liveexport

National Livestock Export Industry Shipboard Performance Report 2007

Project code: LIVE.246

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Date published: June 2008

ISBN: 9 781 741 912531

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

Executive summary

The objective of this project was to summarise the performance of the live export industry in terms of mortality levels of sheep, cattle and goats exported by sea from Australia during 2007.

The overall mortality rate for sheep during sea transport to all destinations during 2007 was 0.97% out of approximately 3.75 million sheep exported. This was more than the 0.90% mortality rate observed in 2006. The main port of loading was Fremantle (2.7 million sheep exported with mortality rate of 0.96%), followed by Portland (0.5 million sheep exported with mortality rate of 0.99%) and Adelaide (0.5 million sheep exported with mortality rate of 1.03%).

The overall mortality rate among the 0.71 million cattle exported from Australia in 2007 was 0.10%, a substantial fall from the 0.18% observed in 2006. The overall mortality rate on voyages to the Middle East/North Africa fell to a record low of 0.19% in 2007. The overall mortality rate on voyages to South-East Asia (0.09%) was similar to 2006. The highest overall mortality rate on a regional basis was 0.26% for exports to miscellaneous areas (comprising Mauritius, Turkey and the Black Sea) followed by Mexico (0.23%).

The overall mortality rate among the 25,546 goats exported by sea from Australia in 2007 was 0.69%, which was more than the 0.49% observed in 2006. Most goats exported by sea during 2007 went to South-East Asia with two shipments to the Middle East and two to Indian Ocean destinations.

Industry stakeholders, government, animal welfare groups and the general public have a keen interest in monitoring industry performance in different sectors of the livestock export trade. The summary report provides a breakdown by species and major destinations.

The Australian Government Department of Agriculture, Fisheries and Forestry also present mortality data, though in a different format, at the DAFF “website”; www.daff.gov.au/animal-plant-health/welfare/export-trade/mortalities.

Contents

1 Background

The live export of sheep and cattle makes a significant contribution to the Australian economy and provides employment in services that support this industry. The livestock export trade provides important support for the sheep and cattle 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 transport from Australia. It allows industry, government and others to monitor mortality trends in these sectors. The report also lists relevant published studies.

The Australian Government Department of Agriculture, Fisheries and Forestry (DAFF) also presents mortality data, though in a different format, at their website: www.daff.gov.au/animal-plant-health/welfare/export-trade/mortalities. The DAFF data refers to reports received during the calendar year, in contrast to the current report which refers to voyages which departed during the calendar year.

2 Project objectives

Produce a report which summarises the mortality levels of sheep, cattle and goats for the 2007 calendar year and provides analysis of mortality trends in the livestock export industry.

Distribute a summary report to industry, government, animal welfare groups and other parties interested in the livestock export trade.

3 Methodology

The information in this report was obtained from ship Master's Reports which record livestock mortalities and other information about each voyage, and also from "Yellow Books" which record more detailed information about numbers of livestock mortalities than is available from the Masters' Report. The 2007 report is based on analysis of ship Masters' reports and "Yellow Books" for voyages which departed Australia during 2007 and which were to hand on 7 March 2008. The Australian Bureau of Statistics provided information on the number of sheep exported to various destination countries from ports in Australia.

Readers should be aware that additional mortality information (Masters' reports or "Yellow Books") for a particular year may be received after publication of that year's summary report. These records are added to the database and used in subsequent analyses. Therefore, statistics for a particular year may vary slightly in subsequent reports from the results as originally published.

Codes are used where appropriate in order to maintain confidentiality.

Summary information was produced using Statistix 7.0

4 Results and discussion

4.1 Sheep

4.1.1 Performance trend

Figures 1 and 2 show the number of sheep and the number of mortalities during sea transport from all ports in Australia to all destinations since 1985 as well as the trendline (linear regression) across the years. The number of sheep exported annually has varied between 3.5 and 6.5 million, and the annual mortality has varied between 0.75 and 3.0%. The trend for numbers of sheep exported and annual mortality has been downward, with a greater decline for annual mortality.

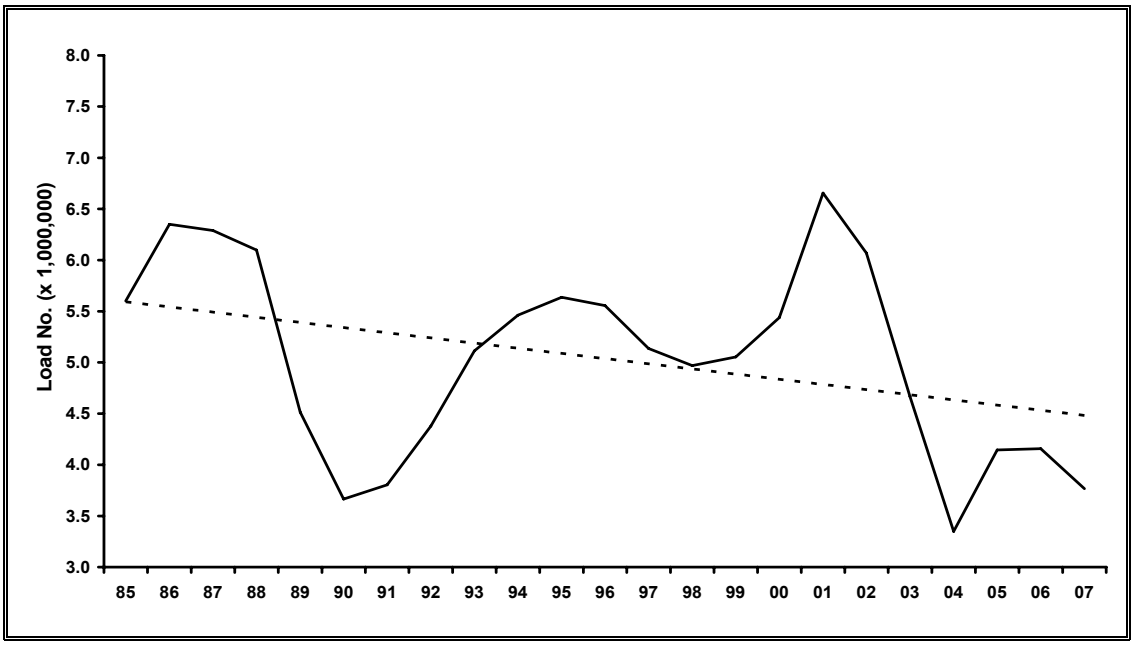

Figure 1 *Number of sheep exported by sea from Australia to all destinations since 1985*

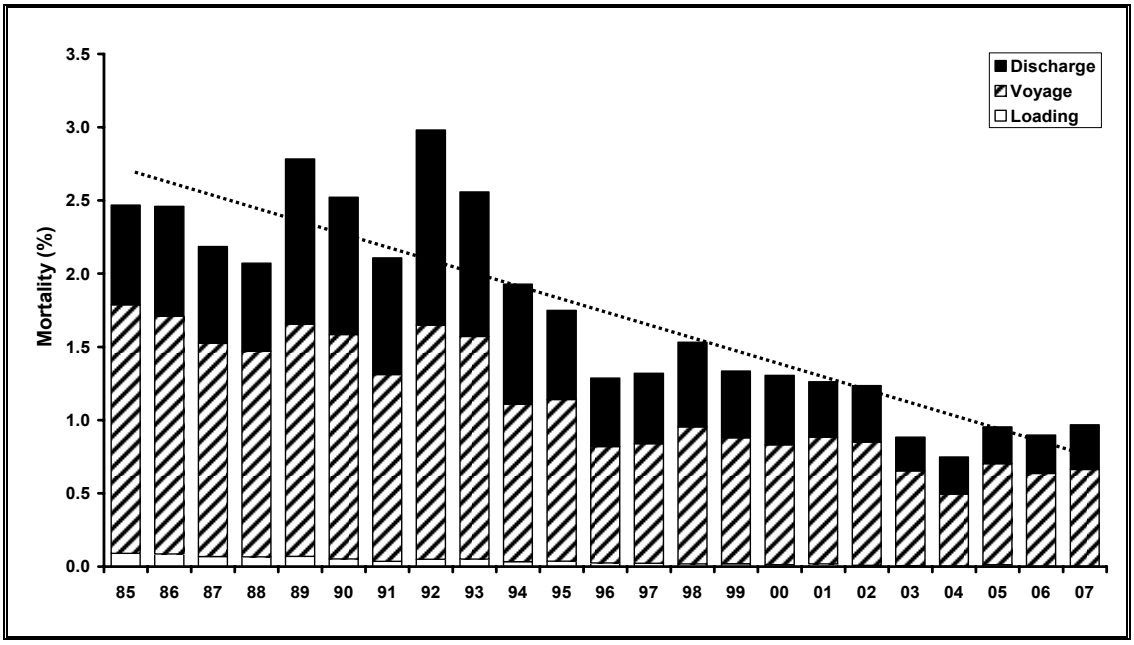

Figure 2 *Annual mortality of sheep exported by sea from Australia to all destinations since 1985*

4.1.2 Overview

Most sheep exported live by sea from Australia in 2007 were sent to the Middle East and were mainly loaded at Fremantle, Adelaide and Portland. Some sheep were exported to other regions including South-East Asia and Mexico. Except where indicated, the comments below refer to voyages of sheep to the Middle East. An overview of the findings of research into the causes of sheep mortalities during export to the Middle East is given in Appendix 1.

4.1.3 Port of loading

The numbers and classes of sheep exported by sea to the Middle East from Fremantle, Adelaide and Portland during 2007 are shown in Table 1. Overall numbers exported in 2007 fell by almost 8% compared to 2006. Compared to 2006, the main changes in 2007 were a reduction in exports of adult wethers from Fremantle and an increase in exports of adult wethers from Adelaide.

Table 1 The numbers and classes of sheep exported by sea to the Middle East from Fremantle, Adelaide and Portland during 2007

Livestock		Fremantle	Adelaide	Portland	Total
Wethers	adults	1,076,531	439,031	447,438	1,963,000
	hoggets	302,351	35,821	58,276	396,448
	lambs	548,757		3,118	551,875
Rams	adults	58,733	13,154	11,766	83,653
	hoggets	56,964			56,964
	lambs	443,802	3,166	107	447,075
Ewes	adults	74,668			74,668
	hoggets	6,487			6,487
	lambs	161,443		98	161,541
Total	sheep	2,729,736	491,172	520,803	3,741,711*

* excludes 26,047 sheep exported to South-East Asia from various ports in Australia and 374 sheep exported to Mexico from Fremantle and Portland.

Most sheep exported by sea from Australia to the Middle East during 2007 were loaded at Fremantle (72.9% of all sheep, Figure 3) with smaller numbers loaded at Portland (13.9%) and Adelaide (13.1%).

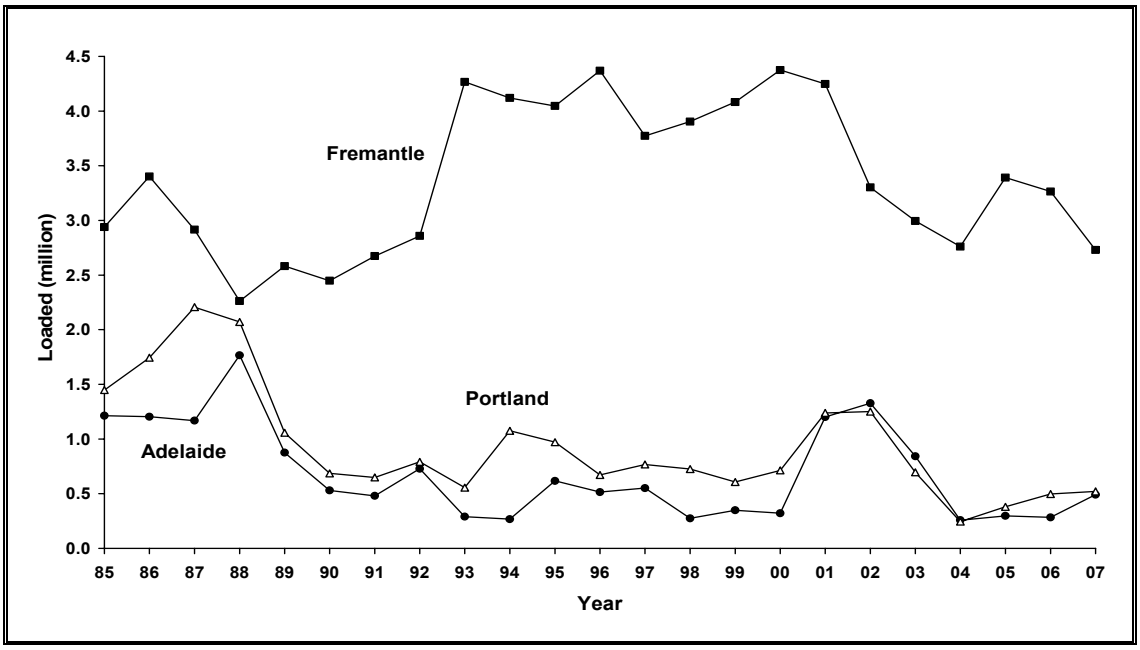

Figure 3 *Numbers of sheep exported by sea to the Middle East from Fremantle* (*Western Australia*)*, Portland* (*Victoria*) *and Adelaide* (*South Australia*) *since 1985*

4.1.4 Destination

The main importing countries for Australian sheep in 2007 are shown in Table 2. Saudi Arabia was the main market (27% of all sheep) followed by Kuwait (25%), Bahrain (15%) and Oman (14%).

Table 2 Destination country for sheep exported from Australia during 2007

Country	Fremantle	Adelaide	Portland	Other	Total
Bahrain	251,904	136,043	173,575		561,522
Israel	35,000				35,000
Jordan	267,829				267,829
Kuwait	628,855	132,825	168,498		930,178
Mexico	254		160		414
Oman	349,253	88,699	101,604		539,556
Qatar	110,350	55,000	26,500		191,850
Saudi Arabia	1,006,895	15,000	10,500		1,032,395
UAE	129,755	23,159	32,840		185,754
S.E. Asia	15,084			13,250	28,334
N.E. Asia				62	62
Other				135	135
Total	2,795,179	450,726	513,677	13,447	3,773,029

SOURCE – Australian Bureau of Statistics, April 2007

Note: - ABS figures also include exports by air

4.1.5 Mortality rates

There were 18 voyages to the Middle East in 2007 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 wherever possible. Where analysis involving split-load voyages has been performed, the consignments of sheep from each load port have been considered as separate "voyages".

The shipboard part of the export process is divided into three phases: loading; voyage to the first port of unloading; 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.

The total mortality rate for all sheep exported to all destination regions during 2007 was 0.97% (Table 3), a rise from the 0.90% observed in 2006.

There were 10 shipments to South-East Asia, and the mortality rate was 0.36% out of 26,047 sheep loaded.

There were 3 shipments to Mexico and the mortality rate was 0.5% out of 374 sheep loaded.

For shipments to the Middle East, the main changes compared to 2006 were increased discharge mortality rate for shipments from Fremantle and Portland, and increased voyage mortality rate for shipments from Adelaide (Table 3 and Figure 4).

Table 3 Annual shipboard mortality rates for sheep exported from Fremantle, Adelaide and Portland to the Middle East, and Total mortality rate for all sheep exported to all destinations

		Mortality rate (%)			
	Year	Load	Voyage	Discharge	Total
Fremantle*	2003	0.01	0.56	0.20†	0.76†
	2004	0.00	0.46	0.25	0.71
	2005	0.02	0.73	0.22	0.97
	2006	0.00	0.63	0.23	0.86
	2007	0.00	0.66	0.29	0.96
Adelaide*	2003	0.01	0.91	0.26	1.18
	2004	0.00	0.89	0.25	1.15
	2005	0.00	0.54	0.46	1.00
	2006	0.01	0.67	0.30	0.98
	2007	0.00	0.74	0.28	1.03
Portland*	2003	0.00	0.72	0.29	1.01
	2004	0.00	0.49	0.29	0.78
	2005	0.00	0.51	0.32	0.83
	2006	0.00	0.57	0.35	0.92
	2007	0.00	0.60	0.40	0.99
Total**	2003	0.01	0.65	0.23†	0.88†
	2004	0.00	0.49	0.25	0.75
	2005	0.01	0.69	0.25	0.95
	2006	0.00	0.63	0.26	0.90
	2007	0.00	0.66	0.31	0.97

* Middle East only

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

† Excludes mortalities on the MV Cormo Express after it was rejected at Saudi Arabia

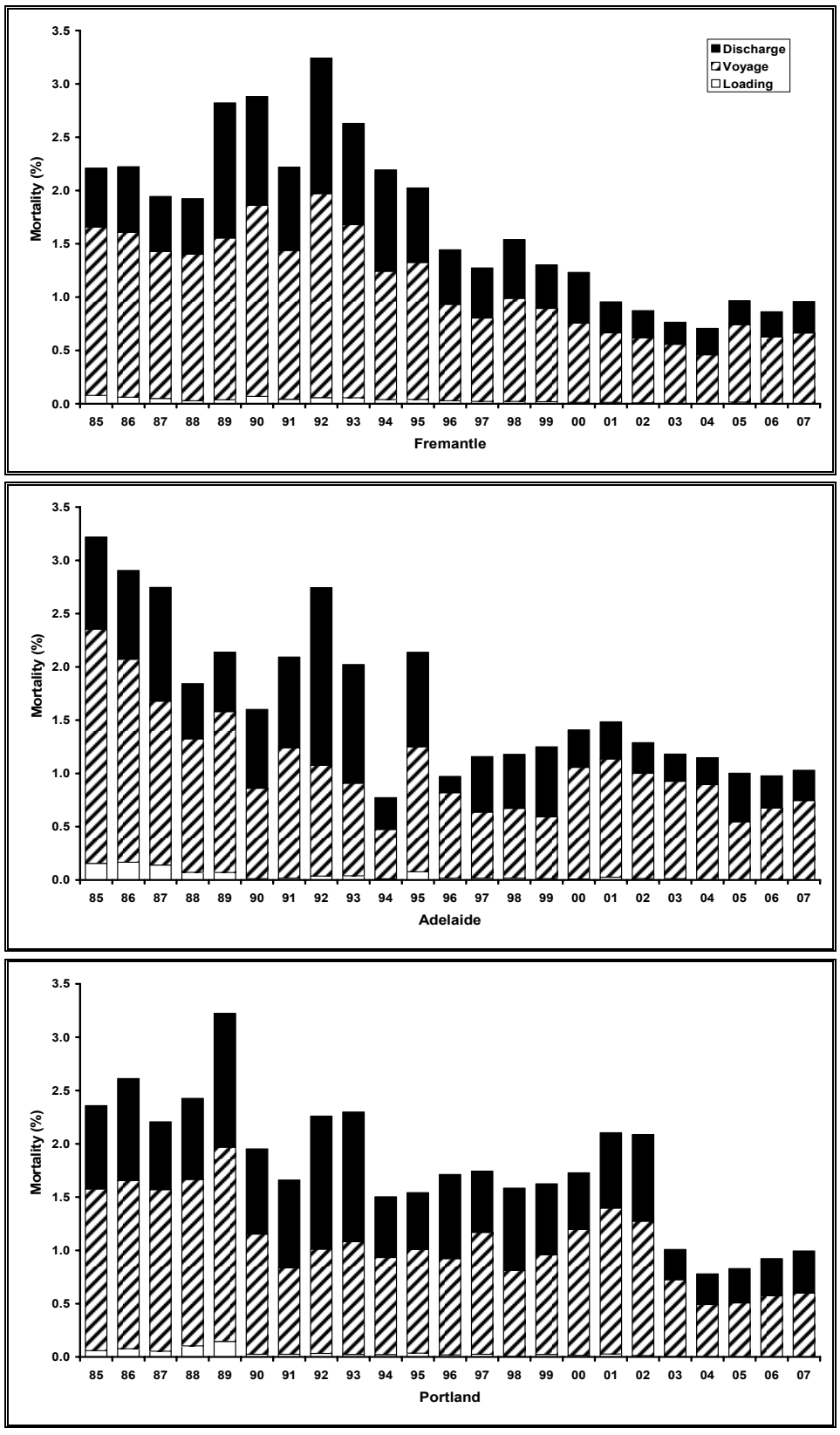

Figure 4 *Annual mortality for sheep exported from Fremantle, Adelaide and Portland to the Middle East since 1985 – figure for Fremantle excludes mortalities on the MV Cormo Express after it was rejected at Saudi Arabia in 2003*

4.1.6 Class of sheep

The mortality rates of various classes of sheep exported from Australia to the Middle East are shown in Table 4 and Figure 5. The highest mortality rates in 2007 were in adult rams and ewes, followed by ram lambs.

Table 4 Overall mortality (%) for classes of sheep exported from Fremantle, Adelaide and Portland to the Middle East in 2007

Class of sheep		Fremantle	Adelaide	Portland	Total
Wethers	adult	0.8	1.1	1.1	0.9
	hogget	0.7	0.7	0.5	0.7
	lamb	0.9	n/a	0.4	0.9
Rams	adult	1.6	1.0	1.2	1.5
	hogget	1.0	n/a	n/a	1.0
	lamb	1.3	0.5	0.0	1.3
Ewes	adult	1.5	n/a	n/a	1.5
	hogget	0.8	n/a	n/a	0.8
	lamb	1.0	n/a	1.0	1.0

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

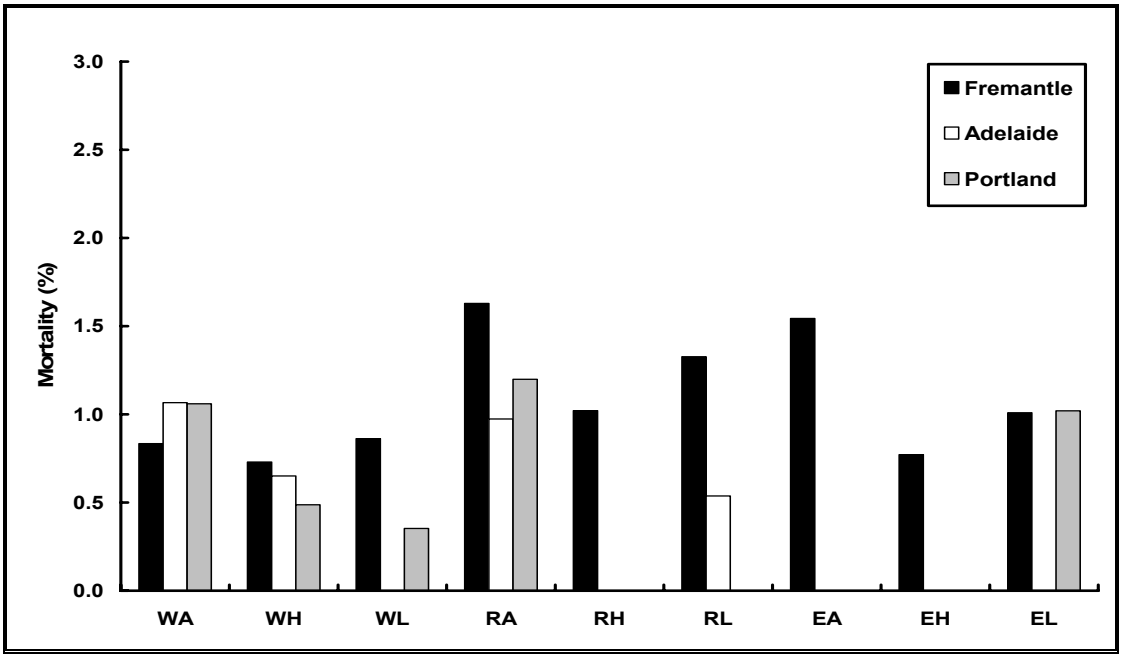

Figure 5 *Overall mortality (%) for classes of sheep exported from Fremantle, Adelaide and Portland to the Middle East in 2007*

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*

4.1.7 Time of year

Mortality rates, on a monthly basis, for voyages from Fremantle, Adelaide and Portland are shown in Table 5.

Mortality rates were higher ($P < 0.05$) in the second half of 2007 compared with the first half in sheep exported from Fremantle and Adelaide; but for Portland, mortality rates were lower ($P < 0.05$) in the second half of the year (Figure 6).

Table 5 Monthly mortality for all sheep exported from Fremantle, Adelaide and Portland to the Middle East from 2000 to 2007

		Year							
Port	Month	00	01	02	03	04	05	06	07
Fremantle	J	0.8	0.7	0.9	0.5	0.8	0.7	0.9	0.4
	F	0.8	0.5	0.7	0.5	0.5	0.6	0.8	0.5
	M	1.0	0.5	0.5	0.4	0.5	0.5	0.7	0.6
	A	1.0	0.6	0.7	0.6	0.4	0.7	0.5	0.4
	M	1.1	0.7	0.7	0.6	0.5	0.5	0.7	0.9
	J	2.2	1.3	0.9	0.8	0.9	0.9	0.8	0.5
	J	2.4	1.4	1.4	0.9	0.6	0.5	0.9	1.0
	A	1.3	1.6	1.1	1.0	0.9	1.4	1.1	1.4
	S	1.8	1.7	0.9	1.0	1.0	1.3	1.1	1.3
	O	1.1	1.1	1.1	1.1	0.8	1.4	0.9	1.4
	N	1.0	1.1	0.9	1.2	0.7	0.7	0.7	1.3
	D	0.9	0.8	0.6	0.7	0.6	1.0	0.8	0.8
	M – O*	1.6	1.3	1.0	0.9	0.8	1.2	0.9	1.1
	Total	1.2	1.0	0.9	0.8	0.7	1.0	0.9	1.0
Adelaide	J	0.2		1.7	0.9	1.2			0.6
	F		1.5	0.8	1.0	1.3			
	M		1.3	0.8	0.9			0.7	0.5
	A	0.6		1.2	0.6		0.5	0.9	0.7
	M	0.5	1.1	0.7	1.2	0.5	0.9		0.6
	J	2.4		1.8	2.3	1.1			2.1
	J	1.3	1.5	1.7	1.2	0.7	1.4		0.5
	A		2.4	0.9	1.0	1.3	1.0	1.1	2.1
	S	0.5	1.7	1.5	1.7	1.3			1.0
	O	0.7	1.0	1.9	1.1			1.2	1.2
	N		1.8	1.1			1.1	0.9	
	D	2.3	1.4	1.4	1.8				0.8
	M – O*	1.3	1.5	1.5	1.4	1.1	1.1	1.0	1.3
	Total	1.4	1.5	1.3	1.2	1.1	1.0	1.0	1.0
Portland	J	1.3	1.9	1.3	0.6		1.0		1.2
	F		2.4	1.0		0.8	0.4		0.8
	M	0.9	0.7	0.7	0.6	1.0		0.9	0.6
	A	0.7	1.0	1.1	0.6	0.8		0.6	
	M		1.8	1.0	0.7	0.5		0.7	1.8
	J		4.0	1.7	1.0	1.0	0.5	1.4	0.7
	J		1.6	5.5	1.7	0.7	1.1		2.5
	A		2.2	7.5	1.4			1.2	0.7
	S	2.8	2.1	2.1	1.8		0.7	1.1	0.6
	O	2.2	3.2		1.4		1.5	1.2	0.8
	N	1.6	2.4			0.9	1.0	0.6	0.7
	D	5.3	2.1	1.3	0.7		0.6	0.3	0.6
	M – O*	2.5	2.7	3.0	1.3	0.6	0.9	1.1	1.1
	Total	1.7	2.2	2.1	1.0	0.8	0.8	0.9	1.0

* May to October. In past years, shipboard mortalities were excessive from some Australian ports during winter months

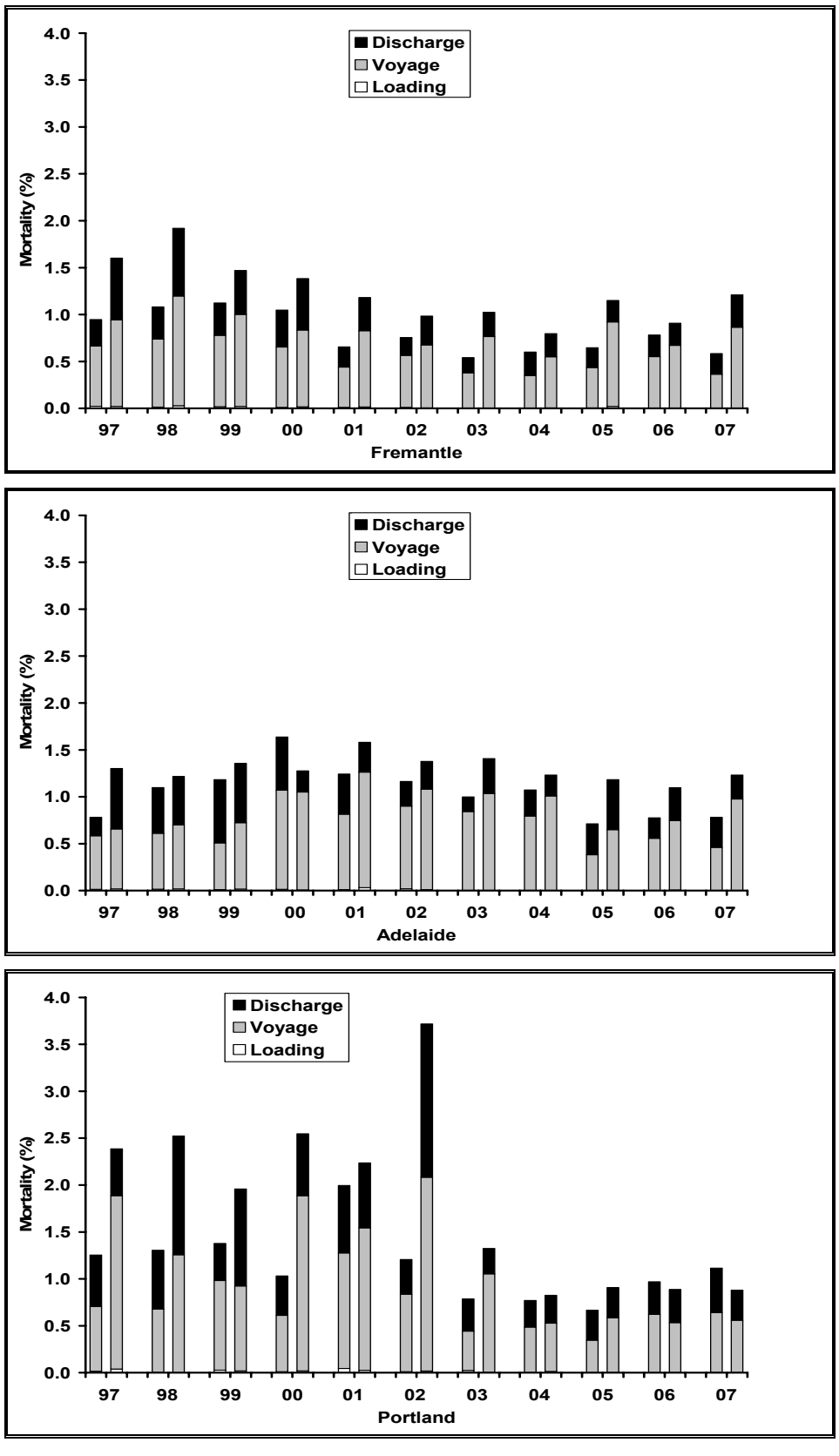

Figure 6 *Mortality (%) for sheep exported by sea from Fremantle, Adelaide and Portland to the Middle East for the first and second half of each year from 1997 to 2007*

Monthly mortality rates for voyages from Fremantle are shown in Figure 7 - note that graphs for monthly mortality rates of voyages from Adelaide and Portland are not presented because of the number of months where no voyage occurred (see Table 5).

Monthly mortality rates (total mortality as a proportion of total loaded for each month) in sheep exported from Fremantle during 2007 approximates the 5-year monthly mortality rates (Figure 7).

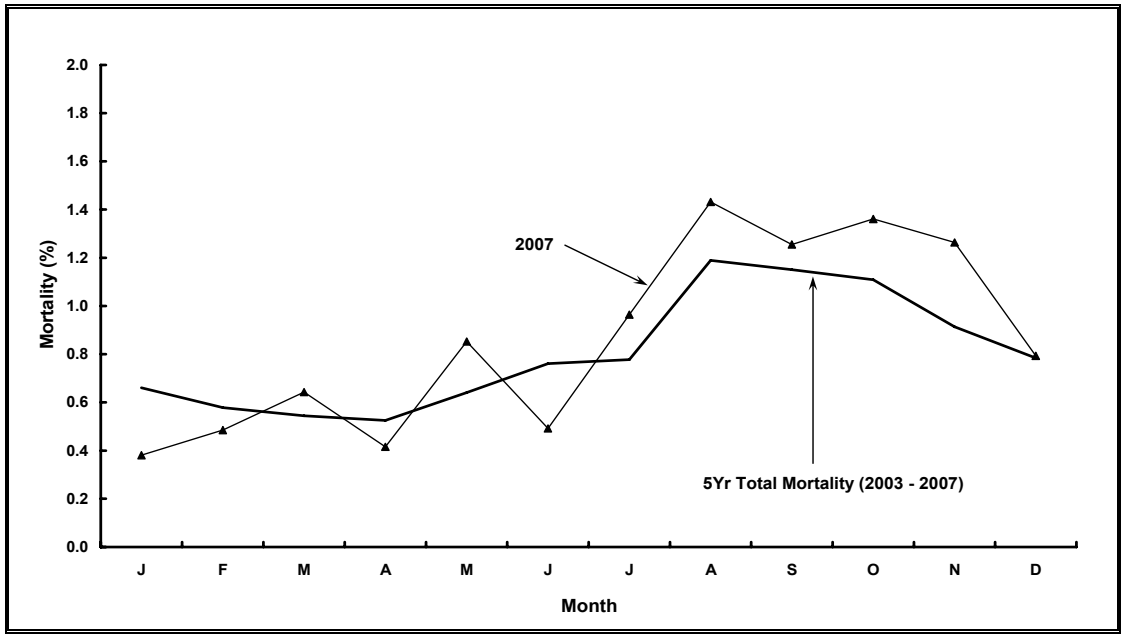

Figure 7 *Monthly mortality rates for shipments from Fremantle to the Middle East in 2007 and the 5-year monthly for the period 2003 to 2007*

4.1.8 Ship

The voyages of each ship were classified into low, medium and high mortality categories for sheep exported to the Middle East from Fremantle (Table 6a), Adelaide (Table 6b) and Portland (Table 6c).

There were five voyages classified as “high mortality” during 2007. Approximately 63% of voyages from Fremantle, 70% of voyages from Adelaide and 77% of voyages from Portland were in the “low” category.

Table 6a Number of voyages in low, medium and high mortality categories for ships loaded at Fremantle in 2007

Ship (code)	Mortality rate			Total
	Low <1.0%	Medium 1.0–2.0%	High >2.0%	
2	1	2	0	3
32	4	2	0	6
33	4	2	0	6
34	4	1	1	6
35	3	3	0	6
37	3	1	0	4
38	6	2	1	9
41	2	1	0	3
Total	27	14	2	43

Table 6b Number of voyages in low, medium and high mortality categories for ships loaded at Adelaide in 2007

Ship (code)	Mortality rate			Total
	Low <1.0%	Medium 1.0–2.0%	High >2.0%	
32	3	0	0	3
34	1	1	0	2
35	0	0	2	2
37	2	0	0	2
41	1	0	0	1
Total	7	1	2	10

Table 6c Number of voyages in low, medium and high mortality categories for ships loaded at Portland in 2007

Ship (code)	Mortality rate			Total
	Low <1.0%	Medium 1.0–2.0%	High >2.0%	
2	1	0	0	1
32	2	1	0	3
34	2	0	1	3
35	2	1	0	3
37	1	0	0	1
38	1	0	0	1
41	1	0	0	1
Total	10	2	1	13

4.2 Cattle

4.2.1 Performance trend

Figures 8 and 9 show the number of cattle and the number of mortalities during sea transport from all ports in Australia to all destinations since 1995 as well as the trendline (linear regression) across the years. The number of cattle exported annually has varied from approximately 450,000 to 960,000, and the annual mortality has varied between 0.10 and 0.42%. The trend for numbers of cattle exported has been slightly upwards whereas the trend for annual mortality has been downward, with a greater decline for annual mortality.

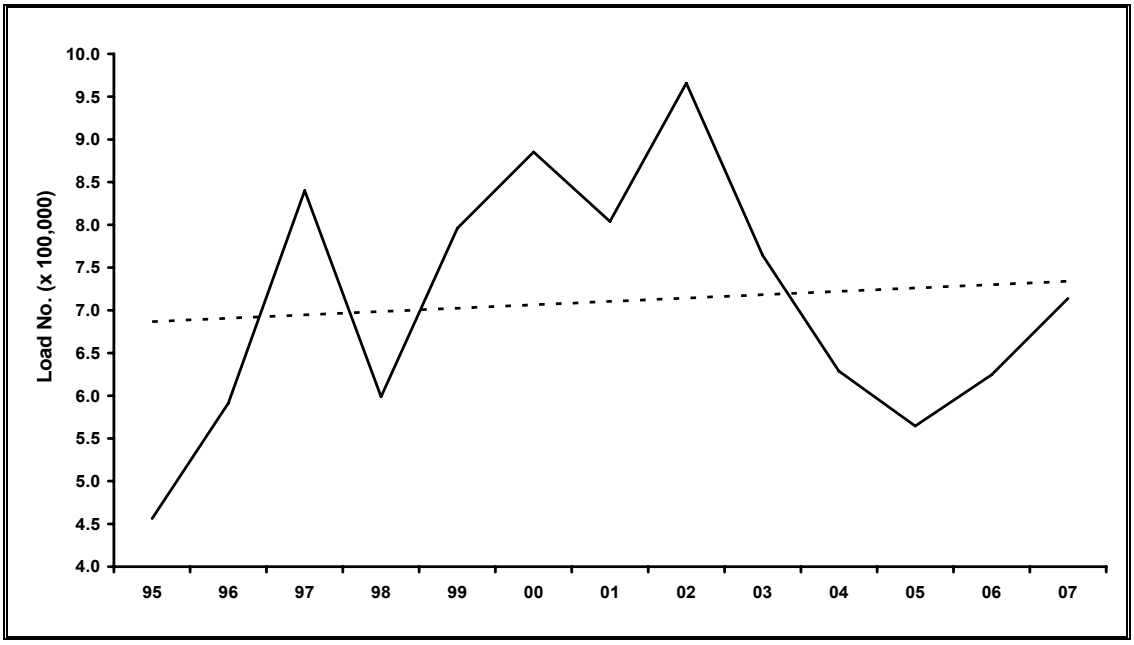

Figure 8 *Number of cattle exported by sea from Australia to all destinations since 1995*

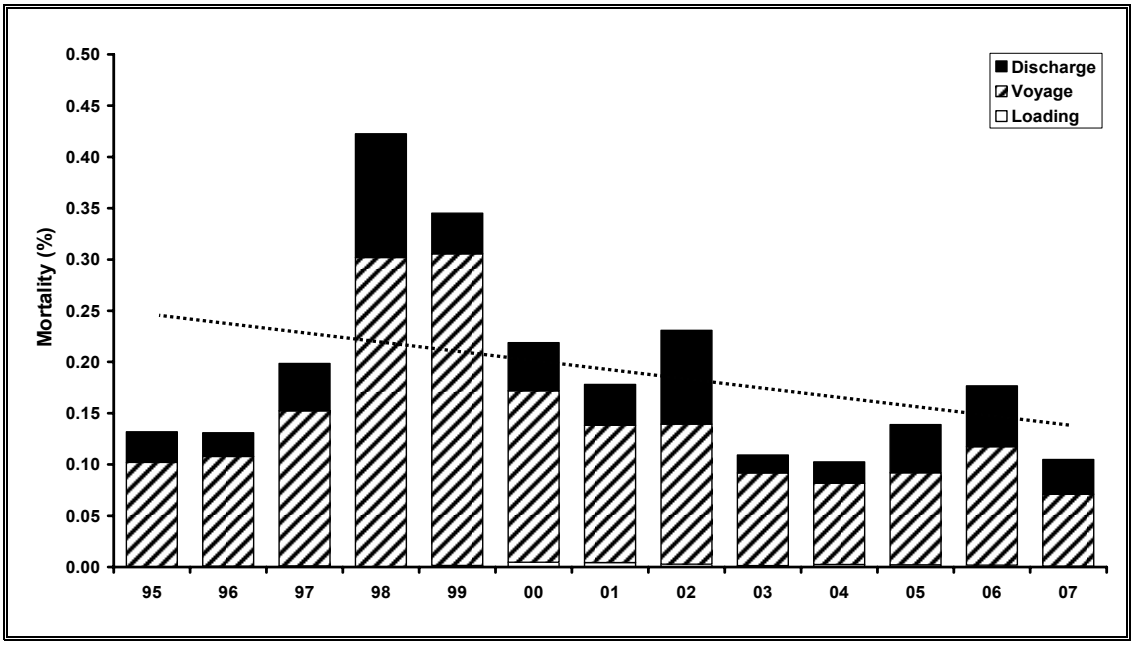

Figure 9 *Annual mortality of cattle exported by sea from Australia to all destinations since 1995*

4.2.2 Overview

The live cattle trade from Australia in 2007 was characterised by the large number of ports of loading in Australia and the regions to which the animals were shipped. This is in contrast to the live sheep trade where there were only three main ports of loading, and virtually all sheep were shipped to the Middle East.

There were 20 voyages in 2007 for which cattle were loaded at more than one port in Australia. Mortalities for split-load voyages were attributed to the port of loading where possible. Where analysis involving split-load voyages has been performed, the consignments of cattle from each load port have been considered as separate “voyages”.

The overall mortality rate among the 0.71 million cattle exported from Australia in 2007 was 0.10% (Table 7), a substantial fall from the 0.18% observed in 2006 and equal to the record low of 2004. The highest overall mortality rate on a regional basis was to miscellaneous areas (comprising Mauritius, Turkey and the Black Sea) followed by Mexico.

Previously, exports to South-East Asia were characterised by small consignments on short voyages. More recently, larger ships have been introduced which have involved loading and discharging at more than one port. The number of voyages to the region increased by 26% in 2007 compared to 2006.

Exports to North-East Asia were mainly steers exported to Japan and dairy cattle exported to China.

Table 7 Mortality rates, number of voyages and number of cattle exported for voyages to major destination regions during 2007

Parameter	ME/N Africa	SE Asia	NE Asia	Mexico	Misc	Total
Voyages (No.)	41	205	21	7	8	282
Cattle (No.)	74,256	573,729	34,837	21,719	8,506	713,047
Mortality rate overall (%)	0.19	0.09	0.06	0.23	0.26	0.10
Mortality rate range (%)	0.0 – 0.5	0.0 – 4.0	0.0 – 0.2	0.1 – 0.4	0.0 – 1.0	0.0 – 4.0
Voyages with nil mortalities (No.)	16	92	10	0	1	119

4.2.3 Middle East

The live cattle trade to the Middle East has remained low over the last five years (Table 8). Overall mortality rates have remained below 0.5% since 1999 except for 2002 and 2006. In 2007, the mortality rate of 0.19% was a record low.

Table 8 Mortality rates, number of voyages and number of cattle exported to the Middle East from 1995 to 2007

Year	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyages with nil mortalities (No.)
1995	11	14,557	0.67	0.0 – 2.1	2
1996	36	65,066	0.65	0.0 – 5.0	14
1997	62	137,869	0.67	0.0 – 4.2	15
1998	122	266,286	0.69	0.0 – 41.5*	23
1999	112	314,981	0.35	0.0 – 3.3	25
2000	96	274,159	0.42	0.0 – 8.0	22
2001	101	287,447	0.32	0.0 – 5.0	27
2002	102	265,005	0.61	0.0 – 35.0*	33
2003	52	106,080	0.45	0.0 – 2.0	18
2004	31	61,679	0.43	0.0 - 1.2	9
2005	38	90,808	0.34	0.0 – 1.0	12
2006	43	119,297	0.52	0.0 – 4.3	13
2007	41	74,256	0.19	0.0 – 0.5	16

* exceptional voyages involving presumed heat stroke in 1998 and heat stroke in 2002

4.2.3.1 Port of loading

There were 4 ports of loading for voyages to the Middle East in 2007, and most cattle were exported from Fremantle, followed by Portland and Port Hedland (Table 9). Mortality rates in 2007 were highest from Port Hedland, followed by Fremantle and Portland.

The voyages from each port were classified into various mortality categories as shown in Table 10. There was only one voyage in the medium or high categories, loaded at Fremantle. No mortalities occurred on half of the voyages from Fremantle.

Table 9 Mortality rates, number of voyages and number of cattle exported from various ports to the Middle East for 2007

Port	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)
Fremantle	27	53,178	0.19	0.0 – 0.5
Adelaide	3	1,231	0.08	0.0 – 0.3
Portland	8	9,932	0.19	0.1 – 0.4
Port Hedland	3	9,915	0.22	0.1 – 0.3

Table 10 Number of voyages in nil, low, medium and high mortality categories for shipments from various ports to the Middle East for 2007

Port	Mortality rate				Total
	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	
Fremantle	14	12	1	0	27
Adelaide	2	1	0	0	3
Portland	0	8	0	0	8
Port Hedland	0	3	0	0	3
Total	16	24	1	0	41

4.2.3.2 Time of year

Monthly mortality rates from southern ports remained below 0.5% throughout the year (Figure 10) and no seasonal variation was apparent. There were no voyages to the Middle East from northern ports in 2007.

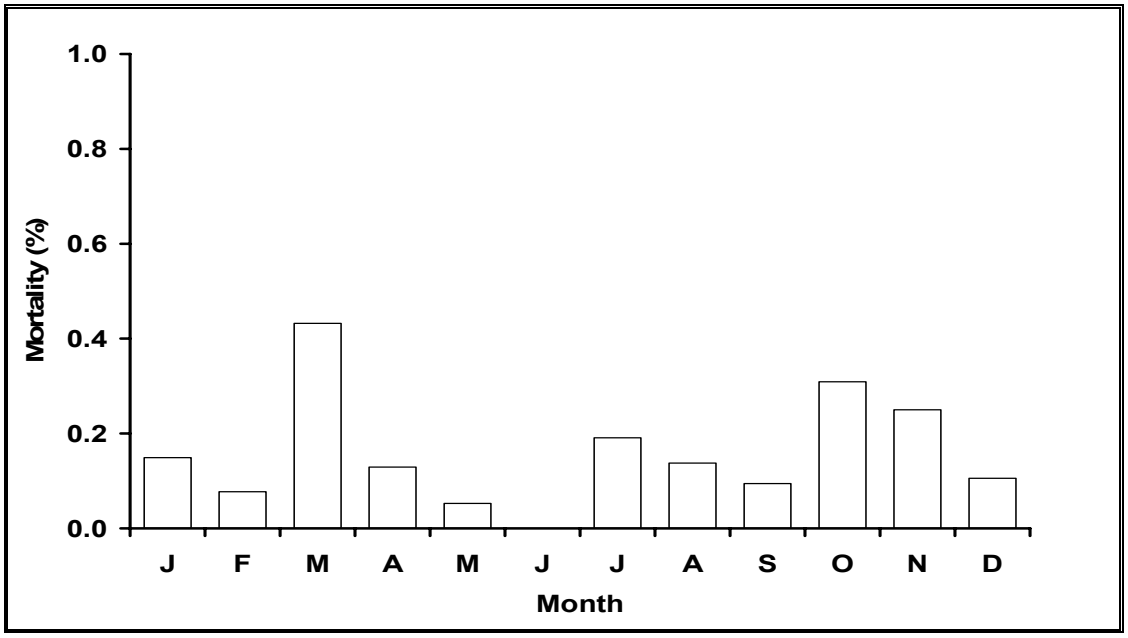

Figure 10 *Monthly mortality rate of cattle on voyages from southern ports to the Middle East for 2007*

4.2.3.3 Voyages from southern ports 1999 to 2007

Additional analysis was conducted for the ports of Fremantle, Adelaide and Portland because of the higher mortality rates on voyages from these ports compared to northern ports in previous years.

The number of cattle exported from Fremantle and the mortality rate fell by almost half compared to the previous year (Table 11). There were few cattle exported from Adelaide in 2007.

Table 11 Mortality rates for cattle loaded at Fremantle, Adelaide or Portland from 1999 to 2007

Year	Fremantle			Adelaide			Portland		
	Voys (No.)	Cattle (No.)	Mort. (%)	Voys (No.)	Cattle (No.)	Mort. (%)	Voys (No.)	Cattle (No.)	Mort. (%)
1999	43	103,290	0.33	10	30,139	0.51	14	45,087	0.83
2000	45	94,787	0.43	7	19,158	0.66	13	40,748	1.01
2001	48	104,404	0.34	11	22,274	0.53	16	35,797	0.82
2002	57	103,914	0.36	17	25,035	0.47	15	46,624	2.03*
2003	50	68,167	0.45	9	16,083	0.70	9	11,146	0.35
2004	22	54,585	0.42	5	4,743	0.63	4	2,351	0.30
2005	28	66,098	0.39	1	1,171	0.08	6	11,310	0.14
2006	33	99,577	0.39	1	310	0.00	6	9,132	2.28†
2007	27	53,178	0.19	3	1,231	0.08	8	9,932	0.19

* 0.74% if one high mortality voyage is excluded

† 0.20% if one high mortality voyage is excluded

4.2.3.4 Ship

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

Table 12 shows the number of voyages in the various mortality categories for each ship. There was only one voyage in the medium or high categories; 39% of all voyages were in the nil category.

Table 12 Number of voyages in nil, low, medium and high mortality categories for shipments to the Middle East for 2007

Ship (code)	Mortality rate				Total
	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	
32	5	2	0	0	7
33	0	7	0	0	7
34	2	2	1	0	5
35	2	2	0	0	4
37	2	1	0	0	3
38	4	3	0	0	7
41	1	1	0	0	2
59	0	2	0	0	2
109	0	1	0	0	1
120	0	1	0	0	1
121	0	2	0	0	2
Total	16	24	1	0	41

4.2.3.5 Class of cattle

In 2007 the highest mortality rates occurred in beef cows (0.37%) followed by bull calves (0.21%) and bull adults (0.19%; Table 13). There were 5,574 cattle that could not be identified to class, which experienced a mortality rate of 0.27%.

Table 13 Mortality rates, number of voyages and number of cattle in various classes exported to the Middle East in 2007

Class	Voyages (No.)	Cattle (No.)	Mortality rate (%)	Mortality rate range (%)
Steer adult*	1	236	0.00	n/a
Bull adult*	23	42,094	0.19	0.0 – 0.5
Bull calf	6	15,824	0.21	0.0 - 0.4
Cow beef	2	537	0.37	0.0 – 0.5
Cow dairy	5	1,074	0.09	0.0 – 1.0
Heifer beef	4	1,204	0.00	n/a
Heifer dairy	12	7,713	0.14	0.0 - 0.6

* includes immature and mature animals (ie animals not classified as "calf")

4.2.4 South-East Asia

Approximately 0.57 million cattle were exported to South-East Asia in 2007 (Table 14). The mortality rate remained the same as 2006 at 0.09% while the number of voyages to the region increased by 26%. No mortalities were reported on 45% of the voyages to the region. The mortality rate has remained below 0.1% since 2001.

Table 14 Mortality rates, number of voyages and number of cattle exported to South-East Asia from 1995 to 2007

Year	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyages with nil mortalities (No.)
1995	365	430,653	0.11	0.0 – 8.5	206
1996	415	505,777	0.05	0.0 – 1.2	280
1997	507	678,585	0.09	0.0 – 1.7	277
1998	229	296,823	0.17	0.0 – 8.8	127
1999	326	462,540	0.34	0.0 – 74.7*	162
2000	385	587,049	0.11	0.0 – 5.3	168
2001	312	472,363	0.08	0.0 – 5.0	139
2002	365	656,767	0.07	0.0 – 8.5	191
2003	306	587,716	0.05	0.0 – 2.2	190
2004	215	460,131	0.05	0.0 – 1.8	116
2005	168	402,210	0.09	0.0 – 0.8	73
2006	163	446,711	0.09	0.0 – 1.0	65
2007	205	573,729	0.09	0.0 – 4.0	92

*exceptional voyage involving heat stroke caused by ventilation failure due to contaminated fuel

4.2.4.1 Port of loading

Most cattle exported to South-East Asia in 2007 were loaded at Darwin followed by Broome and Fremantle (Table 15). The mortality rate was highest for cattle exported from Fremantle.

The voyages from each port were classified into various mortality categories as shown in Table 16. All except five voyages were in the nil or low categories, while there were two voyages in the high category involving the ports of Fremantle and Port Hedland.

Table 15 Mortality rates, number of voyages and number of cattle exported from various ports to South-East Asia in 2007

Port	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)
Townsville	3	51,261	0.06	0.0 – 0.1
Mourilyan	2	2,422	0.21	0.0 – 0.3
Karumba	9	12,193	0.04	0.0 – 0.5
Darwin	90	288,290	0.07	0.0 – 0.6
Wyndham	16	43,000	0.04	0.0 – 0.2
Broome	34	89,913	0.08	0.0 – 0.4
Port Hedland	8	12,381	0.09	0.0 – 1.2
Geraldton	12	18,079	0.04	0.0 – 0.1
Fremantle	31	56,190	0.30	0.0 – 4.0

Table 16 Number of voyages in nil, low, medium and high mortality categories for shipments from various ports to South-East Asia for 2007

Port	Mortality rate				Total
	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	
Townsville	0	3	0	0	3
Mourilyan	1	1	0	0	2
Karumba	7	1	1	0	9
Darwin	49	40	1	0	90
Wyndham	8	8	0	0	16
Broome	12	22	0	0	34
Port Hedland	5	2	0	1	8
Geraldton	5	7	0	0	12
Fremantle	5	24	1	1	31
Total	92	108	3	2	205

4.2.4.2 Time of year

Monthly mortality rates for voyages to South-East Asia were 0.1% or below throughout the year except for January, March, October and December (Figure 11). There were 31 voyages to the South-East Asia from a southern port in 2007.

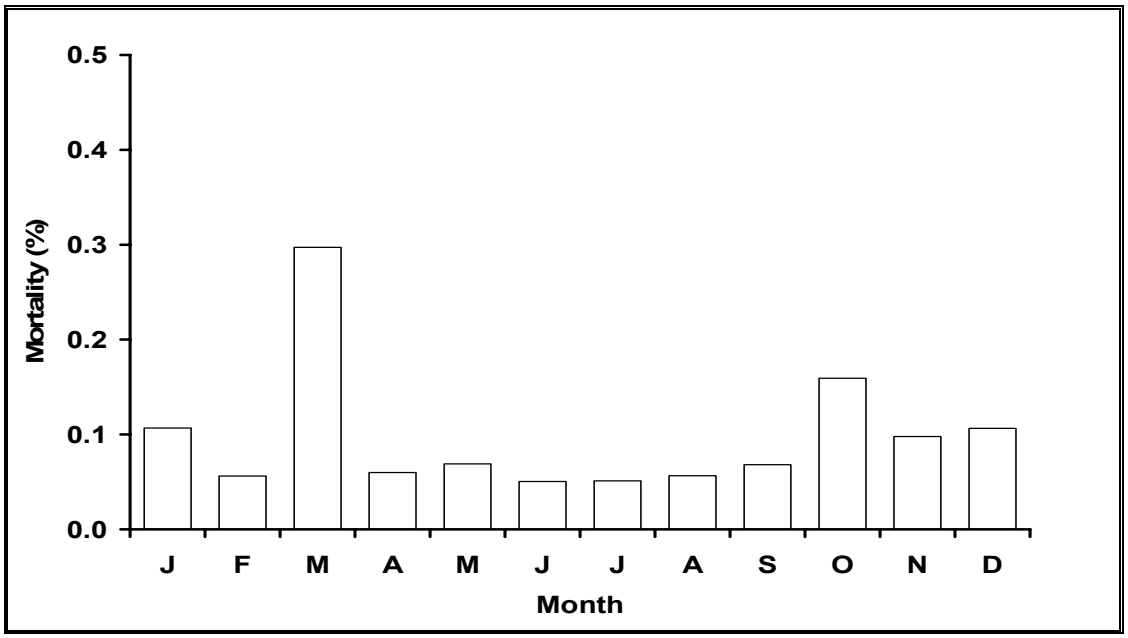

Figure 11 *Monthly mortality rate of cattle on voyages from all ports to South-East Asia for 2007*

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 17. Nearly all voyages were in the nil or low mortality categories; two voyages in the high category involved ships 109 and 115.

Table 17 Number of voyages in nil, low, medium and high mortality categories for shipments to South-East Asia for 2007

Ship (code)	Mortality rate				Total
	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	
37	0	13	0	0	13
41	0	5	0	0	5
88	15	6	0	0	21
90	12	6	0	0	18
95	0	1	0	0	1
100	0	5	0	0	5
103	4	5	0	0	9
109	8	6	1	1	16
112	8	9	0	0	17
113	5	22	0	0	27
114	5	12	0	0	17
115	1	5	2	1	9
117	20	6	0	0	26
119	5	0	0	0	5
120	8	5	0	0	13
121	1	2	0	0	3
Total	92	108	3	2	205

4.2.4.4 Class of cattle

Due to changes in the format of the Ship Master's Report, most cattle exported to South-East Asia in 2007 could not be identified by class. Of those reported, the highest mortality rates occurred in adult bulls (0.20%) followed by beef cows (0.15%; Table 18).

Table 18 Mortality rates, number of voyages and number of cattle in various classes exported to the South-East Asia in 2007

Class	Voyages (No.)	Cattle (No.)	Mortality rate (%)	Mortality rate range (%)
Steer adult*	36	106,822	0.06	0.0 – 0.2
Bull adult*	30	19,016	0.20	0.0 – 0.6
Bull calf	3	1,016	0.00	n/a
Cow beef	17	17,635	0.15	0.0 – 0.4
Heifer beef	33	37,577	0.05	0.0 – 0.7
Heifer dairy	1	2,027	0.10	n/a

* includes immature and mature animals (ie animals not classified as "calf")

4.2.5 North-East Asia

The number of cattle exported to North-East Asia has continued to decrease since 2004. Live cattle exports fell by 8% in 2007 compared to 2006 (Table 19) while mortalities fell by half to a new record low of 0.06%. Prior to this the mortality rate has remained relatively constant for six years at about 0.1%.

Table 19 Mortality rates, number of voyages and number of cattle exported to North-East Asia from 1995 to 2007

Year	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyages with nil mortalities (No.)
1995	7	7,311	0.29	0.1 - 0.5	0
1996	9	12,587	0.40	0.1 - 1.2	0
1997	11	15,960	0.29	0.0 - 2.6	4
1998	10	14,734	0.17	0.0 - 0.4	2
1999	8	10,772	0.22	0.0 - 0.4	1
2000	10	13,830	0.14	0.0 - 0.4	4
2001	14	18,190	0.11	0.0 - 0.9	5
2002	17	22,483	0.12	0.0 - 0.7	7
2003	36	66,861	0.12	0.0 - 1.1	10
2004	49	93,303	0.10	0.0 - 0.8	12
2005	36	52,565	0.09	0.0 – 0.4	14
2006	36	37,963	0.12	0.0 – 1.3	11
2007	21	34,837	0.06	0.0 – 0.2	10

4.2.5.1 Port of loading

Cattle were exported to North-East Asia mainly from Brisbane followed by Portland (Table 20). All cattle loaded at Brisbane were exported to Japan while those loaded at other ports were exported mainly to China. Two consignments went to Eastern Russia.

Table 20 Mortality rates, number of voyages and number of cattle exported from various ports to North-East Asia for 2007

Port	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)
Fremantle	1	553	0.00	n/a
Portland	5	11,682	0.10	0.0 - 0.2
Brisbane	15	22,602	0.04	0.0 - 0.1

4.2.5.2 Ship

The voyages of each ship from Australia to North-East Asia were classified into various mortality categories as shown in Table 21. All voyages were in the nil or low categories.

Table 21 Number of voyages in nil, low, medium and high mortality categories for shipments to North-East Asia for 2007

	Mortality rate				
Ship (code)	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	Total
59	0	1	0	0	1
87	5	4	0	0	9
112	0	1	0	0	1
114	1	0	0	0	1
119	3	2	0	0	5
120	0	1	0	0	1
121	1	2	0	0	3
Total	10	11	0	0	21

4.2.5.3 Class of cattle

Mortality rates for each class of cattle exported to North-East Asia during 2007 are presented in Table 22. The North-East Asian cattle trade comprised mainly steers exported to Japan and dairy heifers exported to China.

In 2007 the highest mortality rates occurred in beef and dairy heifers (0.09%).

Table 22 Mortality rate, number of voyages and number of cattle in the classes exported to North-East Asia in 2007

Class	Voyages (No.)	Cattle (No.)	Mortality rate (%)	Mortality rate range (%)
Steer adult	15	21,123	0.04	0.0 - 0.1
Bull adult	2	6	0.00	n/a
Heifer beef	4	5,274	0.09	0.0 - 0.1
Heifer dairy	4	8,434	0.09	0.0 - 0.2

4.2.6 China

Although considered part of North-East Asia for the purposes of this report, exports to China were previously reported separately because of the rapid growth in exports of dairy cattle to this country (Table 23). During 2007 the number of cattle exported fell by 14% while the mortality rate fell by almost half compared with 2006. If exports to China remain below 10,000, separate analysis will not be made in future reports.

Table 23 Mortality rates, number of voyages and number of cattle exported to China from 1995 to 2007

Year	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyages with nil mortalities (No.)
1995	0				
1996	0				
1997	1	1,290	2.56	n/a	n/a
1998	0				
1999	0				
2000	0				
2001	1	1,363	0.07	n/a	n/a
2002	6	8,407	0.25	0.0 - 0.7	0
2003	18	43,152	0.13	0.0 - 0.8	3
2004	36	75,460	0.09	0.0 - 0.5	7
2005	16	26,491	0.12	0.0 - 0.4	3
2006	6	9,840	0.16	0.0 - 0.3	2
2007	4	8,440	0.09	0.0 - 0.2	1

4.2.6.1 Port of loading

All of the cattle exported to China in 2007 were loaded at Portland

4.2.6.2 Class of cattle

Most of the cattle exported to China in 2007 were dairy heifers (Table 25).

Table 25 Mortality rate, number of voyages and number of cattle in the classes exported to China in 2007

Class	Voyages (No.)	Cattle (No.)	Mortality rate (%)	Mortality rate range (%)
Bull adult	2	6	0.00	n/a
Heifer dairy	4	8,434	0.09	0.0 - 0.2

4.2.6.3 Ship

The voyages of each ship carrying cattle from Australia to China were classified into various mortality categories as shown in Table 26. All voyages were in the nil to low categories.

Table 26 Number of voyages in nil, low, medium and high mortality categories for shipments to China for 2007

	Mortality rate				
Ship (code)	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	Total
59	0	1	0	0	1
114	1	0	0	0	1
120	0	1	0	0	1
121	1	1	0	0	1
Total	1	3	0	0	4

4.2.7 Mexico

The number of cattle exported to Mexico in 2007 was the highest level since 1995 (Table 27). The mortality rate was similar to 2006. Mortality rates have remained below 0.5% since 2001, with the exception of 2002. The majority of the cattle exported to Mexico in 2007 were dairy heifers.

Table 27 Mortality rates, number of voyages and number of cattle exported to Mexico from 1995 to 2007

Year	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)	Voyages with nil mortalities (No.)
1995	0	n/a	n/a	n/a	n/a
1996	2	4,359	0.66	0.6 – 1.0	0
1997	3	6,960	0.80	0.6 – 1.0	0
1998	2	21,163	0.83	0.4 – 1.1	0
1999	4	7,701	0.60	0.0 – 0.7	1
2000	5	9,556	1.38	0.0 – 4.8	1
2001	10	21,478	0.47	0.0 – 1.2	2
2002	6	17,434	0.74	0.0 – 3.0	1
2003	1	2,558	0.08	n/a	n/a
2004	3	5,633	0.37	0.0 – 0.7	1
2005	9	17,464	0.26	0.0 – 0.8	1
2006	7	11,292	0.21	0.0 – 0.4	2
2007	7	21,719	0.23	0.1 – 0.4	0

4.2.7.1 Port of loading

The majority of cattle exported to Mexico were loaded at Portland (Table 28).

Table 28 Mortality rate, number of voyages and number of cattle exported from various ports to Mexico in 2007

Port	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)
Portland	5	20,639	0.22	0.1 - 0.4
Fremantle	2	1,080	0.28	0.2 - 0.3

4.2.7.2 Ship

The voyages of each ship cattle from Australia to Mexico were classified into various mortality categories as shown in Table 29. All voyages were in the low mortality category.

Table 29 Voyage numbers in nil, low, medium and high mortality categories for shipments to Mexico in 2007

	Mortality rate				
Ship (code)	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	Total
37	0	1	0	0	1
103	0	1	0	0	1
121	0	5	0	0	5
Total	0	7	0	0	7

4.3 Goats

4.3.1 Performance trend

Figures 12 and 13 show the number of goats and the number of mortalities during sea transport from all ports in Australia to all destinations since 1993 as well as the trendline (linear regression) across the years. The number of goats exported annually has varied between approximately 7,000 and 120,000, and the annual mortality has varied between 0.5 and 2.7%. The trend for the number of goats exported has been upward whereas the trend for annual mortality has been downward, with a greater decline for annual mortality.

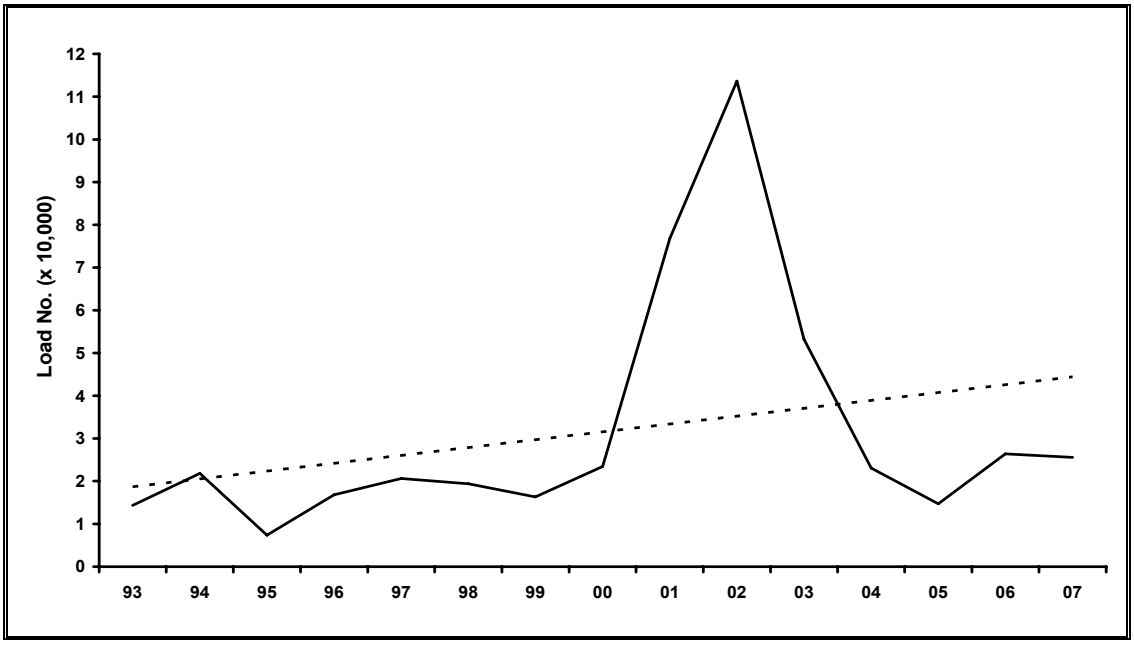

Figure 12 *Number of goats exported by sea from Australia to all destinations since 1993*

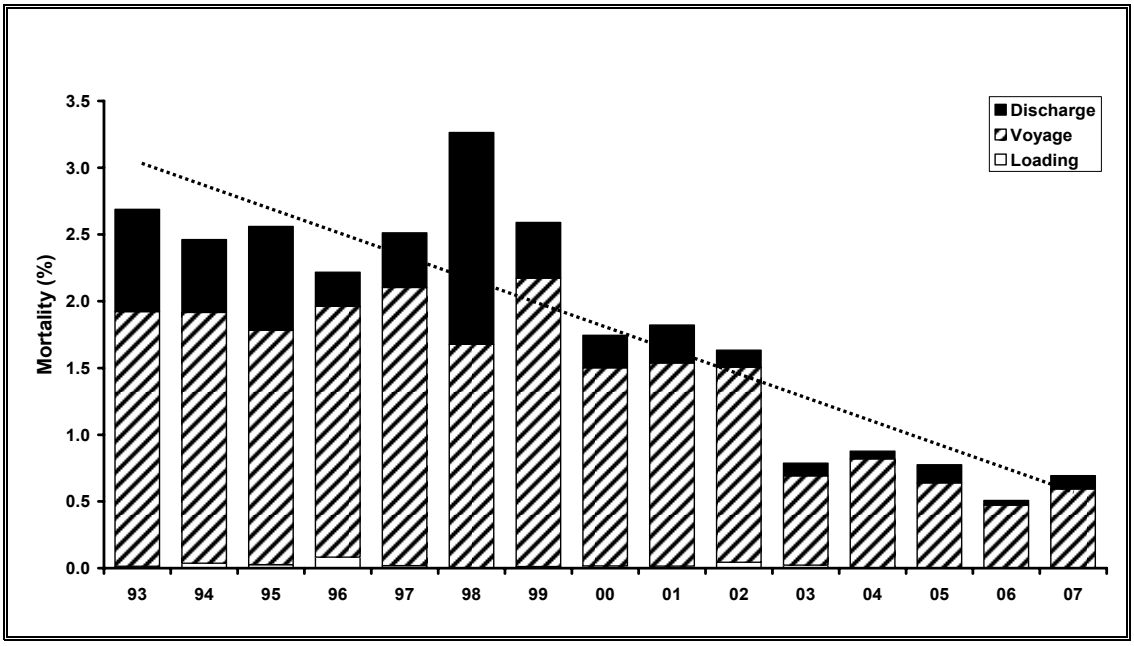

Figure 13 *Annual mortality of goats exported by sea from Australia to all destinations since 1993*

4.3.2 Overview

Most goats exported by sea from Australia in 2007 were sent to South-East Asia with smaller numbers exported to the Middle East and miscellaneous ports in the Indian Ocean. The overall mortality rate among the 25,546 goats was 0.69% (Table 30). This was above the mortality rate of 0.49% for 2006 (figure 13).

Table 30 Mortality rates, number of voyages and number of goats exported by sea during 2007

Parameter	ME/N Africa	SE Asia	Misc	Total
Voyages (No.)	2	21	2	25
Goats (No.)	1,914	21,204	2,428	25,546
Mortality rate overall (%)	0.57	0.35	3.79	0.69
Mortality rate range (%)	0.3 – 0.9	0.0 – 1.1	2.5 – 12.5	0.0 – 12.5

The number of goats exported annually to all destinations from Fremantle, Adelaide and Portland since 1993 is shown in Figure 14.

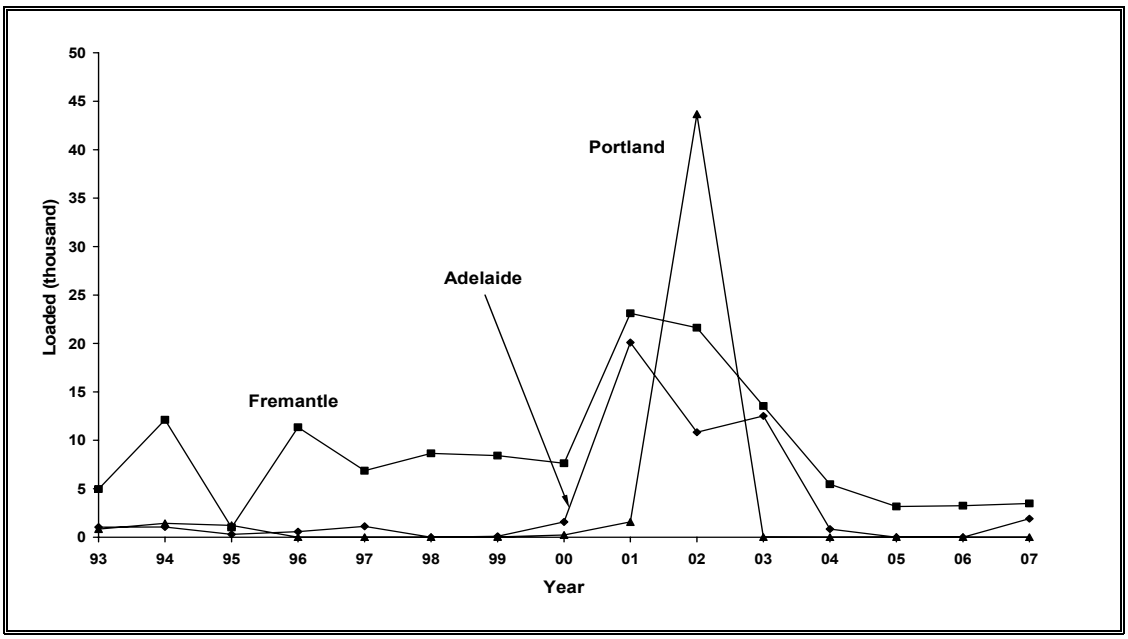

Figure 14 *Number of goats (x1000) exported by sea from Fremantle (Western Australia), Adelaide (South Australia) and Portland (Victoria) since 1993*

4.3.3 Middle East

The number of goats exported by sea to the Middle East has fallen dramatically since 2001 and 2002 (Table 31). Hence, no further description of this particular trade is given in this report.

Table 31 Mortality rates, number of voyages and number of goats exported by sea to the Middle East from 1993 to 2007

Year	Voyages (No.)	Goats (No.)	Mortality rate overall (%)	Mortality rate range (%)
1993	15	6,681	3.85	0.0 - 7.2
1994	16	13,948	2.78	0.0 - 8.8
1995	4	2,526	3.17	0.0 - 6.5
1996	9	9,760	2.17	0.0 - 4.1
1997	10	6,259	2.48	0.0 - 4.6
1998	13	8,650	1.68	0.0 - 5.0
1999	8	6,193	2.80	0.0 - 7.6
2000	12	6,310	2.08	0.0 - 8.0
2001	35	42,878	2.25	0.0 - 9.0
2002	23	69,419	2.03	0.0 - 3.4
2003	16	16,552	0.88	0.0 - 1.7
2004	4	1,021	0.10	0.0 - 0.3
2005	1	12	0.00	n/a
2006	0	0	n/a	n/a
2007	2	1,914	0.57	0.3 - 0.9

4.3.4 South-East Asia

The number of goats exported by sea to South-East Asia peaked during 2001 to 2003, but has fallen substantially since then (Table 32). The mortality rate in 2007 fell to 0.35% and represents a new record low.

Table 32 Mortality rates, number of voyages and number of goats exported by sea to South-East Asia from 1993 to 2007

Year	Voyages (No.)	Goats (No.)	Mortality rate overall (%)	Mortality rate range (%)
1993	17	7,497	1.63	0.0 - 4.7
1994	19	7,867	1.89	0.0 - 5.5
1995	11	4,818	2.24	0.0 - 7.8
1996	12	5,208	1.73	0.0 - 4.1
1997	26	14,363	2.53	0.0 - 7.0
1998	14	10,698	4.55	0.0 – 28.8*
1999	19	10,143	2.44	0.0 - 5.0
2000	28	14,728	1.65	0.0 - 8.7
2001	45	31,150	1.37	0.0 - 6.9
2002	49	42,032	1.05	0.0 - 9.9
2003	41	36,048	0.76	0.0 - 3.1
2004	29	20,801	0.93	0.0 - 2.6
2005	25	14,694	0.78	0.0 – 2.0
2006	25	25,353	0.49	0.0 – 3.0
2007	21	21,204	0.35	0.0 – 1.1

* One voyage delayed at discharge, resulting in excessive discharge mortality

4.3.4.1 Port of loading

For voyages to South-East Asia in 2007, most goats were exported from Darwin, followed by Geraldton and Fremantle (Table 33). Mortality rates were highest from Geraldton and Townsville.

The voyages from each port were classified into various mortality categories as shown in Table 34. Nearly all voyages were in the low category. There were no voyages in the high category during 2007.

Table 33 Mortality rates, number of voyages and number of goats exported from various ports to South-East Asia for 2007

Port	Voyages (No.)	Goats (No.)	Mortality rate overall (%)	Mortality rate range (%)
Darwin	11	13,500	0.24	0.0 – 0.7
Broome	2	1,253	0.48	0.1 – 1.1
Townsville	1	645	0.62	n/a
Geraldton	3	2,624	0.65	0.5 – 0.7
Fremantle	4	3,182	0.47	0.0 – 0.7

Table 34 Number of voyages in low, medium and high mortality categories for shipments of goats from various ports to South-East Asia for 2007

Port	Mortality rate			Total
	Low <1.0%	Medium 1.0–2.0%	High >2.0%	
Darwin	11	0	0	11
Broome	1	1	0	2
Townsville	1	0	0	1
Geraldton	3	0	0	3
Fremantle	4	0	0	4
Total	20	1	0	21

4.3.4.2 Time of year

Monthly mortality rates (total mortality as a proportion of total loaded for each month) in goats exported to the South-East Asia during 2007 are shown in Figure 16. All 2007 monthly mortalities were below the 5-year mortality rate. There were no goats exported during March 2007.

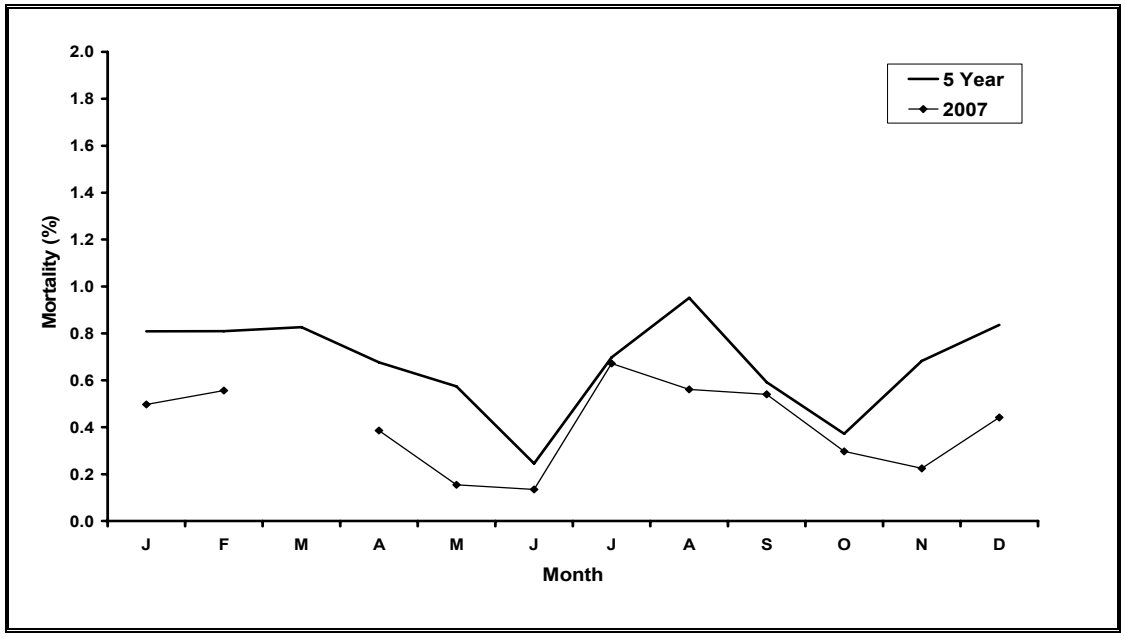

Figure 16 *Monthly mortality during 2007 and 5-year monthly average for the period 2003-2007 for goats exported to South-East Asia*

4.3.4.3 Ship

The voyages of each ship from Australia to South-East Asia were classified into the low, medium and high mortality categories. Note that for this comparison, "voyage" equates to consignment from a port. Consequently, if a ship loaded at two ports, then two "voyages" are shown for that ship, one for each port.

Table 35 shows the number of voyages in the various mortality categories for each ship. Nearly all voyages were in the low category. There were no voyages in the high category during 2007.

Table 35 Number of voyages in low, medium and high mortality categories for shipments of goats to South-East Asia for 2007

Ship (code)	Mortality rate			Total
	Low <1.0%	Medium 1.0–2.0%	High >2.0%	
37	3	0	0	3
41	1	0	0	1
88	5	0	0	5
90	2	0	0	2
100	1	1	0	1
113	2	0	0	2
114	4	1	0	5
119	2	0	0	2
Total	20	1	0	21

5 Appendices

5.1 Appendix 1 - Sheep and cattle mortalities: research summary

To assist with interpretation of the results for sheep, the main findings from research conducted into the causes of mortality and the risk factors for sheep exported from Western Australia to the Middle East are summarised here. It should be noted that these findings are based on information published in the refereed scientific journal articles listed in Appendix 2.

The research involved analysis of industry mortality records, land-based studies and investigations on ships travelling from Western Australia to the Middle East. The aims were to define the level of sheep mortality during the export process, and to identify the causes of mortality and the risk factors.

A typical research voyage involved selecting and identifying about 10,000 sheep on arrival at a pre-embarkation feedlot, tracing them back to the farm and interviewing the farmer/manager to gather information about the previous management of the sheep, undertaking observations and treatments in the pre-embarkation feedlot, loading onto the ship, and conducting post mortem examinations and other observations during the voyage. Many research voyages and more than 1,000 detailed post mortem examinations were undertaken.

The main causes of sheep mortalities during sea transport were inanition and salmonellosis (Richards *et al* 1989). These two causes accounted for about 75% of all mortalities aboard ship. The most important risk factors for sheep mortalities were failure to eat the pelleted feed, farm-group of sheep, age, time of the year, fatness, duration between leaving the farm and unloading in the Middle East, and occasionally, excessive temperature and relative humidity (Norris *et al* 1989b, Norris *et al* 1989a, Higgs *et al* 1991, Norris and Richards 1989, Higgs *et al* 1999).

Mortality rates during the shipping phase varied widely between farm groups of sheep, with high mortality rates concentrated in only a few farm groups (Norris *et al* 1989a, Higgs *et al* 1999). A study of 479 farm groups of sheep from 405 farms in Western Australia showed that mortality rates ranged from nil to 28% with half of all mortalities in only 14% of the farm groups. There were higher mortalities in sheep from the zones of higher rainfall and longer pasture-growing season (Higgs *et al* 1999).

Bars wrapped in dye-soaked sponge were attached to feed troughs to identify sheep which ate the pelleted feed (Norris *et al* 1989a). Although most sheep began eating the pelleted feed in the pre-embarkation feedlot or aboard ship, a few became persistent non-feeders, and it is these animals that were most likely to die. Giving them abundant quantities of feed or increased access to the feed troughs did not reduce the number of persistent non-feeders (Norris *et al* 1990).

Age, fatness and time of year predisposed to mortality (Higgs *et al* 1991). Mortality rates during sea transport were higher in adult wethers (castrated male) than in younger wethers, and were higher in adult wethers in fat condition than in lean condition, and there were more mortalities during the second half of the calendar year than in the first half.

The explanation (Richards *et al* 1991, Higgs *et al* 1991) is that sheep coming from dry pasture in the first half of the year are in negative energy balance and are metabolically adjusted to using body fat reserves for energy – southern Western Australia experiences a Mediterranean climate and pastures decline in quality and quantity during the first half of the calendar year, and supplementary feeding usually with cereal grains or lupins is required for animals to maintain bodyweight. Any sheep which is not eating during the export process therefore has a better chance of survival because it is able to mobilise body fat reserves to produce energy.

In contrast, sheep coming from green pasture in the second half of the year are metabolically adjusted to laying down body fat and those which do not eat during the export process are not able to use body fat reserves for energy and are therefore at increased risk of mortality.

Immature sheep have a strong growth requirement and their powerful appetite drive overrides the seasonal cycles that are prominent in adult sheep. Consequently, there were fewer non-feeders and mortalities among immature sheep.

Factors for which no association (or no consistent association) with mortality was shown include (Norris *et al* 1989b): distance trucked from farm to pre-embarkation feedlot, time on the truck, time off feed from yarding on farm to unloading at the feedlot, purchase history on the farm, social interaction on the farm, experience

of supplementary feeding and type of feed as unweaned lambs, experience of supplementary feeding and type of feed in the last 9 months before export and time of shearing on the farm.

An important finding was that most sheep began eating the pelleted feed within the first few days after loading onto the ship, even if they had not eaten this feed in the pre-embarkation feedlot. This was a consistent finding in research studies during actual commercial voyages and during simulated voyages (Norris *et al* 1990, Norris *et al* 1992). In one such study, 85% to 93% of non feeders in the pre-embarkation feedlot ate pelleted feed within the first three days of simulated shipping (Norris *et al* 1990).

In contrast to exports of sheep, live cattle are exported from many ports around Australia to destinations in South-East Asia, North Asia and the Middle East. Investigations on voyages to the Middle East showed that the main causes of cattle mortalities were heat stroke, trauma and respiratory disease (Norris *et al* 2003). All of the mortalities from heat stroke were in *Bos taurus* breeds and occurred in the latter half of the voyage.

The research also showed that the risk of mortality on voyages to the Middle East was three times greater among cattle exported from southern ports in Australia compared to northern ports. The likely reason is the higher content of tropically-adapted *Bos indicus* cattle in northern Australia and their ability to handle the heat and humidity encountered during the voyage, in contrast to the *Bos taurus* breeds from southern Australia.

5.2 Appendix 2 - Published studies

A list of scientific and extension publications, relevant to the live sheep trade, is shown below.

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

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

5.3 Appendix 3 - Acknowledgements

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

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

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