final report

Project code: **W.LIV.0291**

Prepared by: **Department of Agriculture and Food, Western Australia**
GJ Norman

Date published: August 2016

ISBN: 9781740363198

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

National livestock export industry sheep, cattle and goat transport performance report 2015

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

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 2015.

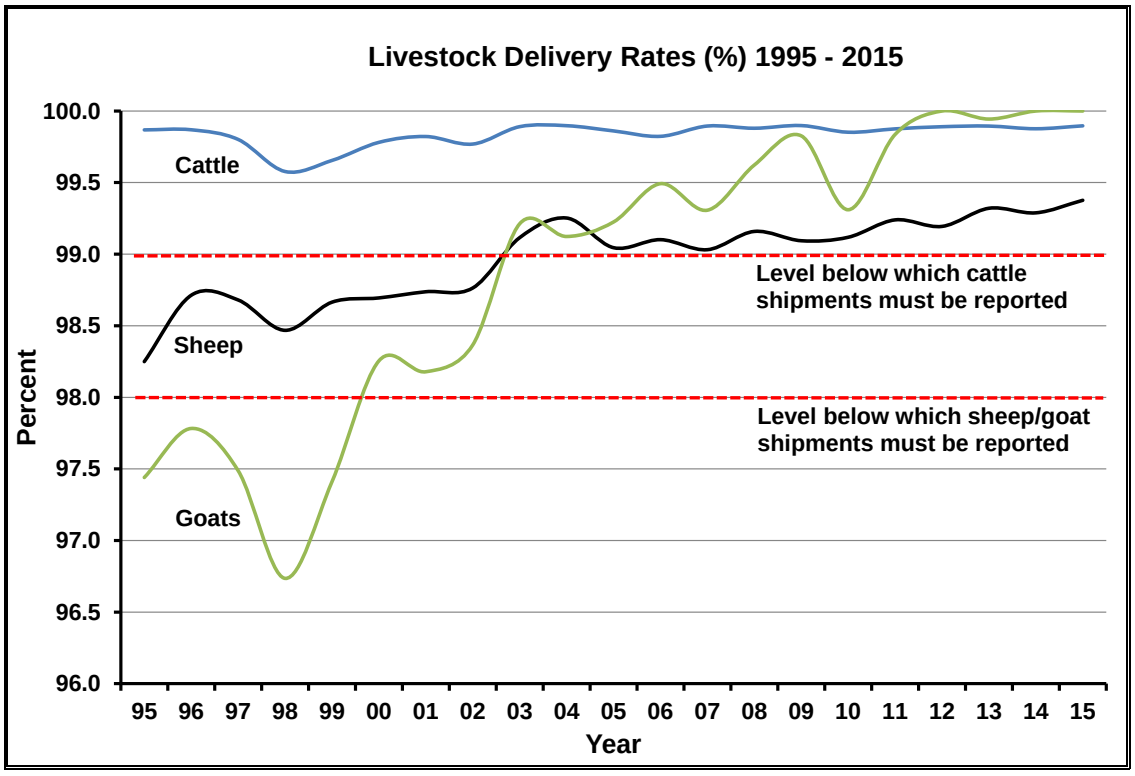
Industry stakeholders, government, animal welfare groups and the general public have a keen interest in monitoring performance in different sectors of the livestock export trade. This summary report provides the only comprehensive breakdown by species, time of year, ships, load ports and major destinations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

The overall mortality rate for sheep during sea transport to all destinations during 2015 was 0.62% (12,560 mortalities in 2.01 million sheep exported). This was well below the 0.71% mortality rate for 2014 and represents a new record low. The main port of loading was Fremantle, which exported 1.80 million sheep with a mortality rate of 0.63% (11,256 mortalities), followed by Adelaide exporting 0.18 million sheep with a mortality rate of 0.60% (1,048 mortalities) and Portland which exported 0.04 million sheep with a mortality rate of 0.61% (256 mortalities).

The overall mortality rate for the record 1.31 million cattle exported from Australia in 2015 was 0.10% (1,355 mortalities). This was well below the mortality rate of 0.12% observed in 2014. The overall mortality rates on voyages to the Middle East/North Africa and North-East Asia were 0.25% (252 mortalities in 0.10 million cattle exported) and 0.08% (81 mortalities in 0.1 million cattle exported) respectively. The overall mortality rate on voyages to South-East Asia was 0.08% (804 mortalities in 1.07 million cattle exported), equalling that which was observed in 2014. The highest overall mortality rate on a regional basis was 0.53%, again for exports to South-East Europe (215 mortalities in 0.04 million cattle exported), while the lowest overall mortality rate was 0.07% for the three voyages representing Miscellaneous Destinations (3 mortalities in 4,500 cattle exported).

There were no mortalities among the 1,000 goats exported by sea from Australia in 2015. All goats exported by sea during 2015 went to South-East Asia.

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



For completeness, summary information regarding the 56,945 sheep, 11,315 cattle and 86,925 goats exported by air during 2015 has also been included in this report. These experienced overall mortality rates of 0.24% (137 mortalities), 0.02% (2 mortalities) and 0.09% (74 mortalities) respectively.

Contents

1 Background

The live export of sheep, cattle and goats makes a significant contribution to the Australian economy, valued at around $1,500 million in 2015, and provides employment in the many services that support this industry. The livestock export trade provides important support for the sheep, cattle and goat industries of Australia and is the only market outlet for producers in some areas of the country.

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

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

It should be noted that the DA mortality figures refer only to voyages for which data was *received* during the calendar year, in contrast to this current report which refers to 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 2015 calendar year and provide an informed analysis of mortality trends in the livestock export industry, and;
b) Maintain data and expertise to provide analysis and informed comment.

3 Methodology

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

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 delivers livestock to more than one discharge port, and these are in close succession, all the mortalities after the beginning of discharge at the first of these ports 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.

Each year a number of ships' journeys involve loading at multiple Australian ports (split-load voyages). Where analysis involves split-load voyages, the consignments of livestock from each load port have been considered as separate "voyages".

Another occurrence that can inflate the number of "voyages" is where voyages have been split because the discharge phase involves completion at ports above and below the arbitrary ten-day "short-haul" and "long-haul" voyage length, which attract the DA / Australian Maritime Safety Authority (AMSA) reportable mortality limits of 0.5% and 1.0% respectively.

It can be seen that a complex voyage involving one or more load ports and an extended discharge phase over a number of regions will generate multiple "voyages". As an example, a ship might load at three ports and discharge over two regions, effectively generating six "voyages" if livestock were sent to each discharge region from each port. In most cases the current high quality of the information supplied allows this close description of the actual conditions experienced.

This is almost a "privileged problem", in that the information is usually so comprehensive that it allows tracking of consignments from individual load ports to individual discharge ports. So, the current definition of "voyage" has almost completely shifted from consignment from load port to discharge region, to consignment from load port to discharge port.

This current report is for all voyages which departed Australia during the calendar year 2015.

Information for livestock exported by air was provided by the Federal Department of Agriculture.

In this report information regarding export destinations for sheep has been sourced directly from Industry figures (shipboard and Exporter records) for the first time. This was because an irregularity in the usual information source was detected.

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

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.

In recent years the significant rise in livestock exports to Turkey and the Black Sea caused an imbalance in the "Miscellaneous Destinations" 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.

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.

All 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 exceptional voyages have been excluded from analysis of trends, explanatory text or footnotes indicate the exclusion.

Further information regarding exceptional voyages can be found at 6.2 Appendix 2.

Any Internet 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).

Readers should be aware that additional 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.

4 Results and discussion

4.1 Sheep

4.1.1 Performance trend

Figures 1 and 2 show the number of sheep exported and the percentage of mortalities during sea transport from all ports in Australia to all destinations over the last decade, as well as the trend line (linear regression) across those years. The 2.01 million sheep exported in 2015 was the second-lowest number exported since recording began in 1985. The number of sheep exported annually since 2006 has varied between 4.19 and 1.94 million, and the annual mortality has varied between 0.97 and 0.62%. 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 2006

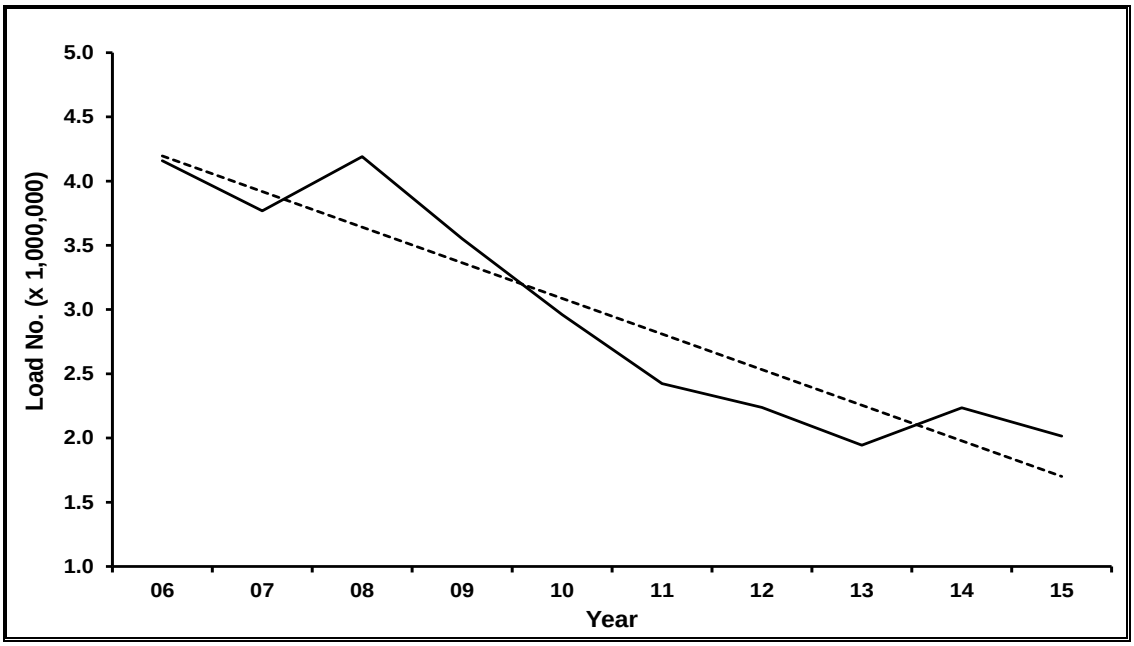
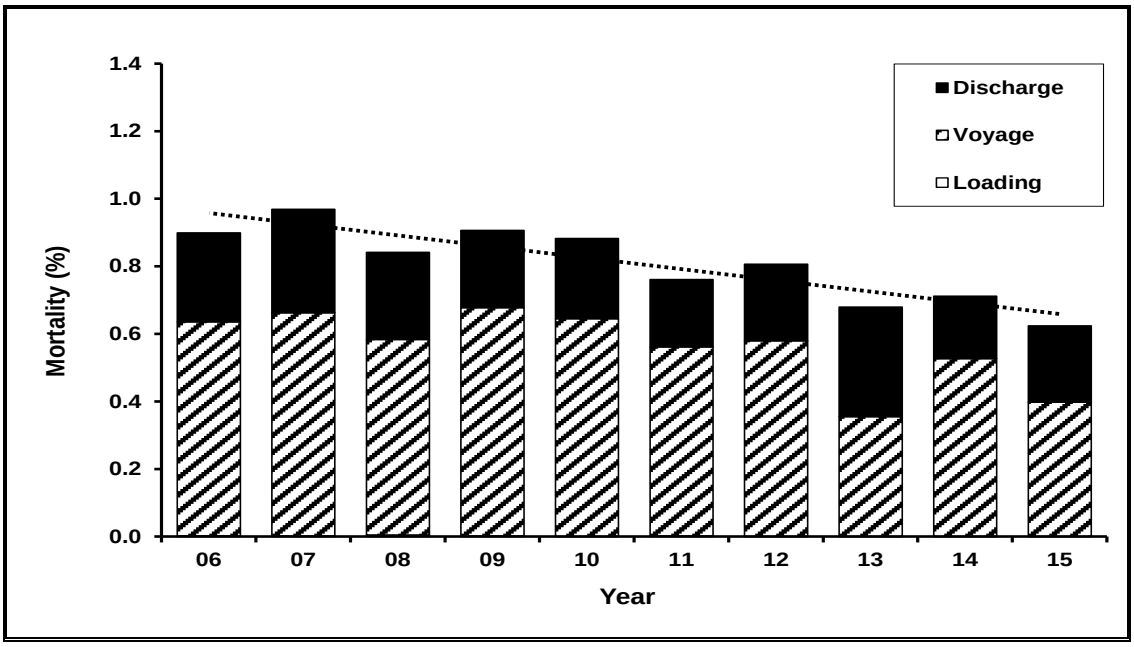


Figure 2 Annual mortality of sheep exported by sea from Australia to all destinations since 2006



4.1.2 Overview

All sheep exported live by sea from Australia in 2015 were loaded either at Fremantle (89.2%), Adelaide (8.7%), or Portland (2.1%). The overall average voyage and discharge lengths were 16.79 and 5.36 days respectively (Table 1, below).

The shipboard part of the export process is divided into three phases: loading (load); voyage to the first port of discharge (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 7 voyages to the Middle East/North Africa in 2015 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 2015. 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 38 "voyages" of sheep to the Middle East/North Africa during 2015. This involved 31 ship journeys, 7 of which were split-loaded.

2,005,913 sheep were exported to the Middle East/North Africa (99.6% of all sheep exported) and the average voyage length (voyage to first discharge port) for exports to this region was 16.96 days, with 5.73 days for discharge (most voyages had multiple discharge ports). The overall mortality for these sheep was 0.62%.

Malaysia was the destination country for the 8,458 sheep (0.4% of all sheep exported) that were exported to South-East Asia on 3 voyages. The overall mortality rate for these sheep was 0.84% with an average voyage length of 14.68 days and an additional 0.70 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 2015

Parameter	ME/N Africa	SE Asia	Total
Voyages (No.)	38	3	41
Sheep (No.)	2,005,913	8,458	2,014,371
Mortality rate overall (%)	0.62	0.84	0.62
Mortality rate range (%)	0.15 – 1.75	0.33 – 1.10	0.33 – 1.75
Voyage days (Ave.)	16.96	14.68	16.79
Discharge days (Ave.)	5.73	0.70	5.36

Destination Country

Countries that imported Australian sheep in 2015 are shown in Table 2. The main importing countries were Kuwait (36% of all Australian sheep exports), followed by Qatar (24%) and Bahrain (16%).

Overall export numbers fell by 9.9% compared to 2014. Markets changed variously, but the biggest changes contributing to the overall fall in exports were for Jordan, Kuwait, Egypt and Qatar, which experienced falls of 59%, 16%, 90% and 11% respectively.

Table 2 Destination country for sheep exported from Australia during 2015

Country	Fremantle	Adelaide	Portland	Other	Total
Bahrain	293,467	7,000	24,000		324,469
Egypt	7,678				7,678
Israel	80,357	5,201			85,558
Jordan	118,309				118,309
Kuwait	679,725	45,062	9,917		734,704
Oman	79,428		5,000		84,428
Qatar	385,769	112,000		14	497,783
U.A.E.	144,169	5,800	3,029	279	153,277
S.E. Asia	8,458			40,869	49,327
N.E. Asia				15,705	15,705
Other				78	78
Total	1,797,362	175,063	41,946	56,945	2,071,316

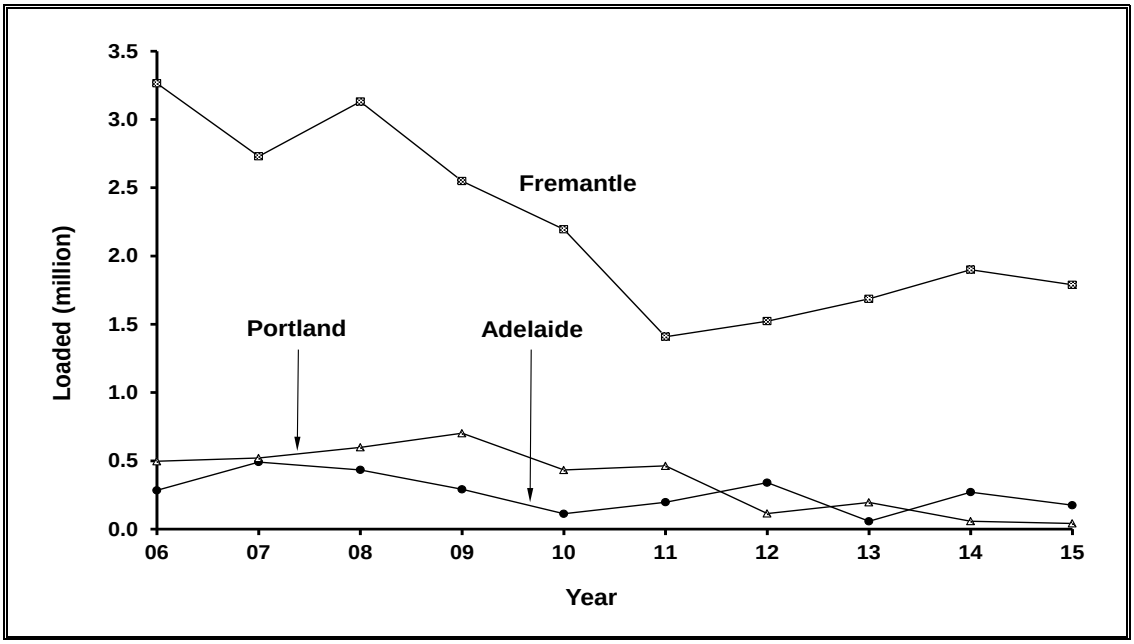
Note: figures include exports by air.

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 2015 were loaded at Fremantle (89.2%, Figure 3) with smaller numbers loaded at Adelaide (8.7%), and Portland (2.1%).

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 2006



The number and class of sheep exported by sea to the Middle East/North Africa from Fremantle, Adelaide and Portland during 2015 are shown in Table 3 (below). Overall numbers exported to the region in 2015 fell by 10.0% compared to 2014, with exports from Fremantle, Adelaide and Portland falling by 5.8%, 35.3% and 27.4 % respectively.

The main changes in 2015 compared to 2014 were decreases in exports of adult wethers (-12%) and ram lambs (-51%). The fall in adult wethers comprised decreases of -7%, -35% and -1% for Fremantle, Adelaide and Portland respectively, while the fall in ram lambs comprised a 41% decrease from Fremantle and almost a 100% decrease from Portland.

Other than small increases in wether and ewe hoggets, and a 63% increase in ewe lambs, all other class numbers fell during 2015.

Table 3 The numbers and classes of sheep exported by sea to the Middle East/North Africa from Fremantle, Adelaide and Portland during 2015

Class of Sheep		Fremantle	Adelaide	Portland	Total
Wethers	adults	955,941	161,606	41,917	1,159,464
	hoggets	185,953			185,953
	lambs	469,824	8,649		478,473
Rams	adults	34,424	404		34,828
	hoggets	10,281	2,700		12,981
	lambs	35,471	996	29	36,496
Ewes	adults	65,782			65,782
	hoggets	3,986			3,986
	lambs	27,242	708		27,950
Total	sheep	1,788,904	175,063	41,946	2,005,913

4.1.3.2 Mortality rates

The total mortality rate for all sheep exported to all destination regions during 2015 was 0.62% (Table 4, below), a decrease from the 0.71% observed in 2014 and a new record low, surpassing the 0.68% observed in 2013.

Fremantle voyage and overall mortality rates fell by 25% and 11 % respectively compared to 2014 levels, while the discharge mortality rate rose by 24% (Table 4 and Figure 4).

Adelaide voyage, discharge and overall mortality rates fell by 17%, 39% and 33% respectively. Similarly, Portland voyage, discharge and overall mortality rates fell by 5%, 31% and 15% respectively.

One high-mortality voyage each for 2013 and 2014 will not be included in some analyses, as the high mortalities occurred 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.

There were no high mortality investigations conducted for sheep exported by sea during 2015.

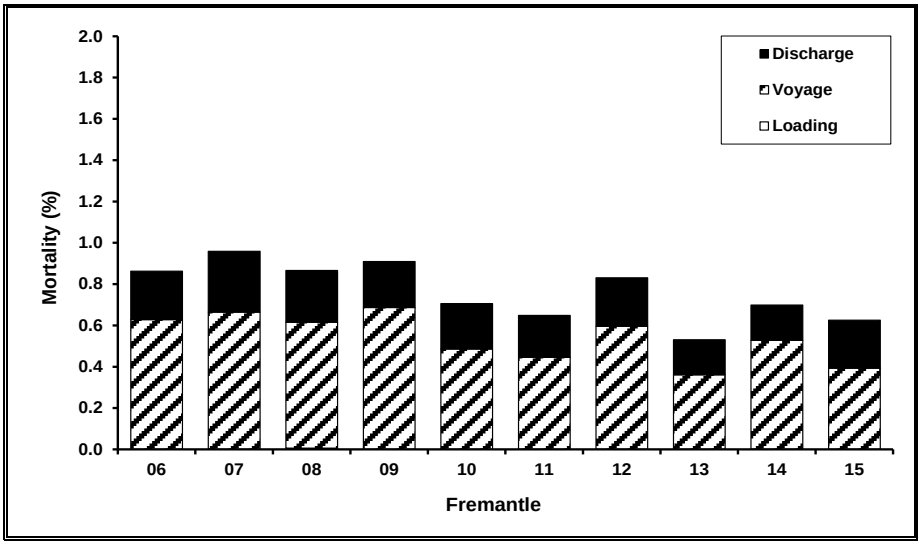
Table 4 Annual shipboard mortality rates for all sheep exported from Fremantle, Adelaide and Portland to the Middle East/North Africa, and the Total mortality rate for all sheep exported to all destinations

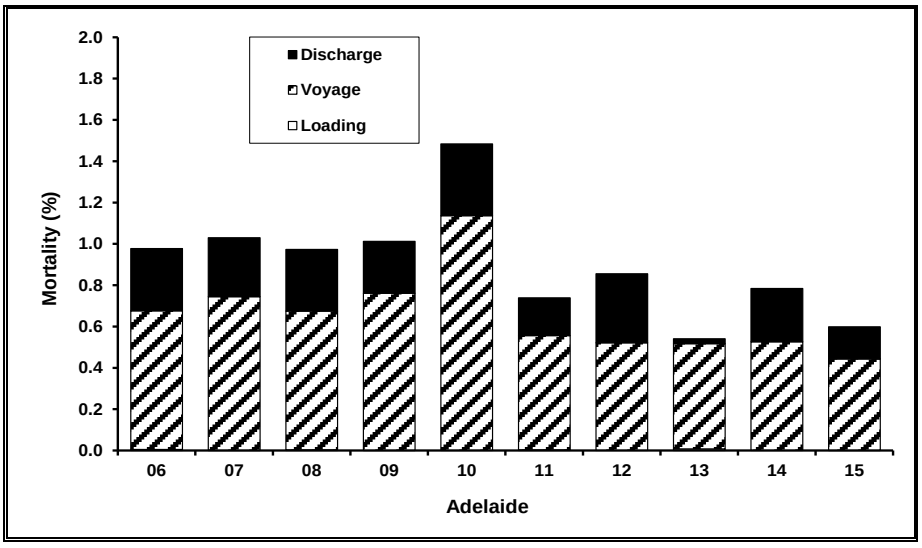
		Mortality rate (%)			
	Year	Load	Voyage	Discharge	Total
Fremantle*	2011	0.00	0.44	0.20	0.65
	2012	0.00	0.60	0.23	0.83
	2013	0.00	0.36	0.17	0.53
	2014	0.00	0.53	0.17	0.71
	2015	0.00	0.39	0.23	0.63
Adelaide*	2011	0.00	0.55	0.18	0.74
	2012	0.00	0.52	0.33	0.86
	2013	0.00	0.17	5.61	5.79
	2014	0.00	0.53	0.26	0.78
	2015	0.00	0.44	0.16	0.60
Portland*	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
	2015	0.00	0.39	0.22	0.61
Total**	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
	2015	0.00	0.40	0.23	0.62

* Middle East/North Africa only

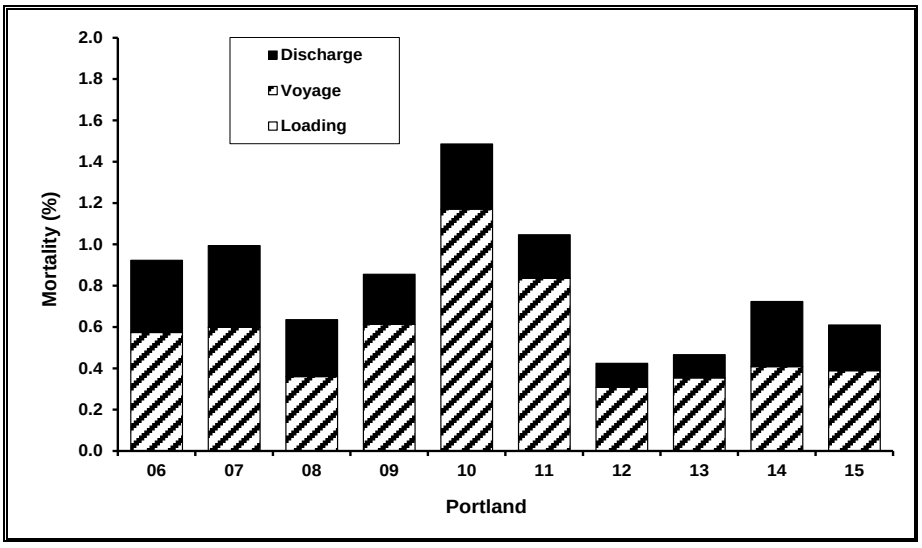
** Total includes all sheep exported by sea from Australia to all destinations

Figure 4 Annual mortality for sheep exported from Fremantle, Adelaide and Portland to the Middle East/North Africa from 2006 to 2015





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 (below). The highest total mortality rate for 2015 was in wether lambs (0.77%), followed by all the classes of rams, with ram adults, hoggets and lambs incurring 0.67%, 0.70% and 0.64% 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.

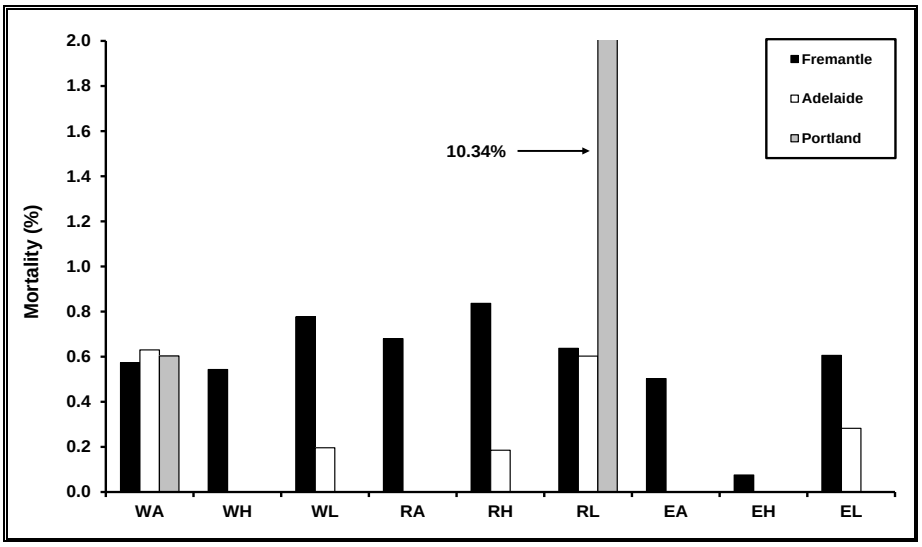
Table 5 Overall mortality (%) for classes of sheep exported from Fremantle, Adelaide and Portland to the Middle East/North Africa in 2015

Class of Sheep		Fremantle	Adelaide	Portland	Total
Wethers	adults	0.57	0.63	0.60	0.58
	hoggets	0.54	n/a	n/a	0.54
	lambs	0.78	0.20	n/a	0.77
Rams	adults	0.68	0.00	n/a	0.67
	hoggets	0.84	0.19	n/a	0.70
	lambs	0.64	0.60	10.34*	0.64
Ewes	adults	0.50	n/a	n/a	0.50
	hoggets	0.08	n/a	n/a	0.08
	lambs	0.61	0.28	n/a	0.60

n/a - not applicable (no sheep of this class were loaded)
* - a few deaths in a very small number loaded

Figure 5 Overall mortality (%) for classes of sheep exported from Fremantle, Adelaide and Portland to the Middle East/North Africa in 2015

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

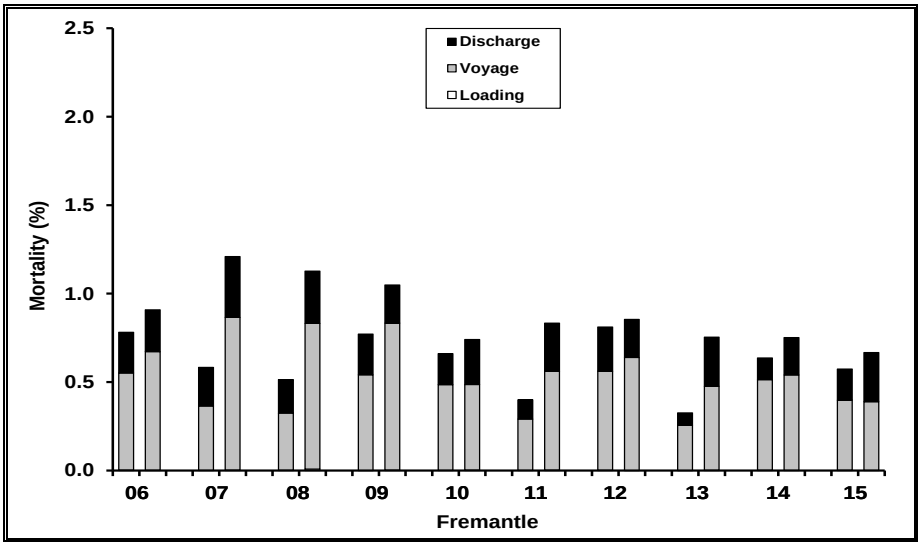


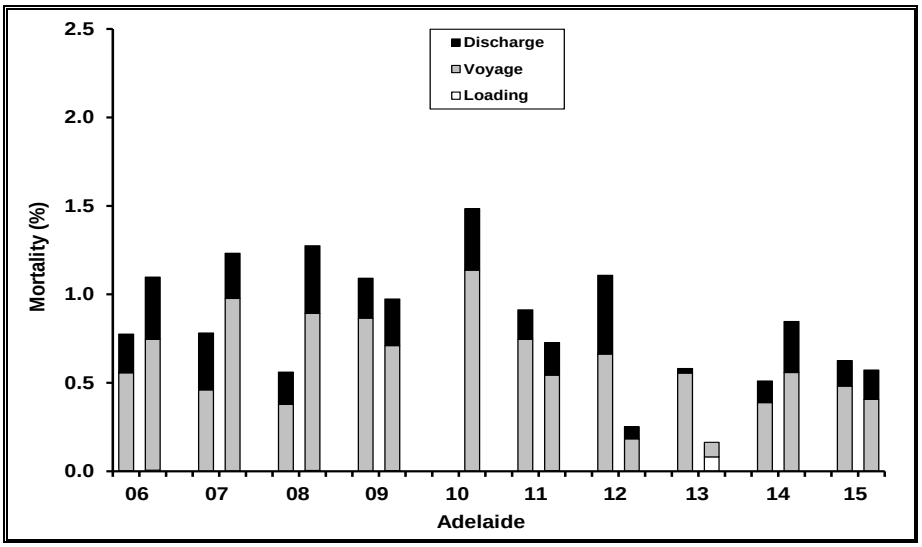
4.1.3.4 Time of year

Overall half-yearly mortality rates for sheep exported to the region were higher in the second half of the year compared with the first half. This was driven by Fremantle sheep, which had significantly different ($P < 0.05$) mortality rates for the first and second halves of the year (0.57% and 0.67% respectively).

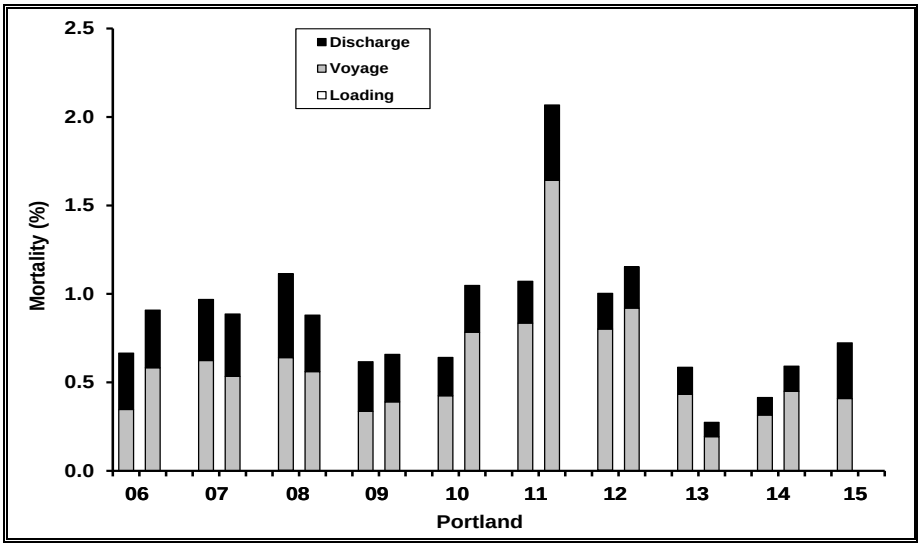
Though first half mortalities for Adelaide were higher (0.63% and 0.57% respectively), the difference was not significant. Portland exported sheep only in the first half of the year.

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 2006 to 2015



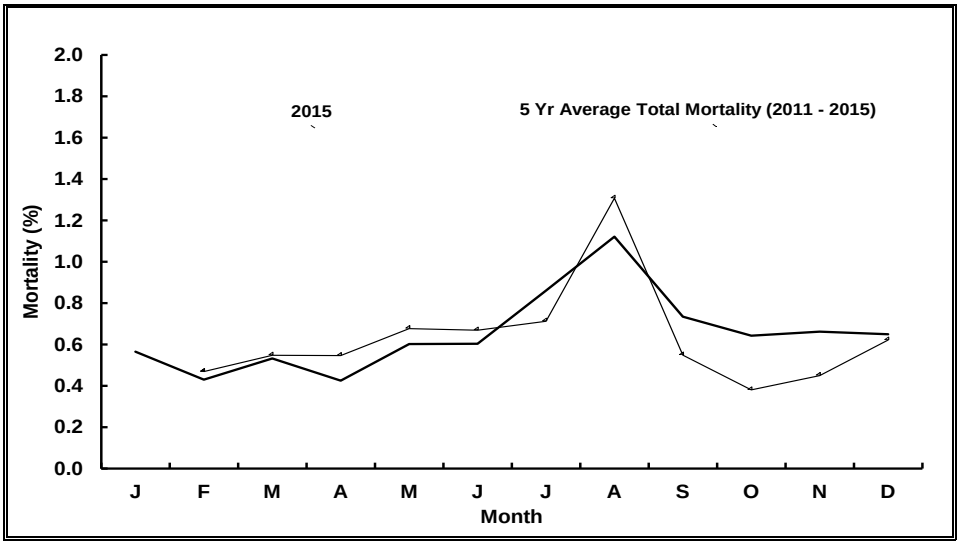


Note – one exceptional voyage excluded in 2013



In 2015, monthly mortality rates (total mortality as a proportion of total loaded for each month) in sheep exported from Fremantle approximated the 5-year average profile, apart from being unusually lower from September to November (Figure 7, below). There were no exports from Fremantle in January 2015.

Figure 7 Monthly mortality rates for shipments from Fremantle to the Middle East/North Africa in 2015 and the 5-year monthly averages for the period 2011 to 2015



4.1.3.5 Time of year and age of sheep

Figure 8, below, 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 2006 to 2015. Results for ewe hoggets are not presented because of the paucity of data.

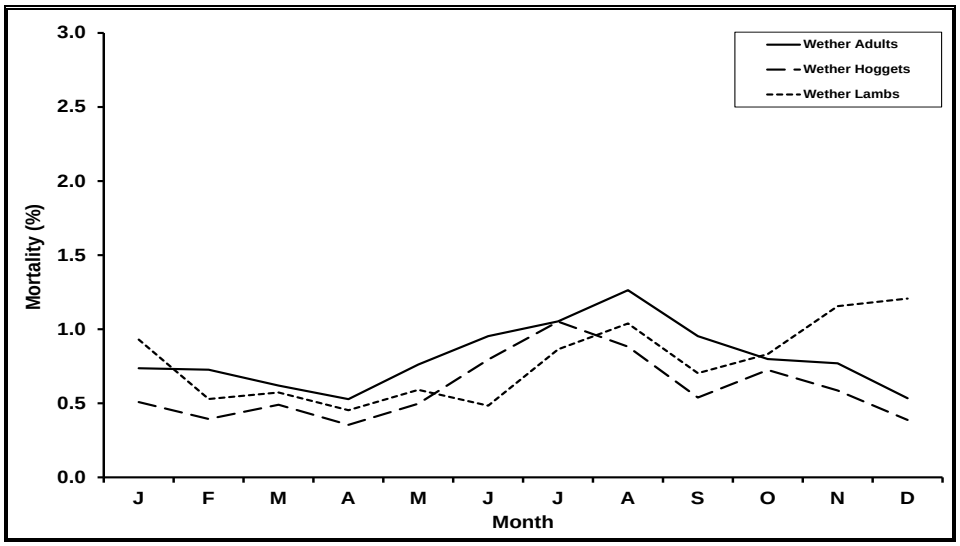
Figure 9, below, shows the mortality rates in the first and second half of the year for the wether classes from 2006 to 2015. There were significantly more deaths ($P < 0.05$) in the second half of the year than in the first half for each year and each age category of wethers, with the following exceptions: adult and hogget wethers in 2006, and adult wethers in 2011, and all three wether classes in 2012.

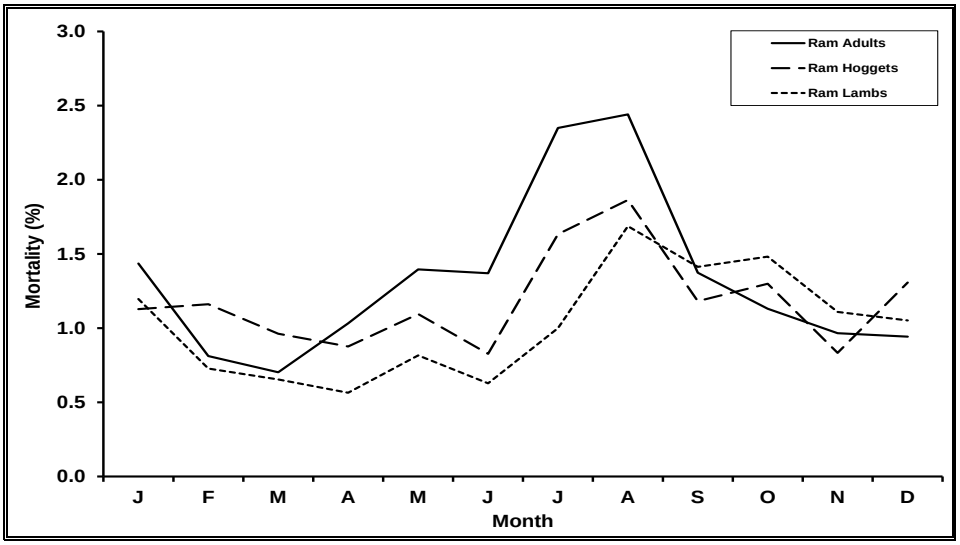
The return to the expected pattern for all wether classes in 2013 was also evident in all three ram classes and in adult ewes (results not presented). In 2013 ewe lambs showed higher mortalities in the first half of the year, but the difference was not significant.

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. The return to the expected pattern in 2013 and continuing so, 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 2006 to 2015 (note - one exceptional voyage each for 2013 and for 2014 excluded; see 6.2 Appendix 2)





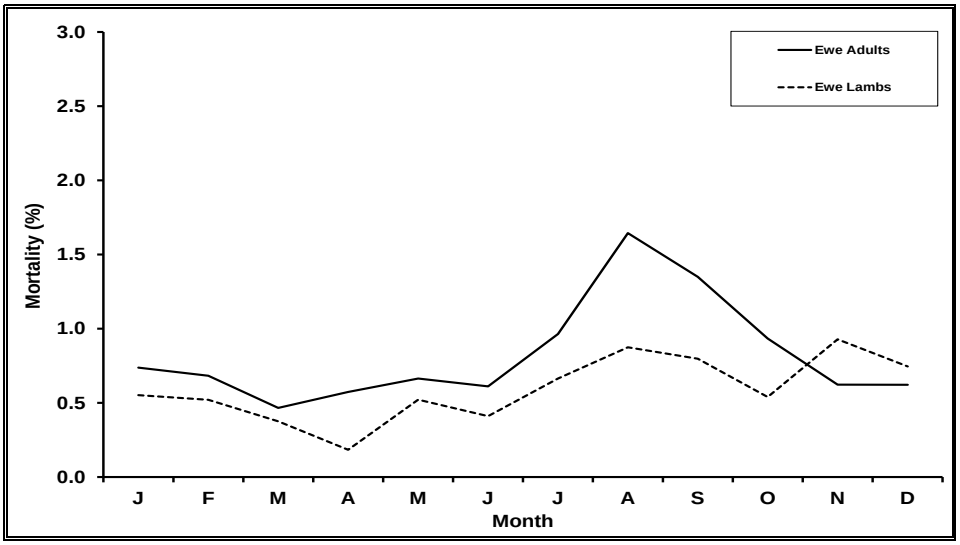
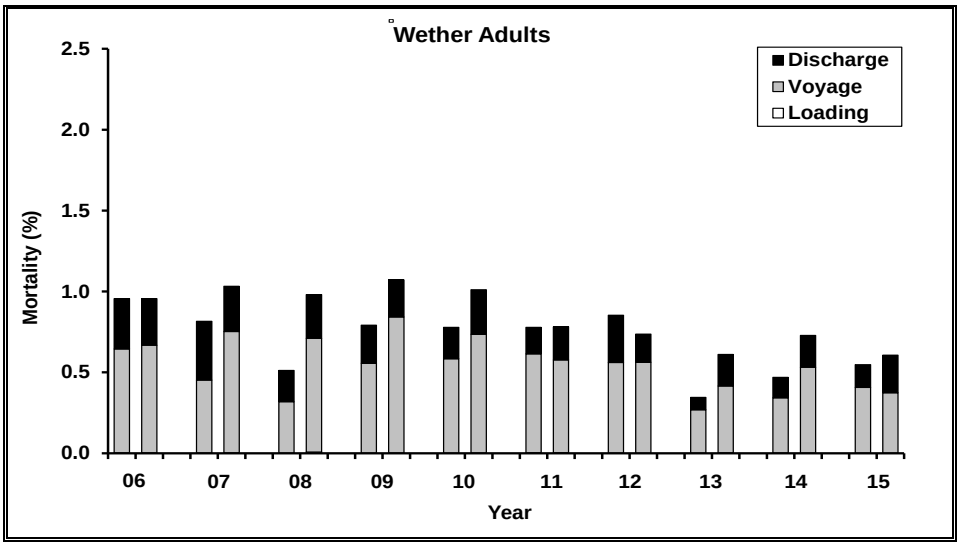
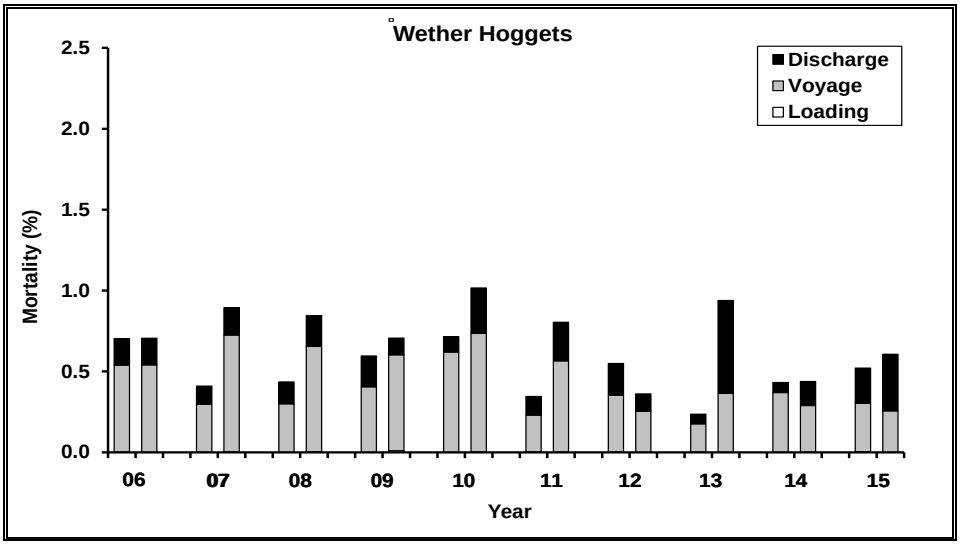
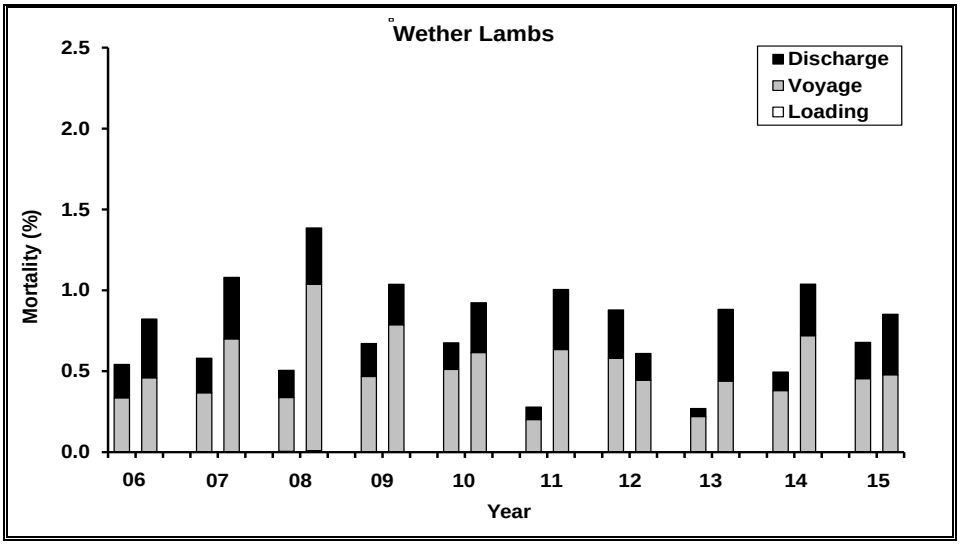


Figure 9 Mortality (%) for wether adults, hoggets and lambs exported by sea from Australia to the Middle East/North Africa for the first and second half of each year from 2006 to 2015 (note – one exceptional voyage each for 2013 and for 2014 excluded; see 6.2 Appendix 2)







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 (Figure 10, below).

Figure 10 Numbers by class of sheep exported from Australia, 1997 to 2015

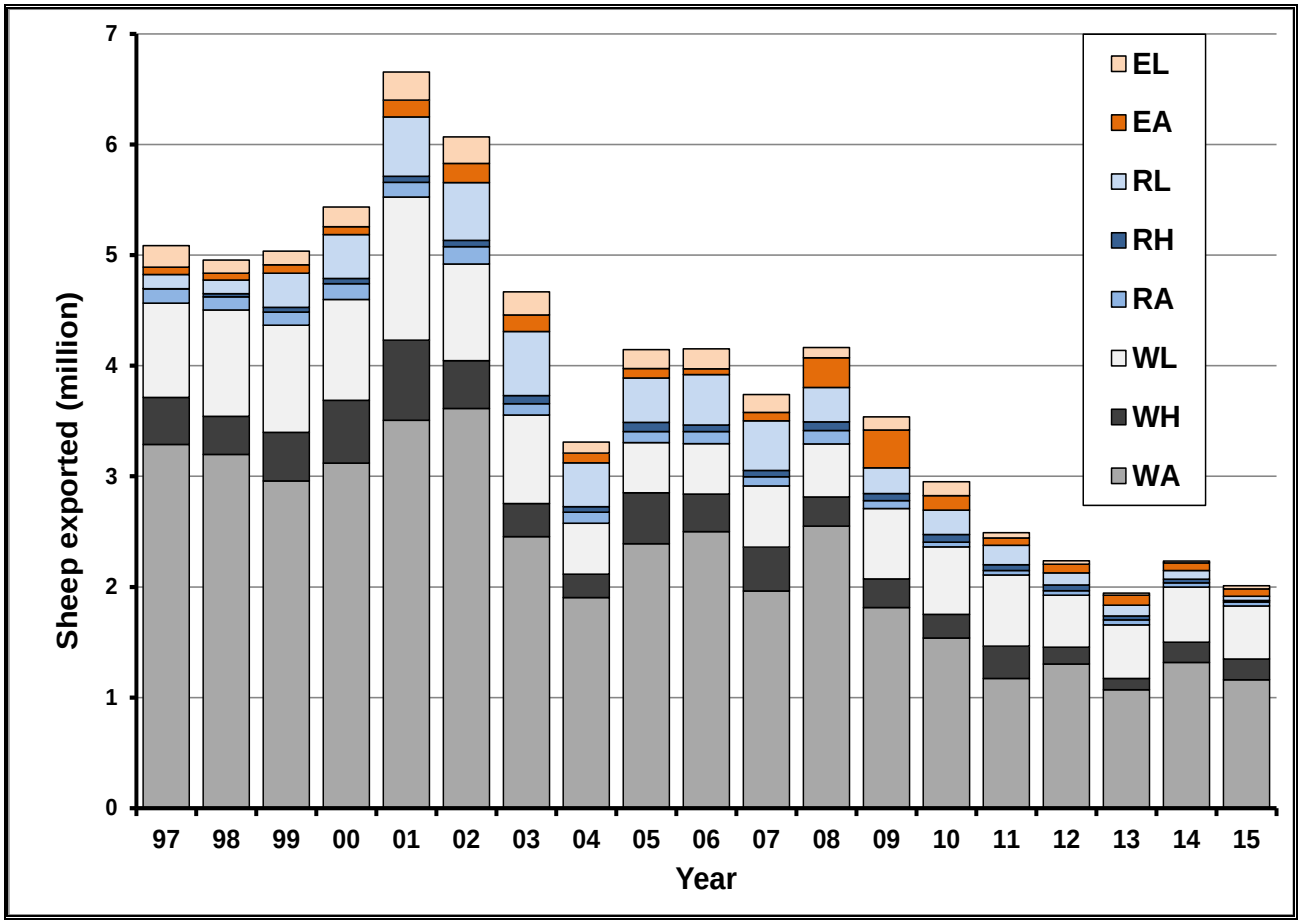
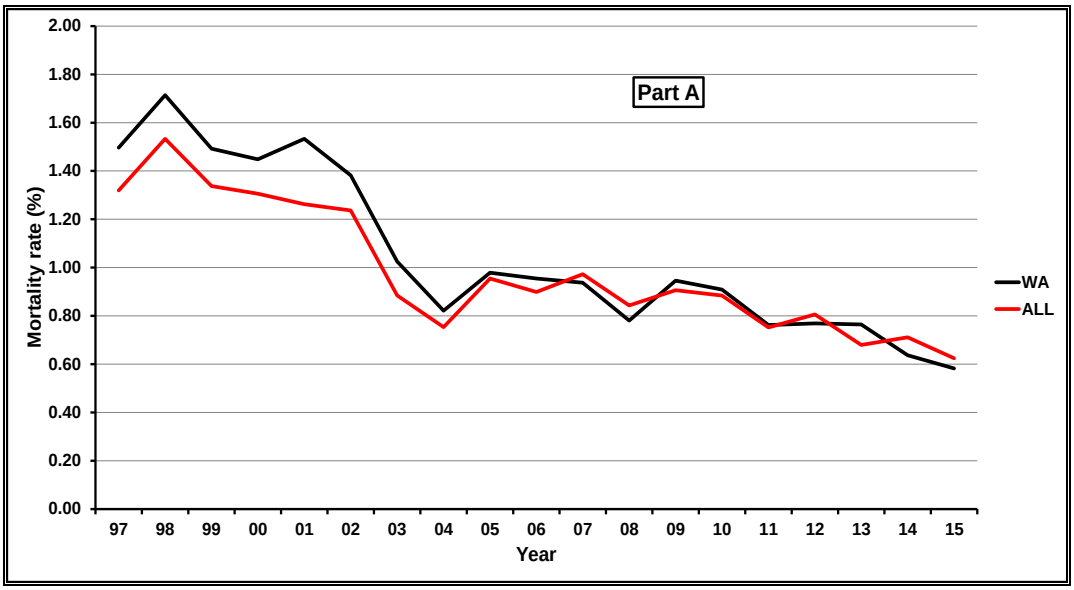


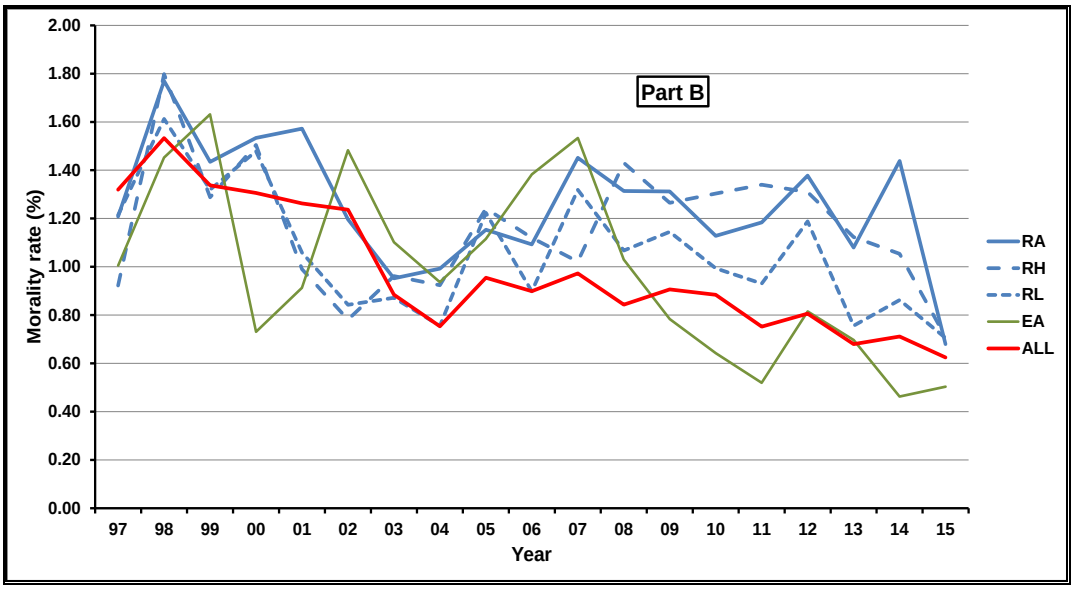
Figure 11 (below) shows that the overall mortality rate is closely linked to the Adult Wether mortality (part A). It can also be seen that ram classes have had consistently high mortality rates over time, with Ram Adults (RA) nearly always highest (Part B).

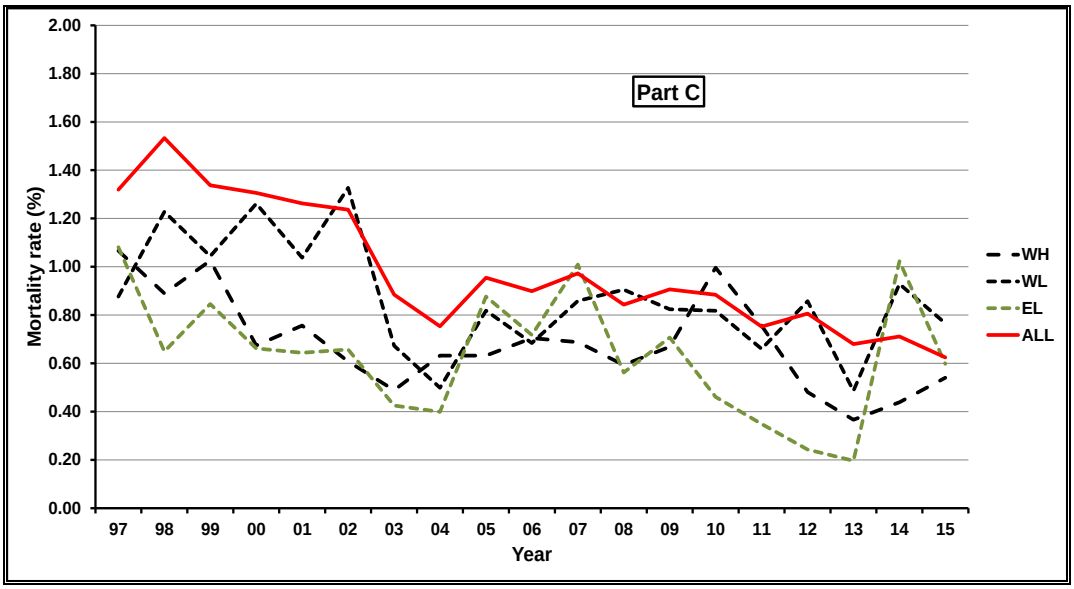
The Adult Ewes (EA) mortality rate has swung wildly over the time, but the three ram classes have remained alone the highest from 2008 onward.

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

Figure 11 Mortality rate (%) by class of sheep exported from Australia, 1997 to 2015







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 (below) show monthly mortality rates (total mortality as a proportion of total loaded for each month) over three periods, 1997-2002, 2003-2008 and 2009-2015, for Adult Wethers and Adult Rams respectively. While the overall pattern for Adult Wethers has reduced more noticeably over time, these periods demonstrate the enduring stability of the seasonal difference.

Figure 12 Average monthly mortality rate (%) for Adult Wethers for three periods

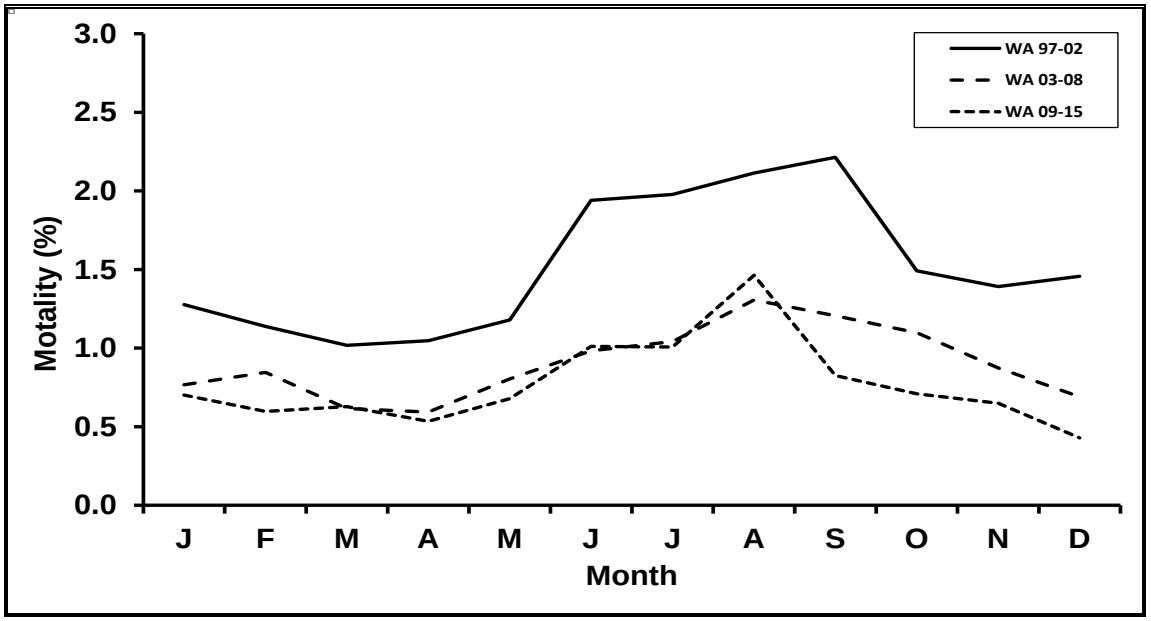
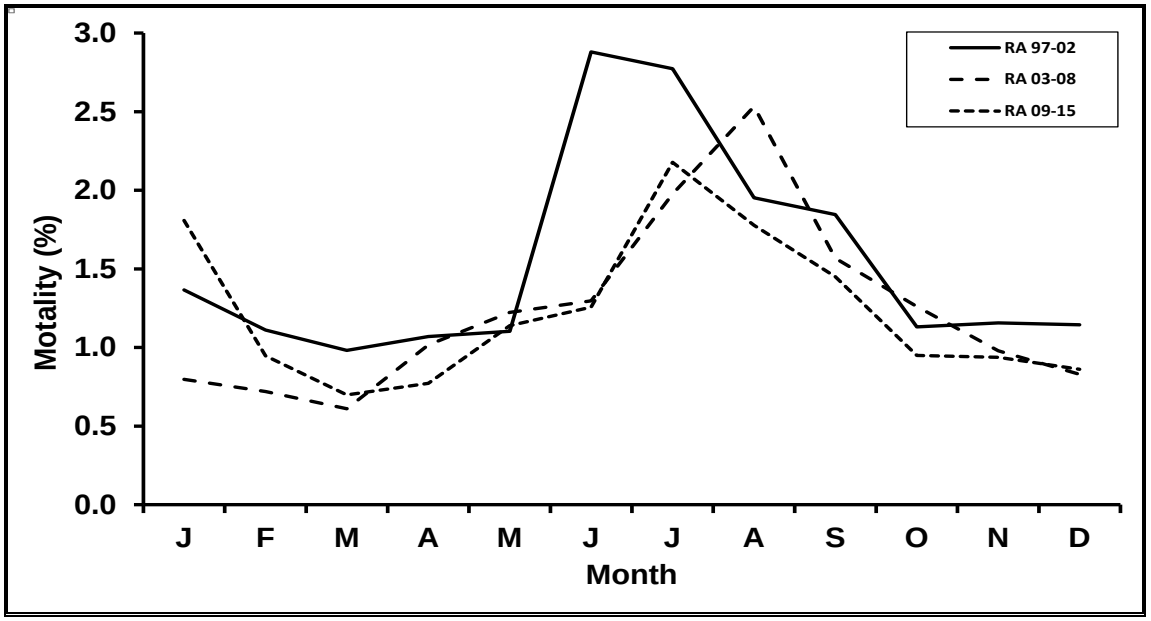


Figure 13 Average monthly mortality rate (%) for Adult Rams for three periods



It can be seen that there is a consistent seasonal difference, with the lowest mortality rates occurring in sheep loaded from February to May, and the highest occurring in those loaded from June through to September.

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

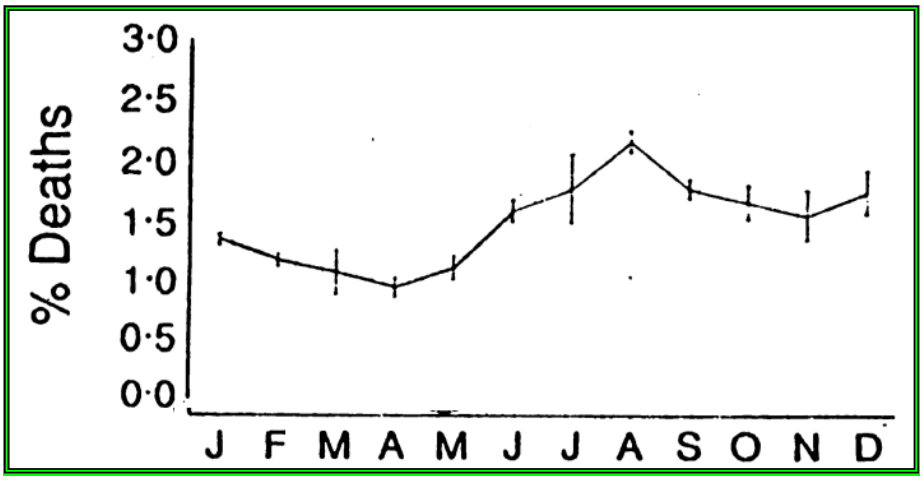
Nevertheless, overall mortality rate could be expected to increase if more sheep, and particularly more of the higher mortality classes, are exported between June and September.

With a constant annual cycle of exports, mortality rates and numbers would be expected to remain steady, however 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 (mid-September in 2016) come forward into the highest mortality months of June - September, overall mortalities will rise significantly with the increased contribution of mortalities, particularly from Ram classes. This might be expressed in a general rise over the at-risk period, or as an increase in the number of high mortality voyages breaching the reportable limits of DA / AMSA.

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

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



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

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

The reduced overall (reverse 'tilde') mortality pattern in the live sheep export trade is undoubtedly associated with 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 on "flattening" the overall reverse 'tilde' pattern, or servicing the trade in a way that compensates for the peak mortality period of the year.

4.1.3.8 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, below), and Adelaide (Table 6b, below). There was only one voyage from Portland during 2015.

There were no voyages in the "high" category in 2015. Approximately 90% of voyages from Fremantle, and 100% of voyages from Adelaide and Portland were in the "low" category.

Table 6a Number of voyages in low, medium and high mortality categories for ships loaded at Fremantle in 2015

Ship (code)	Mortality rate			Total
	Low <1.0%	Medium 1.0–2.0%	High >2.0%	
32	8	1	0	9
33	2	1	0	3
34	6	0	0	6
35	7	0	0	7
43	1	0	0	1
44	2	0	0	2
46	2	1	0	3
Total	28	3	0	31

Table 6b Number of voyages in low, medium and high mortality categories for ships loaded at Adelaide in 2015

Ship (code)	Mortality rate			Total
	Low <1.0%	Medium 1.0–2.0%	High >2.0%	
32	1	0	0	1
33	2	0	0	2
35	1	0	0	1
43	1	0	0	1
46	1	0	0	1
Total	6	0	0	6

4.2 Cattle

4.2.1 Performance trend

The number of cattle shipped from all ports in Australia to all destinations since 2006, as well as the trend line (linear regression) across those years, is shown in Figure 15 (below). Figure 16 (below) shows the number of cattle mortalities during sea transport since 2006. The number of cattle exported annually has varied from approximately 620,000 to 1,310,000, and the annual mortality has varied between 0.10 and 0.18%. The overall trend for numbers of cattle exported is upwards, whereas the trend for annual mortality is slightly downward.

Figure 15 Number of cattle exported by sea from Australia to all destinations since 2006

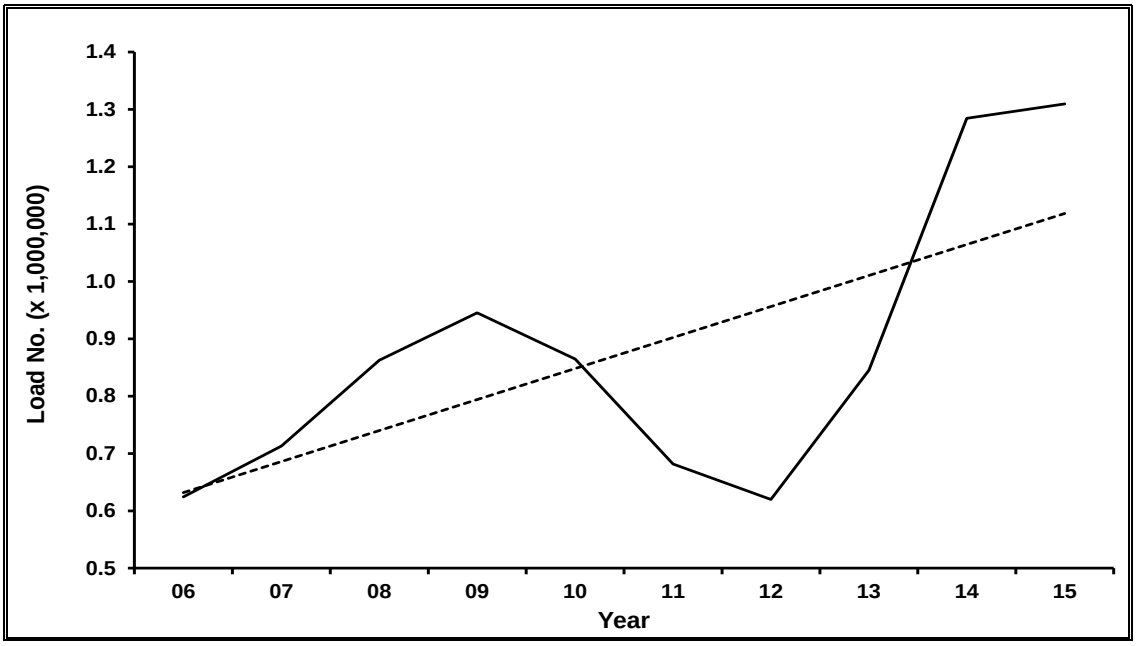
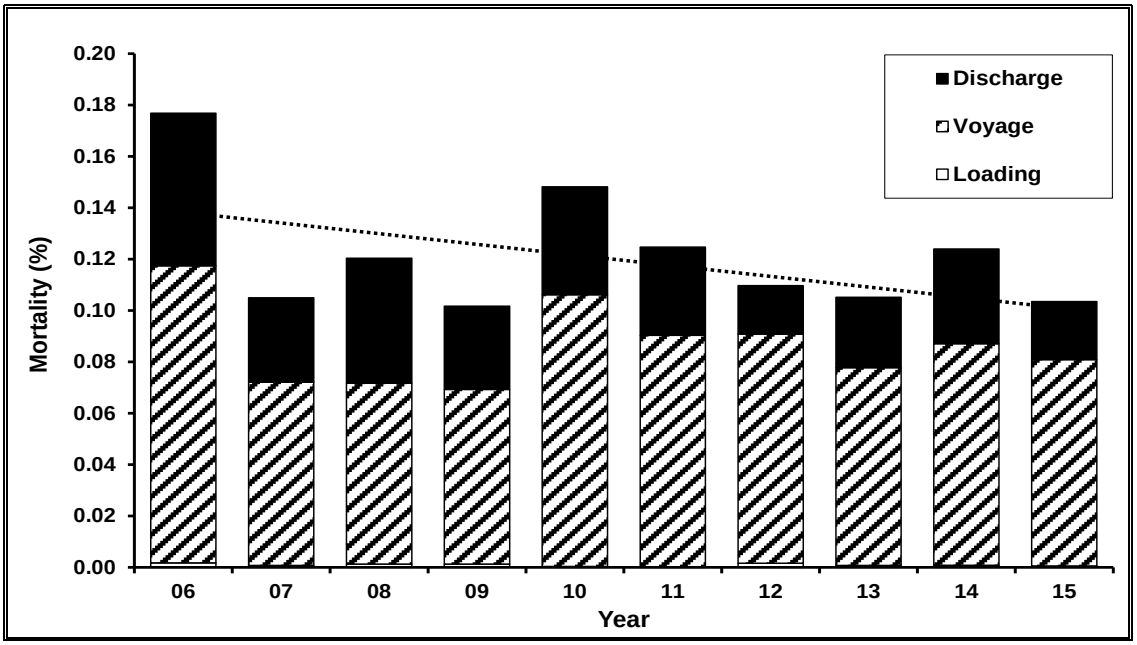


Figure 16 Annual mortality of cattle exported by sea from Australia to all destinations since 2006



4.2.2 Overview

The live cattle trade from Australia in 2015 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 with only three ports of loading, and nearly all sheep shipped to the Middle East/North Africa.

There were 15 ship journeys in 2015 for which cattle were loaded at more than one port in Australia. One of these, a three-port loading, had a single destination, while the remaining 14 were again split for discharge into 39 separate “voyages”, variously for prolonged length of time between discharge ports or for covering both short and long-haul voyage periods, as discussed in Part 3 – Methodology. Mortalities for split-load voyages were able to be attributed to loading ports for all voyages in 2015.

There were 380 cattle "voyages" during 2015. This involved 343 ship journeys, which was 5% more than in 2014. Where analysis involving split-load/discharge voyages has been performed, cattle consignments from each load port to each discharge port have been considered as separate “voyages’.

Ten single-port loaded voyages were split into two for destination, where the separated “voyage” times fell below and above the ten-day AMSA definition for short and long-haul voyages.

The overall number of cattle exported from Australia in 2015 rose by 2% compared to 2014, to a record of 1.31 million (Table 7, below). The overall mortality rate in 2015 was 0.10%, well below the figure of 0.12% observed in 2014. 32% of all cattle voyages returned a nil mortality rate during 2015.

The highest overall mortality rate on a regional basis was for exports to South-East Europe (0.53%), while the lowest overall mortality rate was for exports to Miscellaneous Destinations (0.07%).

Exports to Miscellaneous Destinations comprised three voyages carrying a total of 4,401 cattle with 3 mortalities (0.07%). Voyage and discharge days were an average of 13.69 and 0.55 days respectively. These voyages will not be examined further in this report.

The number of cattle exported to the Middle East/North Africa in 2015 fell by 6% compared to 2014, while the number of voyages rose by 24%. The mortality rate to the region fell from 0.36% in 2014 to 0.25% in 2015.

Exports to South-East Asia rose by 7% in 2015 compared to 2014 to a record high of 1.07 million, while the number of voyages rose by 17% (310 and 266 respectively). Trade to South-East Asia accounted for 81% of all cattle exported in 2015 (up from 78% in 2014), while trade to all other regions fell.

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 2015 these larger vessels accounted for 43% of the cattle exported and 26% of the voyages made to South-East Asia.

Exports to North-East Asia in 2015 fell by 21% compared to 2014, while the mortality rate fell from 0.14% to 0.08%.

Exports to South-East Europe fell by 25%, however the mortality rate rose from 0.47% to 0.53%.

Table 7 Mortality rates, number of voyages, voyage and discharge days, and number of cattle exported for voyages to major destination regions during 2015

Parameter	ME/N Africa	SE Asia	NE Asia	Misc	SE Europe	Total
Voyages (No.)	31	310	32	3	4	380
Cattle (No.)	99,558	1,066,664	98,213	4,401	40,666	1,309,502
Mortality rate o/all (%)	0.25	0.08	0.08	0.07	0.53	0.10
Mortality rate range (%)	0.00 – 0.78	0.00 – 3.68	0.00 – 0.56	0.00 – 0.23	0.23 – 0.79	0.00 – 3.68
Voyage days (Ave.)	19.10	8.34	17.35	13.69	30.52	10.254
Discharge days (Ave.)	3.21	1.52	0.66	0.55	3.59	1.60
Voyages with nil mortalities (No.)	12	102	7	2	0	123

4.2.3 Middle East/North Africa

The number of live cattle exported to the Middle East/North Africa during 2015 fell by 6% compared to 2014 (Table 8, below), despite the number of voyages increasing by 24%. Overall mortality rates have remained at or below 0.5% over the last decade. In 2015 the mortality rate was 0.25%, which is below the 0.28% average across the decade.

Table 8 Mortality rates, number of voyages, average voyage and discharge length, and number of cattle exported to the Middle East/North Africa from 2006 to 2015

Year	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days	Nil mortality voyages (No.)
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
2015	31	99,558	0.25	0.00 – 0.78	19.10	3.21	12

4.2.3.1 Port of loading

There were 4 ports of loading for voyages to the Middle East/North Africa in 2015, with the majority of cattle exported from Fremantle (Table 9, below). Mortality rates in 2015 were highest from Adelaide, followed by Broome and Portland.

The voyages from each port were classified into various mortality categories as shown in Table 10 (below). There were three voyages in the medium or high categories, one loading in Fremantle and two in Adelaide.

All voyages for Portland and Broome were in the nil or low categories, as were 96% and 33% of voyages for Fremantle and Adelaide 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 2015

Port	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days
Fremantle	23	74,992	0.21	0.00 – 0.70	17.40	3.95
Broome	1	9,796	0.25	n/a	25.86	2.92
Adelaide	3	9,344	0.59	0.00 – 0.78	25.91	1.16
Portland	4	5,428	0.24	0.00 – 0.43	22.08	0.58

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 2015

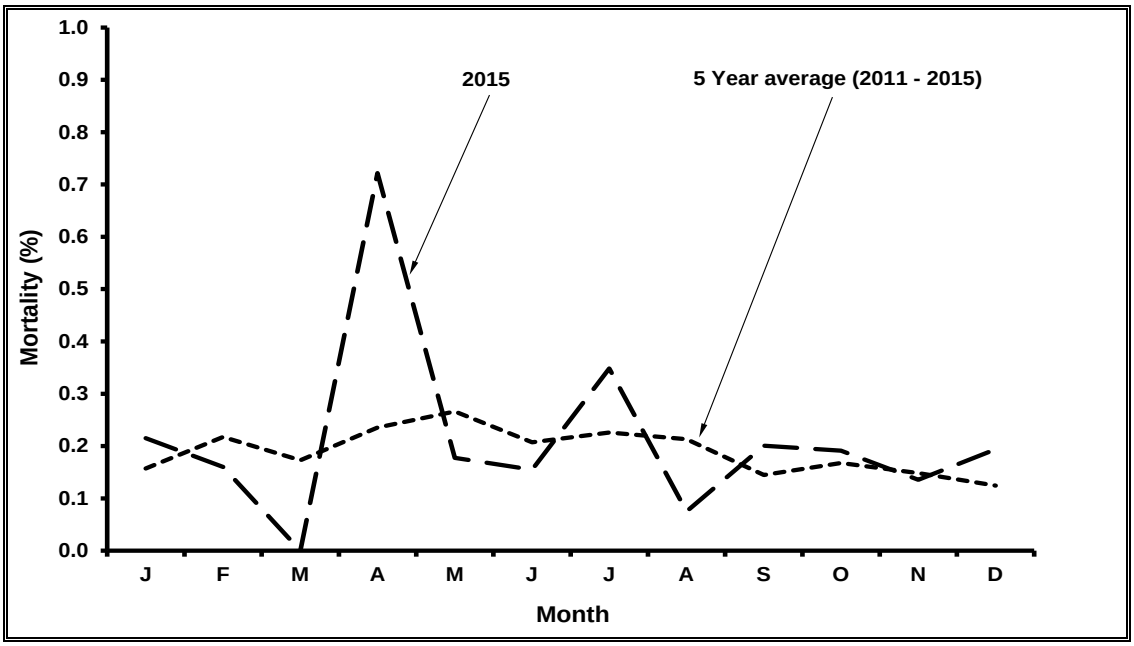
Port	Mortality rate				Total
	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	
Fremantle	10	12	1	0	23
Portland	1	3	0	0	4
Adelaide	1	0	2	0	3
Broome	0	1	0	0	1
Total	12	16	3	0	31

4.2.3.2 Time of year

In 2015, 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 well below 0.5% throughout the year, except for the month of April (Figure 17, below). The monthly mortality rate profile for 2015 approximated the 5-year average, except for the months of March and April.

Note that one 2014 exceptional voyage has been excluded from the data. If this voyage was included, the January percentage for the 5-year average profile would have been 0.33%. A Federal Department of Agriculture investigation summary regarding this voyage is referred to in 6.2 Appendix 2.

Figure 17 Monthly mortality rates of cattle on voyages from all ports to the Middle East/North Africa for 2015 and the 5-year average monthly rates for the period 2011 to 2015



4.2.3.3 Ship

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

Table 11 (below) shows the number of voyages in the various mortality categories for each ship. There were three voyages in the medium or high categories, involving ships 43 and 46. 90% 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 2015

	Mortality rate				
Ship (code)	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	Total
32	3	0	0	0	3
33	0	2	0	0	2
34	2	0	0	0	2
35	5	2	0	0	7
43	0	1	1	0	2
44	0	2	0	0	2
46	1	2	2	0	5
47	0	1	0	0	1
103	1	1	0	0	2
120	0	2	0	0	2
128	0	3	0	0	3
Total	12	16	3	0	31

4.2.3.4 Class of cattle

In 2015, the highest overall class mortality rate occurred in adult bulls (0.90%) (Table 12, below)). Bull classes made up 72% of all cattle shipped to Middle East/North Africa in 2015.

Table 12 Mortality rates, number of voyages and number of cattle in various classes exported to the Middle East/North Africa in 2015

Class	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)
Bull adult*	20	49,498	0.33	0.00 – 0.90
Bull weaner	8	21,714	0.18	0.00 – 0.31
Steer adult*	15	14,512	0.20	0.00 – 0.45
Heifer beef	10	7,819	0.10	0.00 – 0.18
Heifer dairy	7	5,004	0.20	0.00 – 0.43
Steer weaner	4	1,011	0.59	0.00 – 0.72

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

4.2.4 South-East Asia

A record-breaking 1.07 million cattle were exported to South-East Asia in 2015 (Table 13, below), representing an increase of 7% compared to 2014. The mortality rate for voyages to the region remained at 0.08%, while the number of voyages rose by 17%. A nil mortality rate was reported on 33% of the voyages to the region. The mortality rate has remained at or below 0.1% over the last decade, the average being 0.07%.

Table 13 Mortality rates, number of voyages, average voyage and discharge length, and number of cattle exported to South-East Asia from 2006 to 2015

Year	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days	Nil mortality voyages (No.)
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
2015	310	1,066,664	0.08	0.00 – 3.68	8.34	1.52	102

4.2.4.1 Port of loading

Most cattle exported to South-East Asia in 2015 were loaded at Darwin (43%) followed by Townsville (27%) and Broome (10%) (Table 14, below). The mortality rate was highest for cattle exported from Portland (0.43%) followed by Fremantle (0.14%) and Townsville (0.09%).

The voyages from each port were classified into various mortality categories as shown in Table 15 (below). 99% of voyages were in the nil or low categories in 2015. There were three voyages in the medium category and one in the high category, involving the ports of Darwin, Fremantle and Portland.

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 2015

Port	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days
Darwin	164	514,972	0.06	0.00 – 3.68*	6.85	1.35
Townsville	61	305,417	0.09	0.00 – 0.48	10.33	1.84
Broome	27	103,007	0.07	0.00 – 0.49	7.15	1.64
Fremantle	24	55,959	0.14	0.00 – 0.94	13.78	1.80
Wyndham	12	39,418	0.03	0.00 – 0.24	7.08	1.11
Geraldton	8	19,602	0.03	0.00 – 0.12	7.55	1.36
Karumba	11	17,123	0.04	0.00 – 0.30	9.72	1.42
Portland	2	7,002	0.43	0.24 – 0.51	21.25	1.48
Adelaide	1	4,164	0.02	n/a	13.09	7.18

* exceptional voyage; see 6.2 Appendix 2

Table 15 Number of voyages in nil, low, medium and high mortality categories for shipments from various ports to South-East Asia for 2015

Port	Mortality rate				Total
	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	
Darwin	64	98	1	1	164
Townsville	7	54	0	0	61
Broome	5	22	0	0	27
Fremantle	6	17	1	0	24
Wyndham	7	5	0	0	12
Karumba	7	4	0	0	11
Geraldton	6	2	0	0	8
Portland	0	1	1	0	2
Adelaide	0	1	0	0	1
Total	102	204	3	1	310

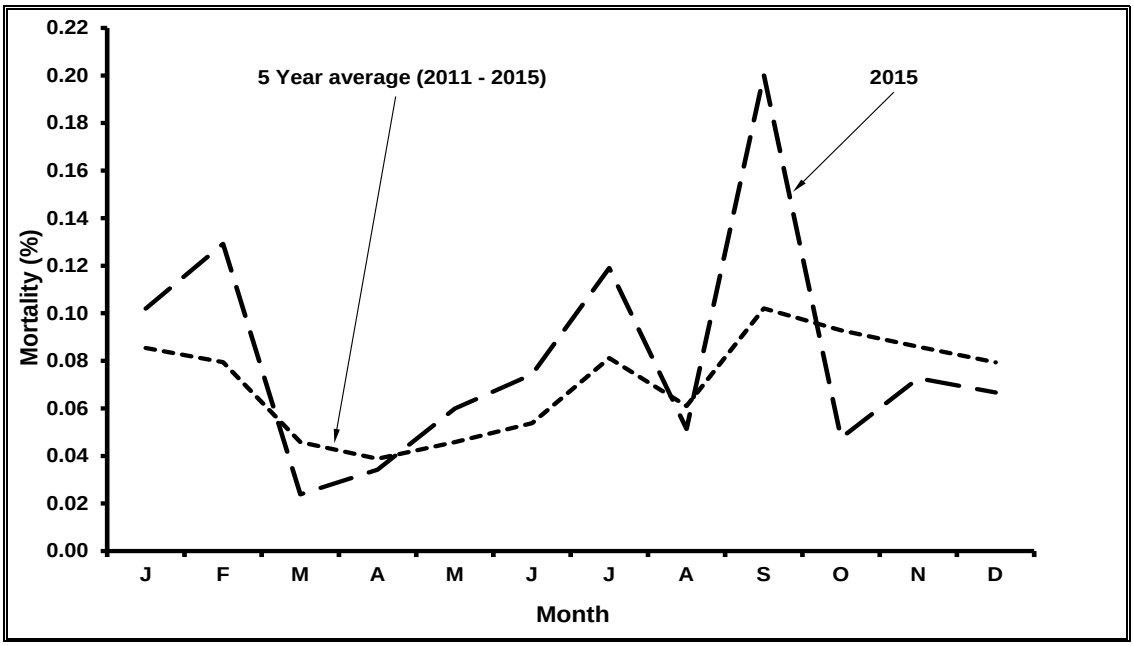
4.2.4.2 Time of year

Monthly mortality rates (total mortality as a proportion of total loaded for each month) for voyages to South-East Asia in 2015 were at or below 0.10% for the year, except for the months of February, July and September (Figure 18, below).

While some voyages were higher than average in September, 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 2015 approximated that of the 5-year average, except for the months mentioned above.

Figure 18 Monthly mortality rates of cattle on voyages from all ports to South-East Asia for 2015 and the 5-year average monthly rates for the period 2011 to 2015



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 (below). All voyages, except four, were in the nil or low mortality categories. There were three voyages in the medium category and one in the high category, involving ships 48, 103 and 125.

The number of voyages to the region rose from 266 in 2014 to 310 in 2015, an increase of 17%.

Ships with a carrying capacity of 6,000 or more head accounted for 26% of voyages to South-East Asia in 2015. They also accounted for 43% of cattle exported, 52% of mortality, 31% of voyage days and 45% of discharge days.

Table 16 Number of voyages in nil, low, medium and high mortality categories for shipments to South East Asia for 2015

	Mortality rate				
Ship (code)	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	Total
43	1	12	0	0	13
44	1	8	0	0	9
45	1	11	0	0	12
47	1	7	0	0	8
48	2	8	2	0	12
49	1	11	0	0	12
50	4	10	0	0	14
59	4	13	0	0	17
77	7	5	0	0	12
95	10	9	0	0	19
103	4	4	0	1	9
114	11	6	0	0	17
117	9	9	0	0	18
120	1	11	0	0	12
122	6	14	0	0	20
123	6	8	0	0	14
124	7	9	0	0	16
125	3	6	1	0	10
126	7	11	0	0	18
127	4	7	0	0	11
128	3	9	0	0	12
129	1	7	0	0	8
130	8	8	0	0	16
131	0	1	0	0	1
Total	102	204	3	1	310

4.2.4.4 Class of cattle

In 2015, 98.68% of cattle exported to South-East Asia were able to be identified by class. The 14,125 cattle that could not be identified by class were exported on 2 voyages, incurring a total mortality of 0.06%. These cattle will not be examined further in this section.

Adult steers and beef heifers comprised 57% and 25% respectively of all classes exported to the region in 2015 (Table 17, below).

The highest mortality rates occurred in beef cows (0.24%) 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 only a few deaths in small numbers loaded.

Table 17 Mortality rates, number of voyages and number of cattle in various classes exported to South-East Asia in 2015

Class	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)
Steer adult*	288	607,921	0.08	0.00 – 0.98
Heifer beef	231	265,178	0.04	0.00 – 1.25
Bull adult*	157	86,394	0.13	0.00 – 13.03[†]
Steer weaner	16	47,704	0.04	0.00 – 0.25
Cow beef	52	28,136	0.24	0.00 – 2.94
Bull weaner	15	10,799	0.07	0.00 – 0.91
Heifer dairy	6	6,139	0.08	0.00 – 0.24
Cow dairy	1	268	0.00	n/a

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

4.2.5 North-East Asia

The number of cattle exported to North-East Asia in 2015 fell by 21% compared to 2014, while the number of voyages fell by 18% (Table 18, below). The mortality rate has remained under 0.2% over the last decade, at an average of 0.11%.

The North-East Asia cattle trade is characterised by steers exported to Japan and heifers exported to China. Occasional shipments are made to Korea and North-Eastern Russia, however none of these shipments occurred in 2015.

Table 18 Mortality rates, number of voyages, average voyage and discharge length, and number of cattle exported to North-East Asia from 2006 to 2015

Year	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days	Nil mortality voyages (No.)
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
2015	32	98,213	0.08	0.00 – 0.56	17.35	0.66	7

4.2.5.1 Port of loading

The majority of cattle exported to North-East Asia in 2015 departed from Portland (70%), followed by Geelong (12%) and Brisbane (10%), with the unusual addition of single voyages from Adelaide and Townsville (Table 19, below). All cattle loaded at Brisbane were exported to Japan, with the remainder being exported to China.

The voyages from each port were classified into various mortality categories as shown in Table 20 (below). During 2015, there no voyages in the high mortality category, while 96% 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 2015

Port	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days
Portland	18	69,153	0.06	0.00 – 0.25	17.48	0.84
Geelong	2	11,416	0.12	0.10 – 0.15	17.55	0.93
Brisbane	10	10,199	0.15	0.00 – 0.56	16.64	0.22
Townsville	1	4,245	0.19	n/a	24.76*	0.81
Adelaide	1	3,200	0.13	n/a	14.13	1.13

* voyage length inflated by delayed departure

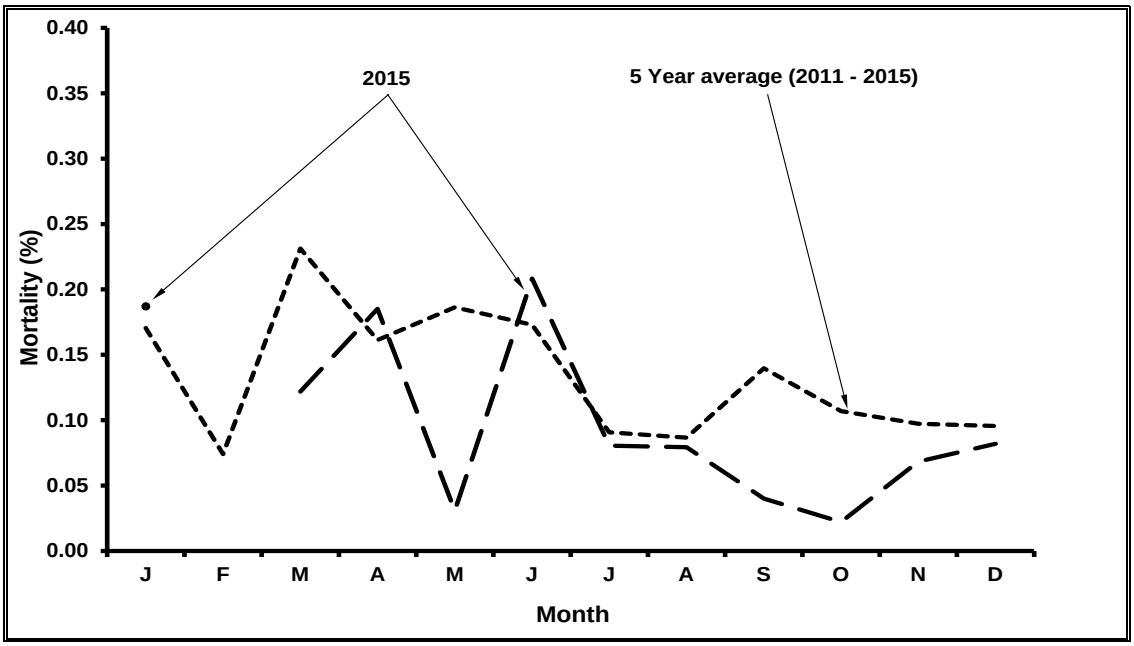
Table 20 Number of voyages in nil, low, medium and high mortality categories for shipments from various ports to North-East Asia for 2015

Port	Mortality rate				Total
	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	
Portland	3	15	0	0	18
Brisbane	4	5	1	0	10
Geelong	0	2	0	0	2
Adelaide	0	1	0	0	1
Townsville	0	1	0	0	1
Total	7	24	1	0	32

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 2015 were below 0.25% throughout the year. They varied from the 5-year average for the months of March, May, September and October (Figure 19).

Figure 19 Monthly mortality rates of cattle on voyages from all ports to North-East Asia for 2015 and the 5-year average monthly rates for the period 2011 to 2015



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 (below).

During 2015 there were no voyages in the high mortality category. There were 96% of voyages 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 2015

	Mortality rate				
Ship (code)	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	Total
44	0	1	0	0	1
45	0	1	0	0	1
47	0	3	0	0	3
48	1	0	0	0	1
49	0	1	0	0	1
95	0	2	0	0	2
103	1	1	0	0	2
115	4	5	1	0	10
120	1	1	0	0	2
126	0	1	0	0	1
127	0	3	0	0	3
128	0	3	0	0	3
129	0	1	0	0	1
130	0	1	0	0	1
Total	7	24	1	0	32

4.2.5.4 Class of cattle

Mortality rates for cattle classes exported to North-East Asia during 2015 are shown in Table 22, below.

The North-East Asian cattle trade comprised mainly steers exported to Japan (10%) and heifer classes exported to China (83%).

The highest mortality rates occurred in adult steers (0.15%), followed by dairy cows (0.10%). Note that the high value in the dairy heifer mortality rate range was for a small part of a consignment of cattle that experienced an overall mortality rate of 0.19%, and therefore did not attract a Federal Department of Agriculture investigation.

Table 22 Mortality rate, number of voyages and number of cattle in the classes exported to North-East Asia in 2015

Class	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)
Heifer dairy	18	69,687	0.08	0.00 – 2.19
Heifer beef	9	12,064	0.07	0.00 – 0.13
Steer adult*	10	10,127	0.15	0.00 – 0.56
Cow dairy	2	6,325	0.10	0.00 – 0.25
Bull adult*	1	10	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 Destination 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 near 0.5% or less over the ten years surveyed (Table 23, below).

The mortality rate in cattle exported to South-East Europe was 0.53% in 2015. Numbers exported fell by 25% compared to 2014.

Table 23 Mortality rates, number of voyages, average voyage and discharge length, and number of cattle exported to South-East Europe from 2006 to 2015

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
2015	4	40,666	0.53	0.23 – 0.79	30.52	3.59	0

4.2.6.1 Port of loading

All cattle exported to South-East Europe in 2015 were from the southern ports of Adelaide, Portland and Fremantle (Table 24, below). Most cattle were loaded at Adelaide (48%), followed by Portland (42%). The mortality rate was highest for cattle exported from Adelaide (0.76%).

The voyages from each port were classified into various mortality categories, as shown in Table 25 (below). There were no voyages in the high category in 2015.

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 2015

Port	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days
Adelaide	2	19,541	0.76	0.64 – 0.79	32.89	3.48
Portland	1	17,152	0.34	n/a	28.13	5.19
Fremantle	1	3,973	0.23	n/a	28.18	2.23

Table 25 Number of voyages in nil, low, medium and high mortality categories for shipments from various ports to South-East Europe for 2015

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

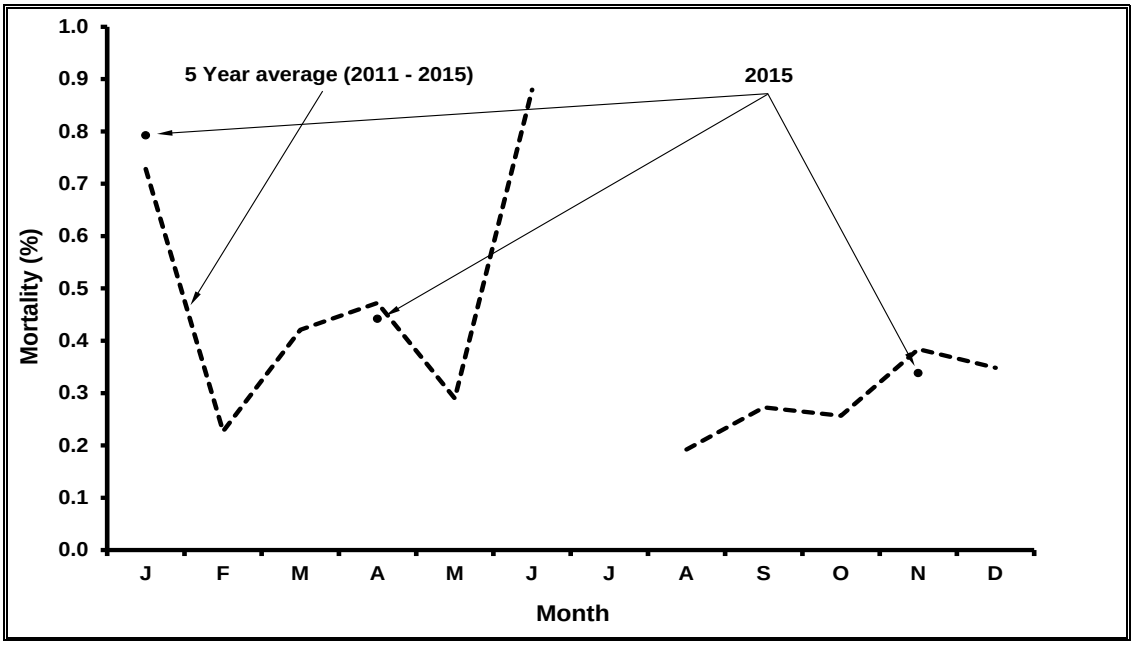
4.2.6.2 Time of year

Monthly mortality rates (total mortality as a proportion of total loaded for each month) for voyages to South-East Europe in 2015 were 0.79%, 0.44% and 0.34% for January, April and November respectively (Figure 20, below).

For the three months on which voyages occurred during 2015, the monthly mortality profile was quite close to the 5-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 20 Monthly mortality rates of cattle on voyages from all ports to South-East Europe for 2015 and the 5-year average monthly rates for the period 2011 to 2015



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 2015.

Table 26 Number of voyages in nil, low, medium and high mortality categories for shipments to South-East Europe for 2015

	Mortality rate				
Ship (code)	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	Total
46	0	1	2	0	3
50	0	1	0	0	1
Total	0	2	2	0	4

4.2.6.4 Class of cattle

Mortality rates for each class of cattle exported to South-East Europe during 2015 are presented in Table 27 (below). Steer classes exported to Russia accounted for all cattle exported to South-East Europe during 2015.

In 2015 the highest mortality rates occurred in weaner steers (0.75%).

Table 27 Mortality rate, number of voyages and number of cattle in the classes exported to South-East Europe in 2015

Class	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)
Steer adult*	4	37,584	0.51	0.23 – 0.80
Steer weaners	1	3,082	0.75	n/a

* 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 21 and 22 (below) 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 21 Number of goats exported by sea from Australia to all destinations since 2006

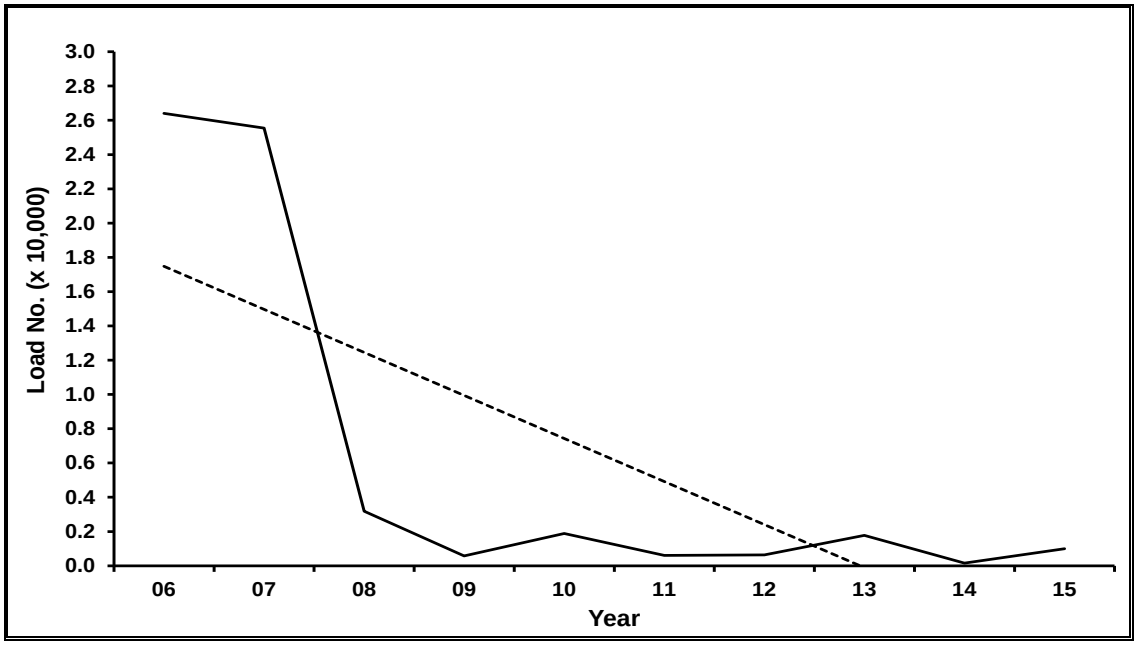
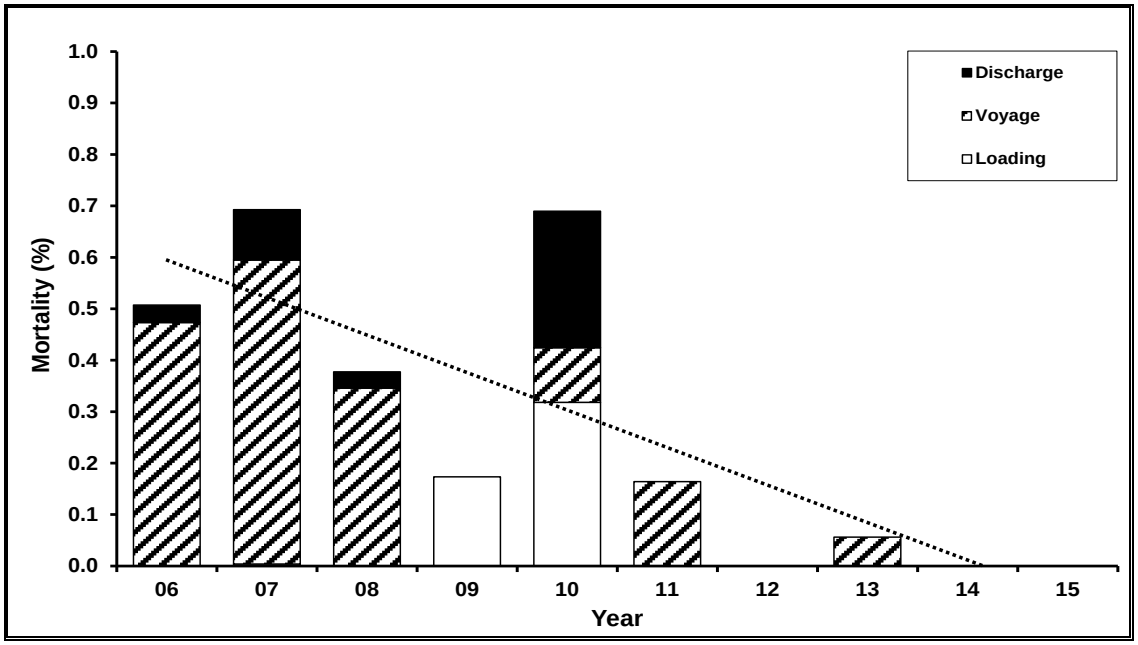


Figure 22 Annual mortality of goats exported by sea from Australia to all destinations since 2006



4.3.2 Overview

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

While the air transport of goats has maintained a substantial presence since the 1990's, gradually this mode of carriage has expanded to take up almost the whole of live goat exports. Currently, the majority of goats are transported by air to South-East Asia.

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

There were 1,000 goats exported by sea from Australia in 2015. They were carried to Brunei on two voyages, both of which were 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 at 42,032 in 2002.

The mortality rate fell to 0.00% in 2012 (Table 28, below), the first time this figure has been achieved since this monitoring program began recording goat figures in 1993.

The mortality rate for 2015 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 2006 to 2015

Year	Voyages (No.)	Goats (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyage days	Discharge days	Nil mortality voyages (No.)
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
2015	2	1,000	0.00	n/a	6.55	0.74	2

4.4 Air Transport

4.4.1 Air transport of live sheep

During 2015, air transport accounted for 2.75% of live sheep exports (56,945 out of 2,071,316 sheep exported). The 56,945 sheep exported by air in 2015 represents a rise of 45% compared to 2014, and is the highest figure recorded over the 2008 to 2015 period.

Air transport of live sheep comprises a mix of breeding and slaughter types. In 2015, 69% of air-transported sheep were for slaughter.

4.4.1.1 Load point / destination

The loading points and destination countries for sheep transported by air from Australia in 2015 are shown in Table 29 (below). The sheep were loaded at Perth, Adelaide, Melbourne and Sydney airports, each accounting for 31.6%, 29.6%, 25.3% and 13.4% of the number exported respectively.

The main importing countries for Australian sheep exported by air in 2015 were Malaysia (66.3%), China (27.6%) and Singapore (3.5%).

Table 29 Load point and destination country for sheep exported by air from Australia during 2015

Country	Adelaide	Melbourne	Perth	Sydney	Total
Malaysia	16,872	762	13,691	6,419	37,744
China		13,364	2,341		15,705
Singapore			1,978		1,978
Other*		293		1,225	1,518
Total	16,872	14,419	18,010	7,644	56,945

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%), 2013 (38.39%), 2014 (7.91%) and 2015 (18.66%). If these flights were excluded, the mortality rates for those years would have been 0.05%, 0.01%, 0.01% and 0.02% respectively. Note that references to Federal Department of Agriculture investigation reports into mortalities over 2% are included in 6.2 Appendix 2.

For air transported sheep from 2008 to 2015, all but 3 mortalities occurred in slaughter types and all but 3 mortalities occurred in the second half of the year. Mortalities occurred on 2.9% of flights (27 of 947).

Sheep exported by air experienced 0.24% mortalities during 2015 (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 2015

Year	Flights	Sheep (No.)	Total Mortalities (No.)	Mortality rate overall (%)
2008	88	11,667	0	0.00
2009	68	23,238	148	0.64
2010	82	21,201	3	0.01
2011	94	30,865	42	0.14
2012	120	23,688	0	0.00
2013	139	35,875	45	0.13
2014	162	39,227	177	0.45
2015	194	56,945	137	0.24

SOURCE – Department of Agriculture

4.4.2 Air transport of live cattle

During 2015, air transport accounted for 0.86% of live cattle exports (11,315 out of 1,320,817 cattle exported). The 11,315 cattle exported by air in 2015 represents a rise of 19.6% compared to 2014, and is the highest figure recorded over the 2008 to 2015 period.

Air transport of live cattle is almost exclusively confined to breeding types, but 2015 saw an unusually high 7% of slaughter cattle exported.

4.4.2.1 Load point / destination

Load points and destinations for cattle transported by air from Australia in 2015 are shown in Table 31 (below).

Almost all cattle were loaded at Melbourne and Sydney airports, accounting for 47% and 48% respectively. The main importing countries for cattle exported by air in 2015 were Vietnam (30%), Malaysia (29.5%) and Indonesia (17.5%).

Table 31 Load point and destination country for cattle exported by air from Australia during 2015

Country	Adelaide	Melbourne	Sydney	Total
Vietnam		1,415	1,974	3,389
Malaysia	587	630	2,120	3,337
Indonesia		1,985		1,985
Laos			859	859
China		579		579
Taiwan		403	3	406
UAE		324		324
Japan			320	320
Other*			116	116
Total	587	5,336	5,392	11,315

SOURCE – Department of Agriculture
* Other includes Bangladesh and Samoa

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 0.02% mortalities during 2015 (Table 32, below). The expected level of mortality is 0.01%. Mortalities occurred on 1.6% of flights over the 2008 to 2015 period (7 of 442).

Table 32 Mortality rates and number of cattle exported by air to all destinations from 2008 to 2015

Year	Flights	Cattle (No.)	Total Mortalities (No.)	Mortality rate overall (%)
2008	44	9,719	14	0.14
2009	62	9,315	0	0.00
2010	43	8,271	1	0.01
2011	48	8,738	0	0.00
2012	41	7,825	1	0.01
2013	54	9,691	67	0.69
2014	74	9,458	0	0.00
2015	76	11,315	2	0.02

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 2015 accounted for the 98.9% of live goat exports (86,925 out of 87,925 goats exported).

Air transport of live goats comprises a mix of breeding and slaughter types, the majority of which are for slaughter. In 2015, 93.8% of air-transported goats were for slaughter.

The 86,925 goats exported by air in 2015 represents a rise of 0.3% compared to 2014, and is the highest figure recorded over the 2008 to 2015 period.

4.4.3.1 Load point / destination

The loading points and destination countries for goats transported by air from Australia in 2015 are shown in Table 33 (below).

The majority of these goats were loaded at Adelaide and Sydney airports, accounting for 51.8% and 41.1% respectively. The main importing country in 2015 was Malaysia, which received 95.4% of all goats exported by air.

Table 33 Load point and destination country for goats exported by air from Australia during 2015

Country	Adelaide	Melbourne	Perth	Sydney	Total
Malaysia	45,066	2,658	1,740	33,470	82,934
UAE		1,718		376	2,094
Sabah				833	833
Brunei				731	431
Philippines				378	378
Other*		1		254	255
Total	45,066	4,377	1,740	35,742	86,925

SOURCE – Department of Agriculture

* Other includes Nepal, New Zealand and Sarawak

4.4.3.2 Mortalities

The reportable level for air-transported goats is 2.0% or 3 goats, whichever is the greater number of animals. For the years 2008 to 2015, there has been only one flight with a reportable mortality level. Note that a reference to the Federal Department of Agriculture investigation reports into this 2015 flight is included in 6.2 Appendix 2.

All mortalities for goats transported by air from 2008 to 2015 occurred in slaughter types, however these comprise the vast majority of goats exported. Mortalities occurred on 2.2% of flights (25 out 1137).

Goats exported by air experienced 0.085% mortalities during 2015 (Table 34). The expected level of mortality is 0.01%.

Table 34 Mortality rates and number of goats exported by air to all destinations from 2008 to 2015

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

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 2015 calendar year. Mortality trends were analysed and the overall mortalities for sheep, cattle and goats exported by sea were shown to be 0.62%, 0.10% and 0.00% respectively, while overall mortalities for sheep, cattle and goats exported by air were 0.24%, 0.02% and 0.09% respectively.

It is recommended that this project continue to be funded and to report on an annual basis in the future. This is the only comprehensive report of its type, providing breakdowns by ship, species, time of year, load ports and major destinations over the calendar year, for both shipboard and air exports, as well as summary analyses of trends over time. The report is of interest and importance to a wide range of stakeholders, and while it is considered that the report effectively presents the Industry performance during the export shipment phase, 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 version of the ship Master's Report. In 2015, 98.68% of cattle exported to South-East Asia could be identified by class, and the Industry cooperation facilitating this outcome is both laudable and very much appreciated.

Analysis over time for sheep, cattle and goats exported by air was introduced for the first time in 2013. The continuation of this information in 2015 completes the coverage of live exports for these species, allowing comparison between the sea and air export industries and analysis of air exports over the past eight years.

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

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 into the regional category of "Middle East / North Africa", 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.

In this report information regarding export destinations for sheep has been sourced directly from Industry figures (shipboard and Exporter records) for the first time. This was because an irregularity in the usual information source was detected. It is recommended that Industry information continues as the source for this section of the report.

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.

The project was large, complex, innovative and successful. Its success offers lessons for future projects that can be implemented for industry benefit. It has contributed substantially to improved resources and systems for monitoring and reporting animal health and welfare outcomes.

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).

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/.

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 has laid the foundation for future research involving activities embedded into routine industry operations. It has generated substantial improvement in the understanding of cattle mortality risk on long-haul voyages and particularly mortality due to respiratory disease. Project findings are expected to contribute to development of strategies to reduce respiratory disease risk during export.

The project Final report was published in October 2015, and can be found at the internet site: http://www.mla.com.au/research-and-development/search-rd-reports/final-report-details/Live-Export/Identifying-the-causes-of-mortality-in-cattle-exported-to-the-Middle-East/3250.

6.1.2 Monitoring and evaluation of the HotStuff model

Australian cattle and sheep exported by sea to northern hemisphere ports may be exposed to conditions that present thermoregulatory challenges. They may be aided in homeostasis maintenance by limiting the deck wet-bulb temperature. Deck wet-bulb temperature is, in turn, influenced by the ambient conditions and the stocking density.

A heat-stress risk-assessment model, 'HotStuff', was developed in 2003 for MLA / LiveCorp, for use on long haul live export voyages to the Middle East. The HotStuff model regulates the shipboard stocking density based on expected ambient conditions and ship characteristics (especially the ventilation rate, or 'pen air turnover' on the animal decks).

In 2009 an expert technical review of HotStuff was undertaken. It was concluded that the methodology and assumptions underpinning HotStuff were sound, reasonable and supported by scientific literature, and that the model's developers had followed well-defined and logical principles of adaptive management in the presence of uncertainty. A link to the Review Project Report can be found at the internet site: http://www.mla.com.au/research-and-development/search-rd-reports/final-report-details/Live-Export/Review-of-the-Livestock-Export-Heat-Stress-Risk-Assessment-Model-HotStuff/796.

The objectives of the more recent Monitoring and Evaluation Project were:
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 enhancement to the model.

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 to the northern hemisphere.

Evaluation of environmental data and corresponding daily mortality records for the 35 voyages monitored 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, and

(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, however release of the findings is pending completion of recommendation 1, the further evaluation of findings with the HotStuff developers.

This project will no longer be updated in future publications of this report.

6.1.3 Heat load in sheep exported to Middle Eastern feedlots

To date the project has:
1. Gathered data on the internal temperatures of groups of sheep from a total of 6 shipments and the environmental conditions that they experienced as they undergo transition from Australia into Middle Eastern feedlots.
2. Gathered data, for the monitored shipments, on the pathophysiology of sheep clinically affected by disease during this transition and at the post-shipment feedlot, with blood and pathology samples analysed along with clinical signs and history of individual animals.
3. Gathered data on other stressors such as feeding, management, and infectious disease during the process, by tracking of 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. Related morbidity and mortality of the sheep to the gathered data, to surmise causes.

Phase two of this work has now commenced, firstly with the focus of supplementing sheep, which experience sustained heat loads throughout the live export process into a hot, humid destination in the Middle Eastern summer, with electrolytes.

Secondly, Middle Eastern environmental conditions will be monitored and also the responses of sheep given different shade types and other measures proposed to cool them.

All data collected from phases one and two will be utilised to inform risk management and recommendations to limit compromises to health and welfare of the sheep, and to minimise losses.

Preliminary data collected during phase two indicates positive results have been achieved by the cooling methods trialled. The full analysis of this data is currently underway.

6.1.4 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, and
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, and
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, however with options for suitable long-haul voyages being limited so far, the on-board testing has been delayed.

The Project began in May 2014, however a proposed finish date is yet to be confirmed, as the research is dependent on appropriate cattle being available.

6.1.5 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, and
2. Review and further develop 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 in late-2016.

6.1.6 Stockman’s manual for exporting livestock by air

The development of this manual targets exporters, operators and stockmen involved in the live air export industry:

The manual will outline the steps of the air-export process, from the planning of the consignment through to disembarkation and reporting. It will also provide advice for management of the stock in the destination country.

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 publicise 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 provided.

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

Internet addresses provided were current at the date of publication.

1. 2013 voyage carrying sheep loaded at two ports (see sections 4.1.3.2, pp10, 11; 4.1.3.4, 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 2%. In the Adelaide consignment the mortality rate was 7.28%, while in the Fremantle consignment the mortality rate was 3.00%.

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

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

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

During this voyage, 165 of the 6,000 cattle loaded (2.75%) and 1,654 of the 42,550 sheep loaded (3.89%) were recorded as mortalities. This exceeds the reportable mortality level of 1% for cattle on voyages of 10 days or greater duration and 2% for sheep, as prescribed by the Australian Standards for the Export of Livestock (ASEL).

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

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

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

3. 2015 voyage carrying cattle loaded at Darwin (see section 4.2.4.4, p30):

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

4. 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 presented on the DA internet site: it can be obtained by request from the DA.

5. 2009 flight carrying sheep loaded at Perth (see section 4.4.1.2, p39):

There were 138 mortalities of the 1,873 sheep loaded on the flight, equating to a mortality rate of 7.36%. The aircraft had two operating air conditioning packs and one air conditioning pack deactivated. Inadequate ventilation in the main cargo hold causing increased temperature, humidity and ammonia levels is suspected as the most likely cause of the mortalities.

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

This report is no longer presented on the DA internet site: it can be obtained by request from the DA.

6. 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%. This exceeds the reportable mortality level for sheep of 2% as prescribed by the ASEL.

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

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

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

7. 2014 flight carrying sheep loaded at Perth (see section 4.4.1.2, 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%. This exceeds the reportable mortality level for sheep of 2% as prescribed by the ASEL.

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

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

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

8. 2015 flight carrying sheep loaded at Sydney (see section 4.4.1.2, page 39):

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

9. 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%. 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, however when it occurs it may cause a significant number of mortalities.

This report is no longer presented on the DA internet site: it can be obtained by request from the DA.

10. 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%. This exceeds the 0.5% reportable mortality level for cattle on voyages less than 10 days as prescribed by the ASEL.

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

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

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

11. 2013 flight carrying cattle loaded at Melbourne (see section 4.4.2.2, page 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%. This exceeds the 0.5% 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 where the climate was hot and humid.

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

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

12. 2015 flight carrying goats loaded at Sydney (see section 4.4.3.2, page 41):

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

6.3 Appendix 3 - Published studies

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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.

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