26	41,414	0.19	0.0 – 0.5
Heifer beef	9	9,070	0.12	0.0 – 3.2**
Steer adult*	6	7,507	0.08	0.0 – 1.0
Heifer dairy	5	4,374	0.16	0.0 – 0.5
Steer weaner	4	4,004	0.03	0.0 – 0.0
Cow beef	1	2,470	0.00	n/a

* may include young as well as mature animals (i.e. animals not separately classified as "weaner")
** one mortality in 31 loaded.

4.2.4 South-East Asia

Approximately 0.59 million cattle were exported to South-East Asia in 2013 (Table 13), representing an increase of 64% compared to 2012. The mortality rate for voyages to the region almost doubled to 0.08% while the number of voyages rose by 39%. A nil mortality rate was reported on 40% 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 2004 to 2013

Year	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days	Nil mortality voyages (No.)
2004	217	465,498	0.05	0.0 – 1.8	6.17	0.92	118
2005	169	403,819	0.10	0.0 – 0.8	6.06	0.97	73
2006	166	452,516	0.09	0.0 – 1.0	6.24	1.38	66
2007	205	573,729	0.09	0.0 – 4.0	6.47	1.10	92
2008	219	682,264	0.10	0.0 – 1.9	6.33	1.14	93
2009	288	795,465	0.08	0.0 – 0.8	6.27	0.99	130
2010	202	551,761	0.04	0.0 – 0.4	6.47	0.86	105
2011	113	446,708	0.04	0.0 – 0.8	6.95	1.72	55
2012	127	361,383	0.04	0.0 – 0.8	6.71	1.32	63
2013	177	594,457	0.08	0.0 – 0.7	7.27	1.92	71

4.2.4.1 Port of loading

Most cattle exported to South-East Asia in 2013 were loaded at Darwin (60%) followed by Broome (12%) and Townsville (11%, Table 14). The mortality rate was highest for cattle exported from Geraldton (0.15%) followed by Fremantle (0.14%) and Townsville (0.11%).

The voyages from each port were classified into various mortality categories as shown in Table 15. All except three voyages were in the nil or low categories. No voyages were in the high category in 2013.

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 2013

Port	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days
Darwin	103	358,871	0.08	0.0 – 0.7	6.74	1.80
Broome	24	71,260	0.07	0.0 – 0.4	6.54	2.06
Townsville	10	65,163	0.11	0.0 – 0.2	9.14	2.91
Fremantle	14	36,825	0.14	0.0 – 0.5	10.00	1.58
Wyndham	11	31,961	0.02	0.0 – 0.2	6.29	3.02
Karumba	9	16,083	0.04	0.0 – 0.1	8.71	1.66
Geraldton	6	14,294	0.15	0.0 – 0.5	9.43	0.91

Table 15 Number of voyages in nil, low, medium and high mortality categories for shipments from various ports to South-East Asia for 2013

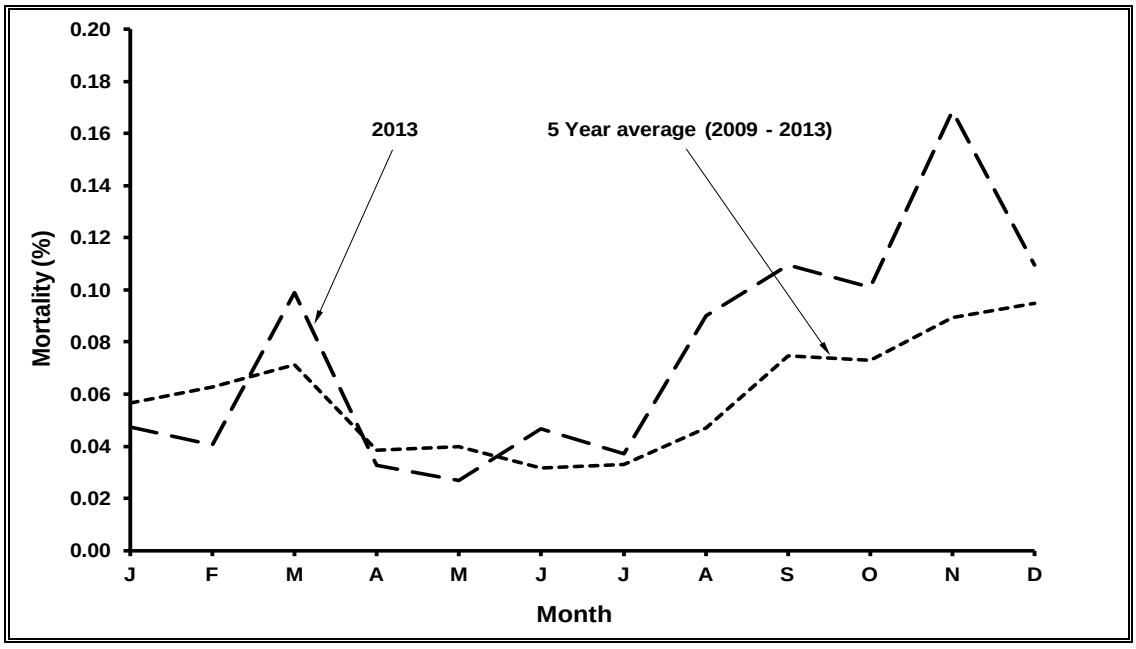
Port	Mortality rate				Total
	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	
Darwin	47	55	1	0	103
Broome	10	14	0	0	24
Townsville	1	9	0	0	10
Fremantle	3	10	1	0	14
Wyndham	6	5	0	0	11
Karumba	4	5	0	0	9
Geraldton	0	5	1	0	6
Total	71	103	3	0	177

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 2013 were below 0.12% for the year except for the month of November (Figure 13). While some November voyages were higher than average, all were well below the reportable level.

The monthly mortality rate profile for 2013 approximated that of the 5-year average.

Figure 13 Monthly mortality rates of cattle on voyages from all ports to South-East Asia for 2013 and the 5-year monthly rates for the period 2009 to 2013



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 one were in the nil or low mortality categories.

The number of voyages to the region increased by 39% in 2013 compared to 2012.

Ships with a carrying capacity of 6,000 or more head accounted for 20% of voyages to South-East Asia in 2013. They also accounted for 43% of cattle exported, 53% of mortality, 17% of voyage days and 47% of discharge days.

Table 16 Number of voyages in nil, low, medium and high mortality categories for shipments to South-East Asia for 2013

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	0	3	0	0	3
43	2	7	0	0	9
44	0	14	0	0	14
46	0	2	0	0	2
47	2	3	0	0	5
59	5	5	0	0	10
77	8	6	0	0	14
95	6	3	0	0	9
103	5	6	0	0	11
114	4	8	1	0	13
115	0	1	0	0	1
117	10	7	0	0	17
120	7	7	0	0	14
121	3	4	0	0	7
122	0	1	0	0	1
123	6	7	1	0	14
124	4	10	1	0	15
125	7	6	0	0	13
126	2	1	0	0	3
Total	71	103	3	0	177

4.2.4.4 Class of cattle

In 2013 all cattle exported to South-East Asia were able to be identified by class.

Adult steers and beef heifers comprised 63% and 21% respectively of all classes exported to the region in 2013 (Table 17).

The highest mortality rates occurred in beef cows (0.24%) followed by adult bulls (0.17%). Note that high values for mortality rate ranges consistently 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 2013

Class	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)
Steer adult*	172	376,623	0.08	0.0 – 1.3
Heifer beef	124	125,849	0.05	0.0 – 1.5
Bull adult*	77	37,562	0.17	0.0 – 5.3
Steer weaner	12	26,117	0.03	0.0 – 0.2
Cow beef	47	25,123	0.24	0.0 – 2.6
Bull weaner	6	1,889	0.00	n/a
Cow dairy	2	1,294	0.08	0.0 – 0.1

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

4.2.5 North-East Asia

The number of cattle exported to North-East Asia in 2013 rose by 9% compared to 2012 while the number of voyages rose by 1 (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 2013.

Table 18 Mortality rates, number of voyages, average voyage and discharge length, and number of cattle exported to North-East Asia from 2004 to 2013

Year	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days	Nil mortality voyages (No.)
2004	50	95,534	0.11	0.0 – 0.8	16.00	1.26	12
2005	39	58,164	0.09	0.0 – 0.4	16.48	1.74	15
2006	26	37,963	0.12	0.0 – 1.3	17.09	1.28	11
2007	21	34,837	0.06	0.0 – 0.2	16.60	1.71	10
2008	19	29,873	0.06	0.0 – 0.4	17.51	1.04	10
2009	23	48,116	0.07	0.0 – 0.2	16.91	0.70	5
2010	34	69,638	0.08	0.0 – 0.3	18.25	0.62	10
2011	31	68,773	0.15	0.0 – 0.5	18.08	0.87	5
2012	30	74,941	0.17	0.0 – 0.7	17.55	0.76	7
2013	31	81,521	0.15	0.0 – 1.2	17.63	0.68	5

4.2.5.1 Port of loading

Cattle were exported to North-East Asia mainly from Portland, Brisbane and Geelong (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 2013 there was one high mortality voyage departing from Brisbane, while 87% 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 2013

Port	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days
Portland	2	60,730	0.11	0.0 – 0.3	17.56	0.83
Brisbane	11	12,898	0.40	0.0 – 1.2	16.82	0.39
Geelong	1	4,343	0.14	n/a	20.15	0.68
Fremantle	2	3,550	0.11	0.1 – 0.3	21.49	1.05

Table 20 Number of voyages in nil, low, medium and high mortality categories for shipments from various ports to North-East Asia for 2013

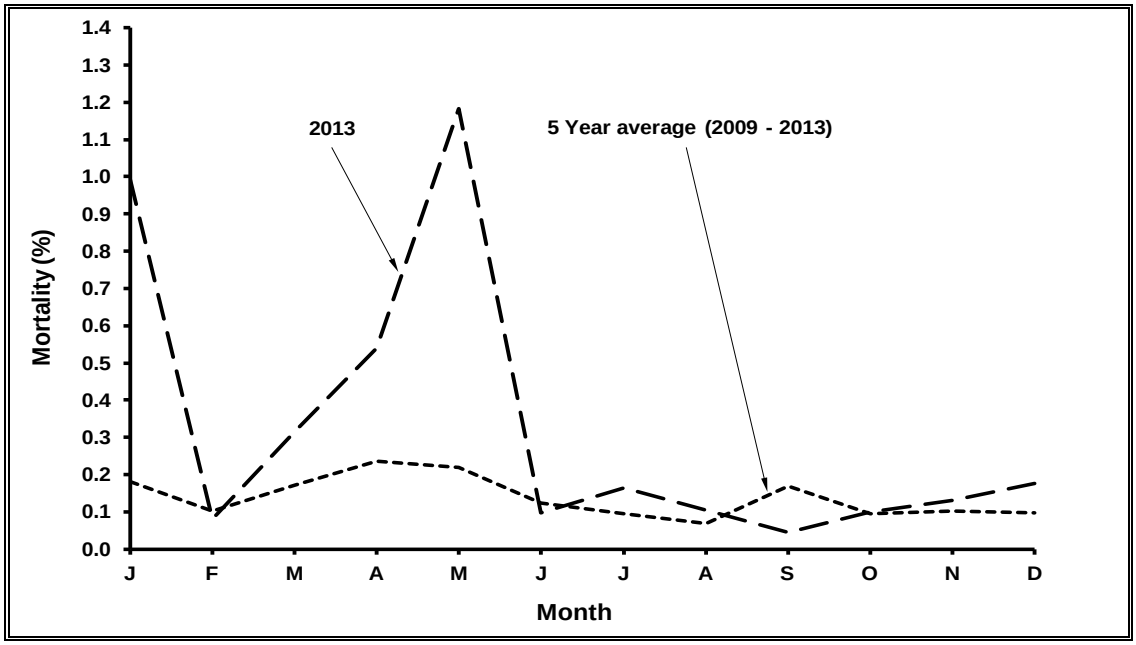
Port	Mortality rate				Total
	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	
Portland	1	16	0	0	17
Brisbane	4	3	3	1	11
Fremantle	0	2	0	0	2
Geelong	0	1	0	0	1
Total	5	22	3	1	31

4.2.5.2 Time of year

Monthly mortality rates (total mortality as a proportion of total loaded for each month) for voyages to North-East Asia in 2013 were at or below 0.5% throughout the year except for the months of January, and May (Figure 14).

One high-mortality and several medium-mortality voyages of steers to Japan resulted in the 2013 monthly mortality profile exceeding the five-year average for much of the first half of the year. The May percentage for 2013 would have been zero if the high-mortality voyage was excluded. A Federal Department of Agriculture investigation summary regarding this voyage is referred to in Appendix 6.2.

Figure 14 Monthly mortality rates of cattle on voyages from all ports to North-East Asia for 2013 and the 5-year monthly rates for the period 2009 to 2013



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 2013 there was one high mortality voyage involving ship 114. For the remainder, 87% 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 2013

	Mortality rate				
Ship (code)	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	Total
43	0	2	0	0	2
44	0	1	0	0	1
47	0	1	0	0	1
48	0	1	0	0	1
59	1	1	0	0	2
77	0	1	0	0	1
95	0	2	0	0	2
103	0	2	0	0	2
114	0	1	0	1	2
115	4	2	3	0	9
117	0	1	0	0	1
120	0	2	0	0	2
121	0	5	0	0	5
Total	5	22	3	1	31

4.2.5.4 Class of cattle

Mortality rates for classes of cattle exported to North-East Asia during 2013 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 (0.40%) followed by beef heifers (0.13%). Note that the high value in the steer mortality rate range is the subject of the Federal Department of Agriculture investigation mentioned on page 27.

Table 22 Mortality rate, number of voyages and number of cattle in the classes exported to North-East Asia in 2013

Class	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)
Heifer dairy	14	48,205	0.10	0.0 – 0.3
Heifer beef	7	20,514	0.13	0.0 – 0.3
Steer adult*	11	12,802	0.40	0.0 – 1.2

* 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 2010 while the mortality rate rose to a peak of 0.5% in 2011 before falling back to pre-2010 levels in 2013 (Table 23).

The mortality rate in cattle exported to South-East Europe fell by 36% in 2013 compared to 2012, while numbers exported fell by 41%.

Table 23 Mortality rates, number of voyages, average voyage and discharge length, and number of cattle exported to South-East Europe from 2006 to 2013

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	0.0 – 0.2	26.99	1.18	1
2008	8	14,341	0.11	0.0 – 0.2	25.42	1.17	1
2009	1	3,493	0.37	n/a	41.60	0.96	0
2010	11	78,673	0.44	0.0 – 0.8	25.08	5.03	1
2011	15	83,033	0.51	0.2 – 1.4	26.78	5.00	0
2012	14	75,170	0.28	0.0 – 0.9	28.78	3.58	1
2013	5	44,560	0.18	0.0 – 0.6	24.58	3.87	0

4.2.6.1 Port of loading

Cattle exported to South-East Europe in 2013 were all from the southern ports of Fremantle, Adelaide and Portland (Table 24). Most cattle were loaded at Portland (74%) followed by Fremantle (15%). The mortality rate was highest for cattle exported from Adelaide (0.25%).

The voyages from each port were classified into various mortality categories as shown in Table 25. All voyages were in the low category in 2013.

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 2013

Port	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days
Portland	2	32,883	0.17	0.1 – 0.2	26.01	5.79
Fremantle	2	6,828	0.16	0.1 – 0.2	22.44	3.15
Adelaide	1	4,849	0.25	n/a	26.06	1.48

Table 25 Number of voyages is nil, low, medium and high mortality categories for shipments from various ports to South-East Europe for 2013

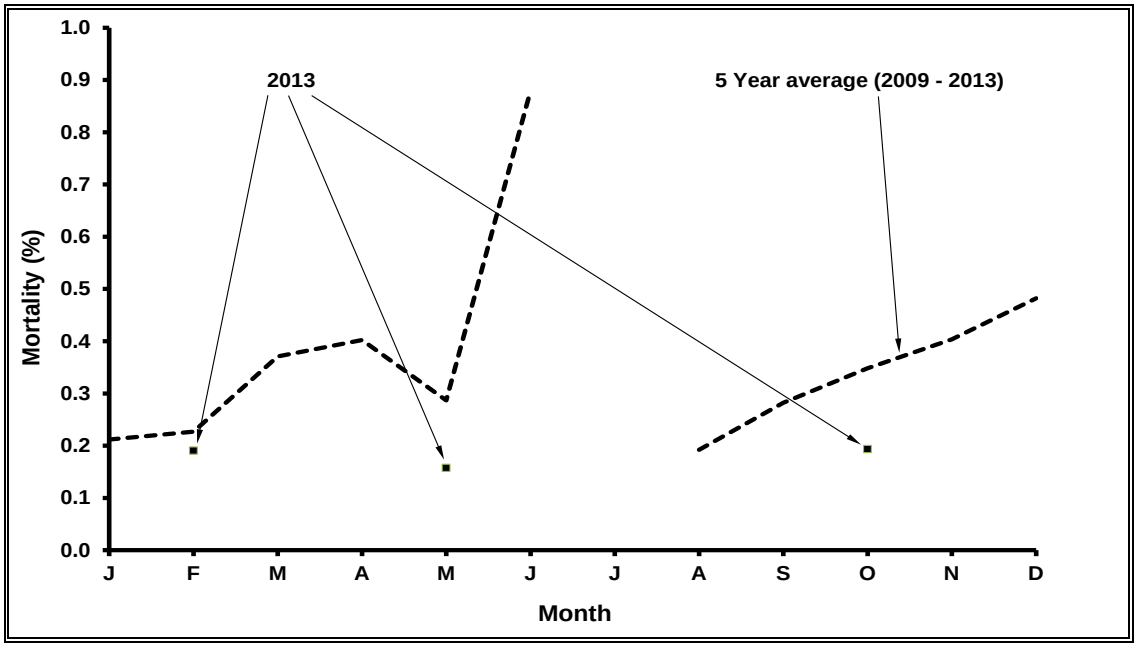
Port	Mortality rate				Total
	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	
Fremantle	1	4	1	0	6
Adelaide	0	5	0	0	5
Portland	0	2	1	0	3
Total	1	11	2	0	14

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 2013 were below 0.2% throughout the year (Figure 15).

For the three months on which voyages occurred during 2013, the monthly mortality profile was well below 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 Appendix 6.2.

Figure 15 Monthly mortality rates of cattle on voyages from all ports to South-East Europe for 2013 and the 5-year monthly rates for the period 2009 to 2013



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 2013.

Table 26 Number of voyages in nil, low, medium and high mortality categories for shipments to South-East Europe for 2013

Ship (code)	Mortality rate				Total
	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	
46	0	2	0	0	2
48	0	3	0	0	3
Total	0	5	0	0	5

4.2.6.4 Class of cattle

Mortality rates for each class of cattle exported to South-East Europe during 2013 are presented in Table 27. Cattle to South-East Europe comprised bulls (13%) and steers (10%) exported to Turkey and dairy cattle (75%) and bulls (2%) exported to Russia.

In 2013 the highest mortality rates occurred in adult bulls (0.29%) followed by weaner steers (0.27%).

Table 27 Mortality rate, number of voyages and number of cattle in the classes exported to South-East Europe in 2013

Class	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)
Heifer dairy	1	17,432	0.18	n/a
Heifer beef	2	16,103	0.15	0.1 – 0.2
Bull adult*	4	3,424	0.29	0.1 – 0.6
Bull weaner	2	3,360	0.15	0.0 – 0.2
Steer weaner	2	3,012	0.27	0.1 – 0.4
Steer adult*	2	1,229	0.16	0.0 – 0.2

* 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 600 and 26,000, and the annual mortality has varied between 0.00 and 0.88%. The trend for exports and annual mortality has continued downward.

Figure 16 Number of goats exported by sea from Australia to all destinations since 2004

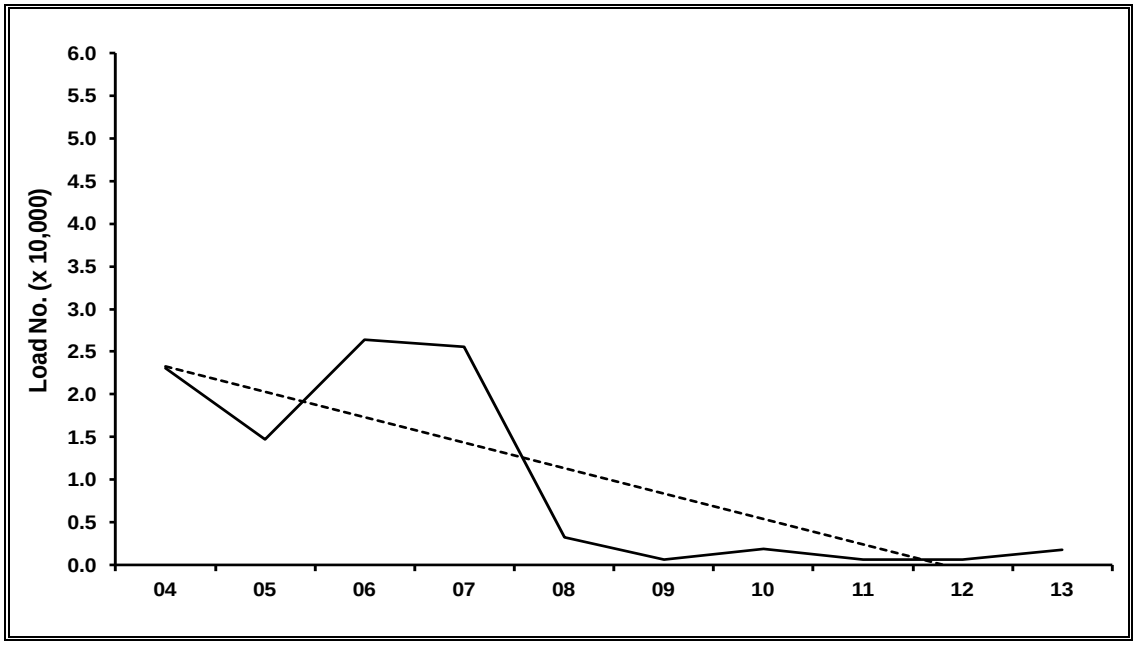
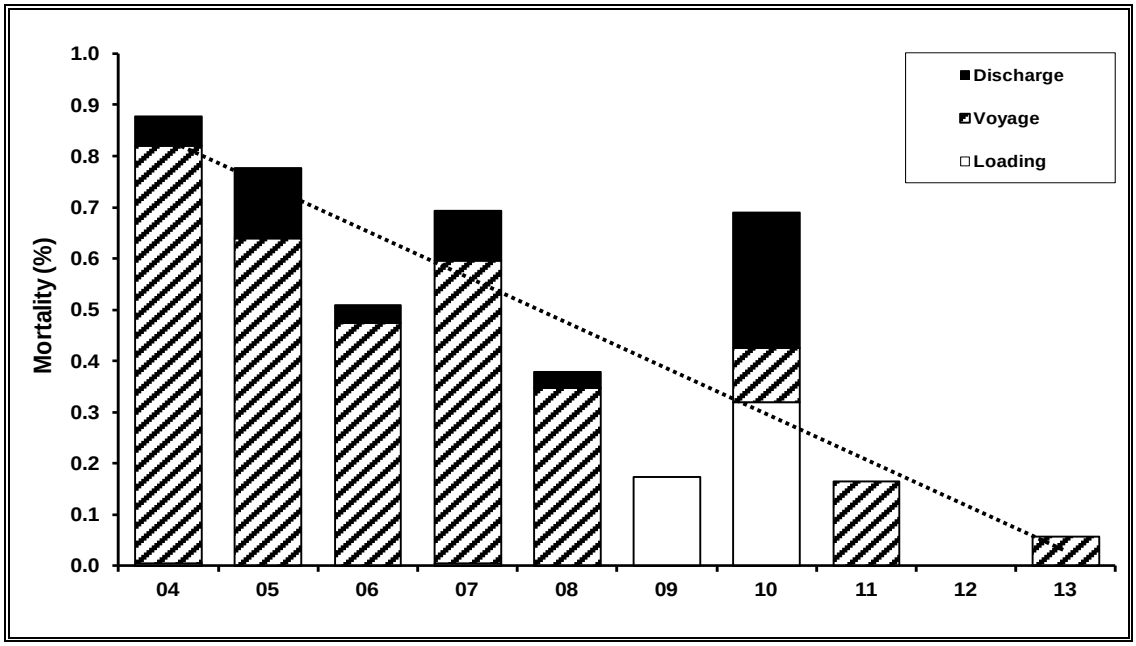


Figure 17 Annual mortality of goats exported by sea from Australia to all destinations since 2004



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 1,776 goats exported by sea from Australia in 2013. They were all carried to Brunei on three voyages, two of which were loaded in Darwin and the other in Karumba. The overall mortality rate was 0.06% after a single mortality was experienced on the Karumba voyage.

4.3.3 South-East Asia

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

Table 28 Mortality rates, number of voyages, average voyage and discharge length, and number of goats exported to South-East Asia from 2004 to 2013

Year	Voyages (No.)	Goats (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days	Nil mortality voyages (No.)
2004	29	20,801	0.93	0.0 – 2.6	7.86	0.86	8
2005	25	14,694	0.78	0.0 – 2.0	7.52	1.16	9
2006	26	26,408	0.51	0.0 – 3.0	7.67	1.89	6
2007	21	21,204	0.35	0.0 – 1.1	7.90	1.90	5
2008	8	3,180	0.75	0.0 – 5.1	9.08	0.72	3
2009	2	577	0.17	0.0 – 0.3	9.78	0.75	1
2010	5	1,885	0.69	0.0 – 1.3	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	0.0 – 0.1	7.76	1.69	2

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 2013 78% of air-transported sheep were for slaughter.

During 2013 air transport accounted for the 1.8% of live sheep exports (35,875 out of 1,979,816 sheep exported). The number of sheep exported by air in 2013 rose by 51% compared to 2012.

4.4.1.1 Load point / destination

The loading points and destination countries for sheep transported by air from Australia in 2013 are shown in Table 29.

The majority of these sheep were loaded at Perth and Sydney airports, accounting for 53% and 26% respectively.

The main importing countries for sheep exported by air in 2013 were Malaysia (79%), China (13%) and Singapore (7%).

Table 29 Load point and destination country for sheep exported by air from Australia during 2013

Country	Adelaide	Melbourne	Perth	Sydney	Total
Malaysia	2,801		16,559	9,122	28,482
China		4,694			4,694
Singapore			2,358		2,358
Other		20	115	206	341
Total	2,801	4,714	19,032	9,328	35,875

SOURCE – Department of Agriculture
Other includes Argentina, New Zealand, Norfolk Island, Sarawak, Thailand, Turkey, USA 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%) and one in 2013 (38.39%). If these flights were excluded, the mortality rates for those years would have been 0.05%, and 0.01% respectively. Note that references to Federal Department of Agriculture investigation reports into mortalities over 2% are included in Appendix 6.2.

All mortalities for sheep transported by air from 2008 to 2013 occurred in slaughter types and in the second half of the year. Mortalities occurred on 2.5% of flights (15 out 591).

Sheep exported by air experienced 0.13% mortalities during 2013 (Table 30). The expected level of mortality is 0.04%.

Table 30 Mortality rates and number of sheep exported by air to all destinations from 2008 to 2013

Year	Flights	Sheep (No.)	Total Mortalities (No.)	Mortality rate overall (%)
2008	88	11667	0	0.00
2009	68	23238	148	0.64
2010	82	21201	3	0.01
2011	94	30865	42	0.14
2012	120	23688	0	0.00
2013	139	35875	45	0.13

SOURCE – Department of Agriculture

4.4.2 Air transport of live cattle

Air transport of live cattle is almost exclusively confined to breeding types. During 2013 air transport accounted for the 1.1% of live cattle exports (9,691 out of 854,009 cattle exported). The number of cattle exported by air in 2013 rose by 24% compared to 2012.

4.4.2.1 Load point / destination

The loading points and destination countries for cattle transported by air from Australia in 2013 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 2013 were Kazakhstan (48%), Indonesia (13%) and Malaysia (13%).

Table 31 Load point and destination country for cattle exported by air from Australia during 2013

Country	Melbourne	Sydney	Total
Kazakhstan	4,613		4,613
Indonesia	788	484	1,272
Malaysia		1,243	1,243
China	937		937
Japan		695	695
Sabah		452	452
Thailand		205	205
Other	232	42	274
Total	6,570	3,121	9,691

SOURCE – Department of Agriculture
Other includes New Zealand, Philippines, Sri Lanka, Taiwan, USA and Uruguay

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 Appendix 6.2.

Cattle exported by air experienced 0.69% mortalities during 2013 (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 2013

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

SOURCE – Department of Agriculture

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 2013 accounted for the 97.7% of live goat exports (74,484 out of 76,260 goats exported).

Air transport of live goats comprises a mix of breeding and slaughter types, the majority of which are for slaughter. In 2013 96% of air-transported goats were for slaughter.

The number of goats exported by air in 2013 rose by 16% compared to 2012.

4.4.3.1 Load point / destination

The loading points and destination countries for goats transported by air from Australia in 2013 are shown in Table 33.

The majority of these goats were loaded at Sydney and Adelaide airports, accounting for 59% and 35% respectively.

The main importing country for goats exported by air in 2013 was Malaysia, which took 97% of the numbers exported.

Table 33 Load point and destination country for goats exported by air from Australia during 2013

Country	Adelaide	Melbourne	Perth	Sydney	Total
Malaysia	25,867		2,333	43,992	72,192
UAE		737		168	905
Sabah				762	762
Sarawak				465	465
Other		59		101	160
Total	25,867	796	2,333	45,488	74,484

SOURCE – Department of Agriculture
Other includes Canada, Indonesia, Norfolk Island, Thailand, Uruguay 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 2013.

All mortalities for goats transported by air from 2008 to 2013 occurred in slaughter types, but these comprise the vast majority of goats exported. Mortalities occurred on 1.1% of flights (9 out 849).

Goats exported by air experienced 0.012% mortalities during 2013 (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 2013

Year	Flights	Goats (No.)	Total Mortalities (No.)	Mortality rate overall (%)
2008	136	73149	1	0.001
2009	199	81571	0	0.000
2010	214	79949	8	0.010
2011	99	51487	1	0.002
2012	90	64209	0	0.000
2013	111	74484	9	0.012

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 2013 calendar year. Mortality trends were analysed and the overall mortalities for sheep, cattle and goats exported by sea were 0.68%, 0.11% and 0.06%, while overall mortalities for sheep, cattle and goats exported by air were 0.13%, 0.69% 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. 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 shipboard 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, and also the needs of this report. 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 2013, 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 has been introduced for the first time. This 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" presented in the 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 be appended to this report where exceptional voyages receive specific mention in the text or in footnotes. This recommendation also applies to exceptional flights.

It is also recommended for future reporting that where mortality rate range data is presented in tables, the numbers be shown to the second decimal place. This will illustrate differences that may be real but not apparent with numbers shown to one decimal place.

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 aims 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 limited printing and is available upon request to MLA)

Voyages were enrolled if they met the following criteria: 3,000 or more cattle; long haul voyages (greater than10 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.

The project findings were submitted for publication in a scientific journal in May 2014.

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/Final-report-details?projectid=14963

The objectives of the current Monitoring and Evaluation Project are:
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 concensus 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 has been delayed until completion of recommendation 1, the further evaluation of findings with the HotStuff developers.

6.1.3 Performance data collection – scoping study

This project has involved consideration of the current and likely future regulatory environments, external drivers, and current industry practices in relation to collection and management of data on animal health and welfare outcomes across the livestock export supply chain.

The Researchers recommend that the livestock export industry consider the development of a web-based, industry-owned, data management system to provide animal identification and traceability capability and associated functions limited to regulatory compliance and industry QA requirements.

The Project commenced in July 2012, and the study findings and a link to the Project Report can be found at the internet site - http://www.mla.com.au/Research-and-development/Final-report-details?projectid=15496

6.1.4 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 final report is with MLA, awaiting implementation within the Live Export sector. The CRMP is currently available for industry trial and feedback.

6.1.5 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 routine transition from Australia into Middle Eastern feedlots, during 4 shipments (2 winter and 2 summer).
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.

Researchers aim to monitor 50 sheep per shipment for at least two summer-to-winter and two winter-to-summer shipments through to the point of slaughter.

Currently one summer-to-winter, and two winter-to-summer shipments have been monitored. A winter-to-summer shipment specifically targeting a higher-humidity Middle Eastern port has also been monitored, with an intended follow-up summer-to-winter shipment planned for the same port before the project finishes in late 2014 - early 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.

This 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 cannot endorse any findings or recommendations made.

1. 2013 voyage carrying sheep loaded at two ports (see section 4.1.3.2, page 10):

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. 2010 voyage carrying cattle loaded at Fremantle (see section 4.2.3.2, page 21):

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.

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.

http://www.agriculture.gov.au/biosecurity/export/live-animals/livestock/regulatory-framework/compliance-investigations/investigations-mortalities/report-35

3. 2013 voyage carrying cattle loaded at Brisbane (see section 4.2.5.2, page 27):

On 25 May 2013, two consignments of cattle were exported on the same vessel from Australia to Japan. There were 18 mortalities in one consignment of 1260 cattle, a mortality rate of 1.43 per cent. This exceeds the reportable mortality level of one per cent for cattle on voyages of ten days or greater duration as prescribed by the ASEL. In the other consignment of 600 cattle, there were four mortalities, a mortality rate of 0.67 per cent.

The investigation did not find any information to link the mortalities to the preparation of the cattle in the registered premises or the loading of the vessel. AMSA did not identify any deficiencies with the vessel. The cattle were prepared and loaded in accordance with ASEL requirements, ate well during the voyage and were given access to adequate amounts of feed and water.

The investigation could not determine the cause of the mortalities. It is considered likely that a combination of bovine respiratory disease, cool weather before export resulting in poor acclimatisation to high temperature and humidity during the voyage, and rough shipping conditions may have contributed to the mortalities.

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

4. 2011 voyage carrying cattle loaded at Portland (see section 4.2.6.2, page 30):

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.

http://www.agriculture.gov.au/biosecurity/export/live-animals/livestock/regulatory-framework/compliance-investigations/investigations-mortalities/report-39

5. 2009 flight carrying sheep loaded at Perth (see section 4.3.1.2, page 34):

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.

http://www.agriculture.gov.au/biosecurity/export/live-animals/livestock/regulatory-framework/compliance-investigations/investigations-mortalities/report-34

6. 2013 flight carrying sheep loaded at Perth (see section 4.3.1.2, page 34):

On 7 November 2013, 112 sheep were exported by air from Perth to Kuala Lumpur. There were 44 mortalities during the flight, a mortality rate of 39.3 percent. This exceeds the reportable mortality level for sheep of two percent as prescribed by the ASEL.

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

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

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

7. 2008 flight carrying cattle loaded at Melbourne (see section 4.3.2.2, page 35):

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.

http://www.agriculture.gov.au/biosecurity/export/live-animals/livestock/regulatory-framework/compliance-investigations/investigations-mortalities/report-28

8. 2013 flight carrying cattle loaded at Melbourne (see section 4.3.2.2, page 35):

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

9. 2013 flight carrying cattle loaded at Melbourne (see section 4.3.2.2, page 35):

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 inappetant sheep during export by sea Aust Vet J **67:** 244-247

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Australian Government Department of Agriculture, Fisheries and Forestry (2012) Australian standards for the export of livestock (version 2.3) and Australian position statement on the export of livestock

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

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