

# live export

## National livestock exports mortality summary 2006

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### Executive summary

The objectives of the project were to summarise the mortality levels of sheep, cattle and goats exported by sea from Australia during 2006. A second objective was to distribute a summary report to industry stakeholders, government, animal welfare groups and other parties interested in monitoring mortalities the livestock export trade.

The overall mortality rate for sheep during sea transport to all destinations during 2006 was 0.90% out of approximately 4 million sheep exported. This was less than the 0.95% mortality rate observed in 2005 ( $P < 0.05$ ). The main port of loading was Fremantle (3.3 million sheep exported with mortality rate of 0.86%), followed by Portland (0.5 million sheep exported with mortality rate of 0.91%) and Adelaide (290,000 sheep exported with mortality rate of 0.98%). Mortality rates of sheep exported from Portland remained low during winter months, repeating the pattern seen in recent years.

The overall mortality rate among the 0.62 million cattle exported from Australia in 2006 was 0.18%, a rise from the 0.14% observed in 2005 ( $P < 0.05$ ). The highest overall mortality rate on a regional basis was to the Middle East/North Africa (0.52%) followed by Mexico (0.21%). The overall mortality rate on voyages to the Middle East/North Africa rose in 2006 largely because of increased mortalities on one voyage. The overall mortality rate on voyages to South-East Asia (0.09%) was similar to 2005.

The overall mortality rate was 0.49% among the 25,353 goats exported from Australia in 2006, a decline from the 0.77% observed in 2005 ( $P < 0.05$ ). There were no goats exported by sea to the Middle East in 2006, all shipments being made to South-East Asia.

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

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](http://www.daff.gov.au/animal-plant-health/welfare/export-trade/mortalities)

## Contents

<b>1</b>	<b>Background .....</b>	<b>5</b>
<b>2</b>	<b>Project objectives .....</b>	<b>5</b>
<b>3</b>	<b>Methodology .....</b>	<b>5</b>
<b>4</b>	<b>Results and discussion .....</b>	<b>6</b>
<b>4.1</b>	<b>Sheep.....</b>	<b>6</b>
4.1.1	Overview.....	6
4.1.2	Port of loading .....	6
4.1.3	Destination.....	7
4.1.4	Mortality rates .....	8
4.1.5	Class of sheep.....	10
4.1.6	Time of year.....	11
4.1.7	Ship .....	14
<b>4.2</b>	<b>Cattle .....</b>	<b>15</b>
4.2.1	Overview.....	15
4.2.2	Middle East.....	16
4.2.2.1	<i>Port of loading</i>	16
4.2.2.2	<i>Time of year</i>	17
4.2.2.3	<i>Voyages from southern ports 1999 to 2006</i>	18
4.2.2.4	<i>Ship</i>	18
4.2.2.5	<i>Class of cattle</i>	19
4.2.3	South-East Asia.....	20
4.2.3.1	<i>Port of loading</i>	20
4.2.3.2	<i>Time of year</i>	21
4.2.3.3	<i>Ship</i>	22
4.2.3.4	<i>Class of cattle</i>	22
4.2.4	North-East Asia .....	23
4.2.4.1	<i>Port of loading</i>	23
4.2.4.2	<i>Ship</i>	24
4.2.4.3	<i>Class of cattle</i>	24
4.2.5	China .....	25
4.2.5.1	<i>Port of loading</i>	25
4.2.5.2	<i>Class of cattle</i>	25
4.2.6	Mexico .....	27
4.2.6.1	<i>Port of loading</i>	27
4.2.6.2	<i>Ship</i>	27

<b>4.3</b>	<b>Goats .....</b>	<b>29</b>
4.3.1	Overview.....	29
4.3.2	Middle East.....	30
4.3.3	South-East Asia.....	31
	4.3.3.1 <i>Port of loading</i>	31
	4.3.3.2 <i>Time of year</i>	32
	4.3.3.3 <i>Ship</i>	32
<b>5</b>	<b>Conclusions and recommendations .....</b>	<b>34</b>
<b>6</b>	<b>Bibliography .....</b>	<b>34</b>
<b>7</b>	<b>Appendices.....</b>	<b>34</b>
7.1	Appendix 1 - Sheep and cattle mortalities: research summary	34
7.2	Appendix 2 - Published studies .....	35
7.3	Appendix 3 - Acknowledgements .....	36

### 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 also present mortality data, though in a different format, at the DAFF "website"; [www.daff.gov.au/animal-plant-health/welfare/export-trade/mortalities](http://www.daff.gov.au/animal-plant-health/welfare/export-trade/mortalities)

### 2 Project objectives

Produce a report which summarises the mortality levels of sheep, cattle and goats for the 2006 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 2006 report is based on analysis of ship Masters' reports and "Yellow Books" which were to hand on 20 March 2007. 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 mortality information 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 Overview

Most sheep exported live by sea from Australia 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.

#### 4.1.2 Port of loading

The numbers and classes of sheep exported by sea to the Middle East from Fremantle, Adelaide and Portland during 2006 are shown in Table 1. Overall numbers exported in 2006 were similar to 2005.

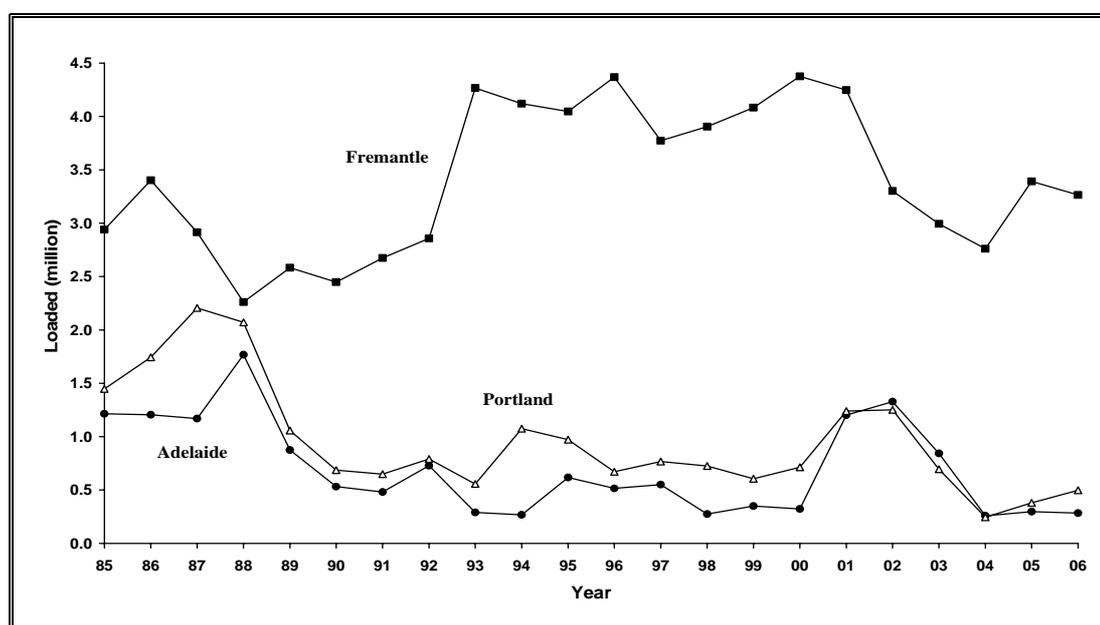
**Table 1** The numbers and classes of sheep exported by sea to the Middle East from Fremantle, Adelaide and Portland during 2006

Livestock		Fremantle	Adelaide	Portland	Total
Wethers	adults	1,753,355	242,922	429,196	2,425,473
	hoggets	255,113	29,650	55,767	340,530
	lambs	445,306	5,726	3,135	454,167
Rams	adults	88,619	5,119	6,813	100,551
	hoggets	57,867	0	1,766	59,633
	lambs	454,279	680	205	455,164
Ewes	adults	47,858	0	0	47,858
	hoggets	0	0	0	0
	lambs	162,024	0	0	162,024
<b>Total</b>	<b>sheep</b>	<b>3,264,421</b>	<b>284,097</b>	<b>496,882</b>	<b>4,045,400*</b>

\* excludes 13,677 sheep exported to South-East Asia from ports in Western Australia and 20,875 sheep exported to Mexico from Fremantle and Portland. Also excludes 71,309 sheep exported to the Middle East from Devonport.

## National livestock exports mortality summary 2006

Most sheep exported by sea from Australia to the Middle East during 2006 were loaded at Fremantle (79.3% of all sheep, Figure 1) with smaller numbers loaded at Portland (12.1%), Adelaide (6.9%) and Devonport (1.7%).



**Figure 1** Numbers of sheep exported by sea to the Middle East from Fremantle (Western Australia), Portland (Victoria) and Adelaide (South Australia) since 1985

### 4.1.3 Destination

The main importing countries for Australian sheep in 2006 are shown in Table 2. Saudi Arabia was the main market (29% of all sheep) followed by Kuwait (23%), Jordan (16%) and Bahrain (13%).

**Table 2** Destination country for sheep exported from Australia during 2006

Country	Fremantle	Adelaide	Portland	Other	Total
Bahrain	280,087	83,000	168,756	25,000	556,843
Israel	10,751		9,089		19,840
Jordan	617,943	35,000	31,997		684,940
Kuwait	701,868	110,843	116,714	32,738	962,163
Mexico	1,107		949		2,056
Oman	229,698		90,332		320,030
Qatar	76,098	42,000	60,000	13,571	191,669
Saudi Arabia	1,193,635				1,193,635
UAE	170,392	18,902	19,994	85	209,373
S.E. Asia	13,656			12,391	26,047
N.E. Asia				245	245
Other				193	193
<b>Total</b>	<b>3,295,235</b>	<b>289,745</b>	<b>497,831</b>	<b>84,223</b>	<b>4,167,034</b>

SOURCE – Australian Bureau of Statistics, 10 April 2006

Note: - ABS figures also include exports by air

## National livestock exports mortality summary 2006

### 4.1.4 Mortality rates

There were 11 voyages to the Middle East for which sheep were loaded at more than one port in Australia (split-load voyages) in 2006. 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 2006 was 0.90% (Table 3), a fall from the 0.95% observed in 2005 ( $P < 0.05$ ).

There were 13 shipments to South-East Asia, and the mortality rate was 0.31% out of 14,458 sheep loaded.

There were 2 shipments to Mexico and the mortality rate was 0.4% out of 20,875.

For shipments to the Middle East, the main changes compared to 2005 were 1) total mortality rate from Fremantle fell mainly due to reduced voyage mortality rate, and 2) total mortality rate from Portland rose due to rises in voyage and discharge mortality rates (Table 3 and Figure 2).

**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

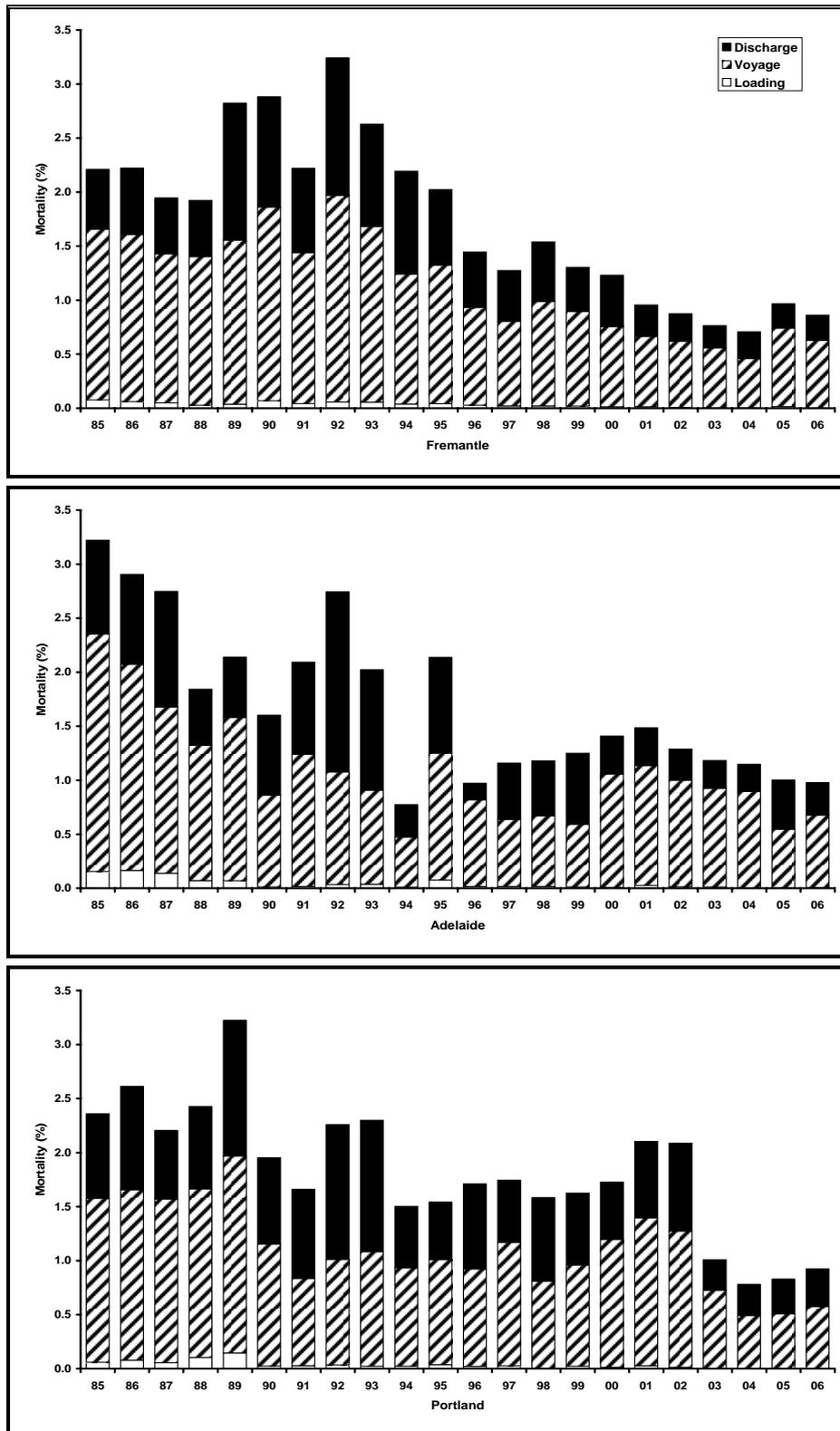
	Year	Mortality rate (%)			Total
		Load	Voyage	Discharge	
<b>Fremantle*</b>	2002	0.01	0.61	0.26	0.87
	2003	0.01	0.56	0.20†	0.76†
	2004	0.00	0.46	0.25	0.71
	2005	0.02	0.73	0.22	0.97
	2006	0.00	0.63	0.23	0.86
<b>Adelaide*</b>	2002	0.01	0.99	0.29	1.29
	2003	0.01	0.91	0.26	1.18
	2004	0.00	0.89	0.25	1.15
	2005	0.00	0.54	0.46	1.00
	2006	0.01	0.67	0.30	0.98
<b>Portland*</b>	2002	0.01	1.27	0.82	2.10
	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
<b>Total**</b>	2002	0.01	0.84	0.39	1.24
	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

\* Middle East only

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

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

## National livestock exports mortality summary 2006



**Figure 2** Annual mortality for sheep exported from Fremantle, Adelaide and Portland to the Middle East since 1985 – figure for Fremantle excludes mortalities on the MV Corno Express after it was rejected at Saudi Arabia in 2003

## National livestock exports mortality summary 2006

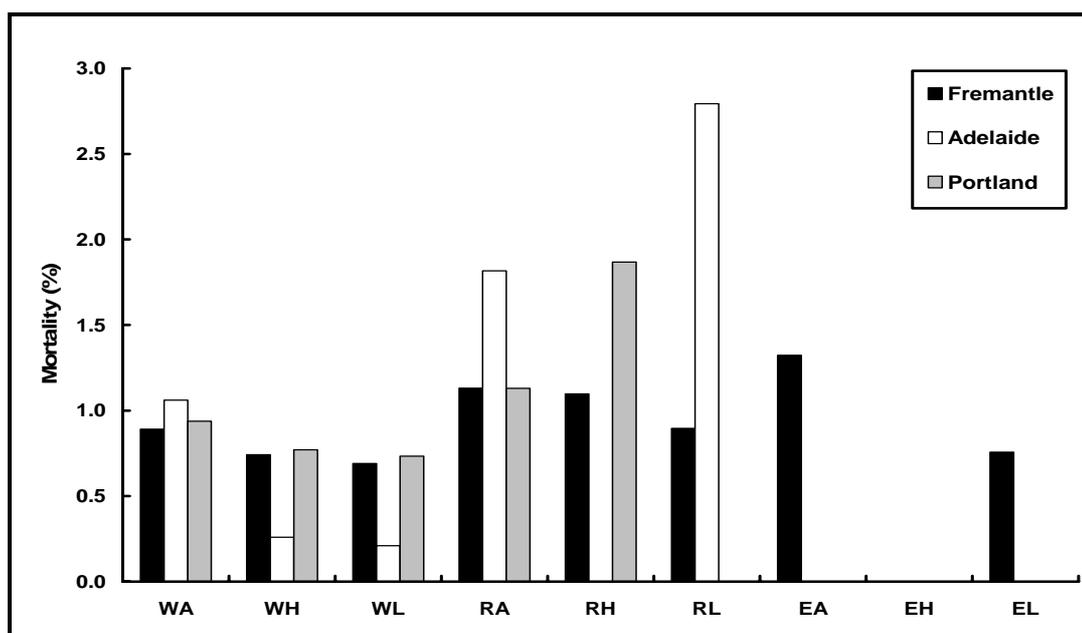
### 4.1.5 Class of sheep

The mortality rates of various classes of sheep exported from Australia to the Middle East are shown in Table 4 and Figure 3. The highest mortality rates were in adult ewes and rams, followed by ram hoggets.

**Table 4** Overall mortality (%) for classes of sheep exported from Fremantle, Adelaide and Portland to the Middle East in 2006

Class of sheep		Fremantle	Adelaide	Portland	Total
Wethers	adult	0.9	1.1	0.9	0.9
	hogget	0.7	0.3	0.8	0.7
	lamb	0.7	0.2	0.7	0.7
Rams	adult	1.1	1.8	1.1	1.2
	hogget	1.1	n/a	1.9	1.1
	lamb	0.9	2.8	0.0	0.9
Ewes	adult	1.3	n/a	n/a	1.3
	hogget	n/a	n/a	n/a	n/a
	lamb	0.8	n/a	n/a	0.8

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



**Figure 3** Overall mortality (%) for classes of sheep exported from Fremantle, Adelaide and Portland to the Middle East in 2006

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

## National livestock exports mortality summary 2006

### 4.1.6 Time of year

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

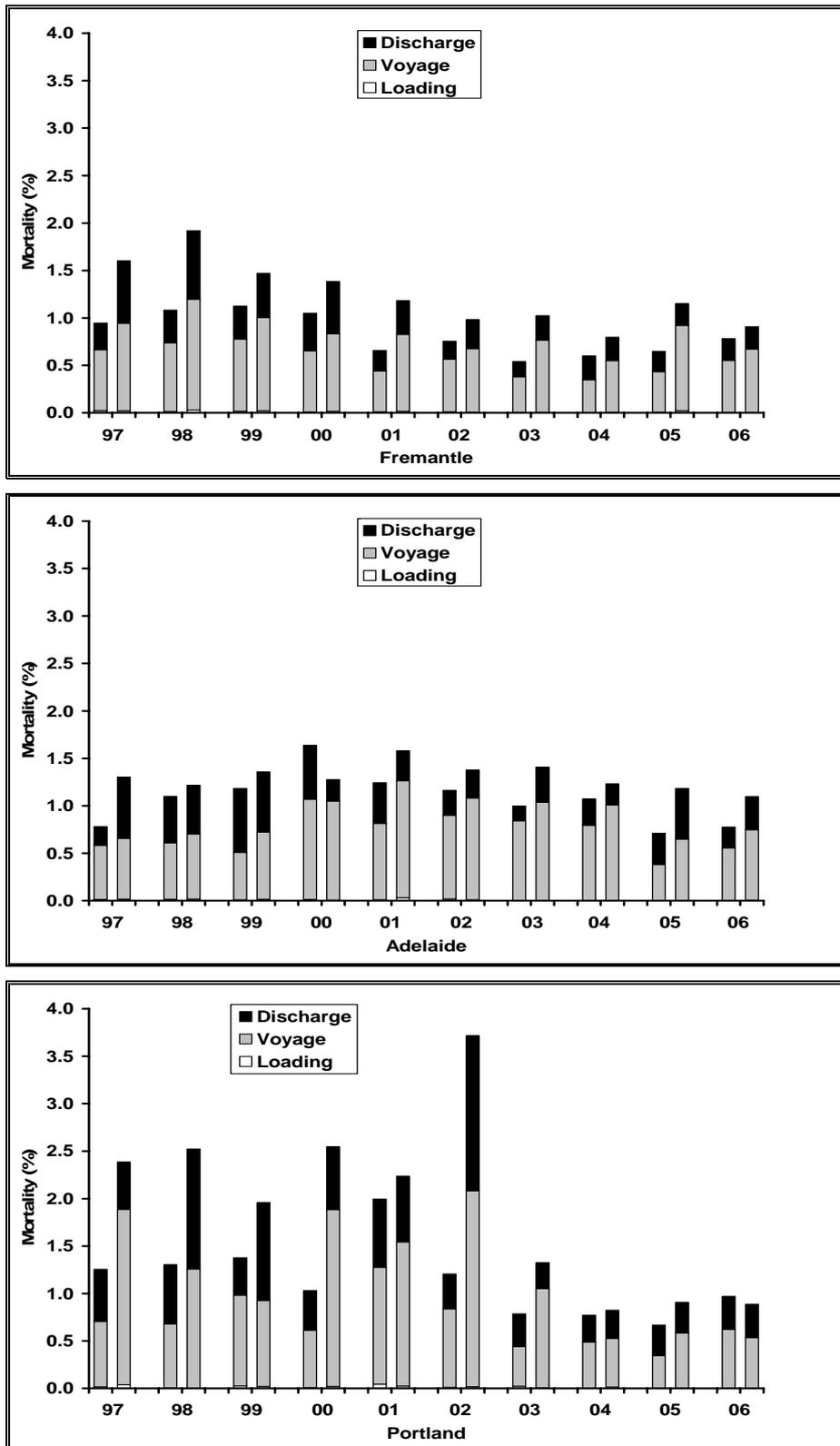
Mortality rates were higher ( $P < 0.05$ ) in the second half of 2006 compared with the first half in sheep exported from Fremantle and Adelaide; but for Portland, mortality rates were lower ( $P < 0.05$ ) in the second half of the year (Figure 4).

**Table 5** Monthly mortality for all sheep exported from Fremantle, Adelaide and Portland to the Middle East from 2000 to 2006

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

\* May to October

## National livestock exports mortality summary 2006

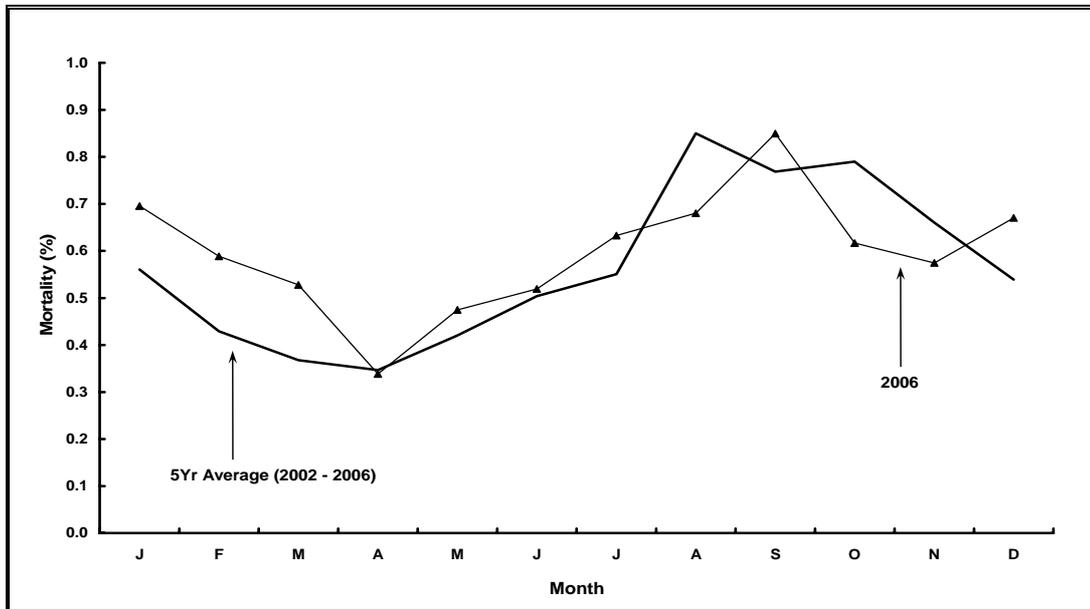


**Figure 4** Mortality (%) for sheep exported by sea from Fremantle, Adelaide and Portland to the Middle East for the first and second half of each year from 1997 to 2006

## National livestock exports mortality summary 2006

Monthly mortality rates for voyages from Fremantle are shown in Figure 5 - 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 in sheep exported from Fremantle during 2006 closely reflected the 5-year monthly "average" (proportion of all mortalities divided by number loaded; Figure 5).



**Figure 5** Monthly mortality rates for shipments from Fremantle to the Middle East in 2006 and the 5-year monthly average for the period 2001 to 2006

## National livestock exports mortality summary 2006

### 4.1.7 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 no voyages classified as "high mortality" during 2006. Approximately 72% of voyages from Fremantle, 60% of voyages from Adelaide and 54% 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 2006

Ship (code)	Mortality rate			Total
	Low <1.0%	Medium 1.0–2.0%	High >2.0%	
2	4	2	0	6
32	3	1	0	4
33	5	3	0	8
34	7	1	0	8
35	2	3	0	5
37	4	0	0	4
38	7	2	0	9
40	2	1	0	3
Total	34	13	0	47

**Table 6b** Number of voyages in low, medium and high mortality categories for ships loaded at Adelaide in 2006

Ship (code)	Mortality rate			Total
	Low <1.0%	Medium 1.0–2.0%	High >2.0%	
32	2	1	0	3
33	1	0	0	1
34	0	1	0	1
Total	3	2	0	5

**Table 6c** Number of voyages in low, medium and high mortality categories for ships loaded at Portland in 2006

Ship (code)	Mortality rate			Total
	Low <1.0%	Medium 1.0–2.0%	High >2.0%	
2	2	1	0	3
32	0	2	0	2
34	3	1	0	4
35	0	1	0	1
37	1	0	0	1
Total	6	5	0	11

## 4.2 Cattle

### 4.2.1 Overview

The live cattle trade from Australia was characterised by the large number of ports of loading in Australia, the number of ships involved 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 21 voyages in 2006 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 0.62 million cattle exported from Australia in 2006 was 0.18% (Table 7), a rise from the 0.14% observed in 2005 ( $P < 0.05$ ). The highest overall mortality rate on a regional basis was to the Middle East/North Africa followed by Mexico.

In the past, exports to South-East Asia were characterised by small consignments on short voyages. Recently, larger ships have been introduced which have involved loading and discharging at more than one port.

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

The number of cattle exported to North-East Asia and Mexico was lower in 2006 than in 2005 but was higher for other regions.

**Table 7** Mortality rates, number of voyages and number of cattle exported for voyages to major destination regions during 2006

Parameter	ME/N Africa	SE Asia	NE Asia	Mexico	Misc	Total
Voyages (No.)	43	163	26	7	1	240
Cattle (No.)	119,297	446,711	37,963	11,292	3,382	618,645
Mortality rate overall (%)	0.52	0.09	0.12	0.21	0.09	0.18
Mortality rate range (%)	0.0 – 4.3	0.0 – 1.0	0.0 – 1.3	0.0 – 0.4	n/a	0.0 – 4.3
Voyages with nil mortalities (No.)	13	65	11	2	0	91

## National livestock exports mortality summary 2006

### 4.2.2 Middle East

The live cattle trade to the Middle East has remained low over the last four years (Table 8). Overall death rates have remained below 0.5% since 1999 except for 2002 and 2006. In 2006 mortalities rose by half compared to 2005 due to one high mortality voyage.

**Table 8** Mortality rates, number of voyages and number of cattle exported to the Middle East from 1995 to 2006

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

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

#### 4.2.2.1 Port of loading

There were 4 ports of loading for voyages to the Middle East in 2006, and most cattle were exported from Fremantle, followed by Port Hedland and Portland (Table 9). Mortality rates in 2006 were highest from Portland, followed by Fremantle and Port Hedland. The Portland rate would have been 0.20% if one exceptionally high mortality voyage was excluded.

The voyages from each port were classified into various mortality categories as shown in Table 10. There were ten voyages in the medium and high categories, 7 of which were loaded in Fremantle. Two consignments from Fremantle and Portland were in the high category.

**Table 9** Mortality rates, number of voyages and number of cattle exported from various ports to the Middle East for 2006

Port	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)
Fremantle	33	99,577	0.39	0.0 – 1.6
Adelaide	1	310	0.00	n/a
Portland	6	9,132	2.28	0.0 – 4.3
Port Hedland	3	10,278	0.18	0.1 – 0.3

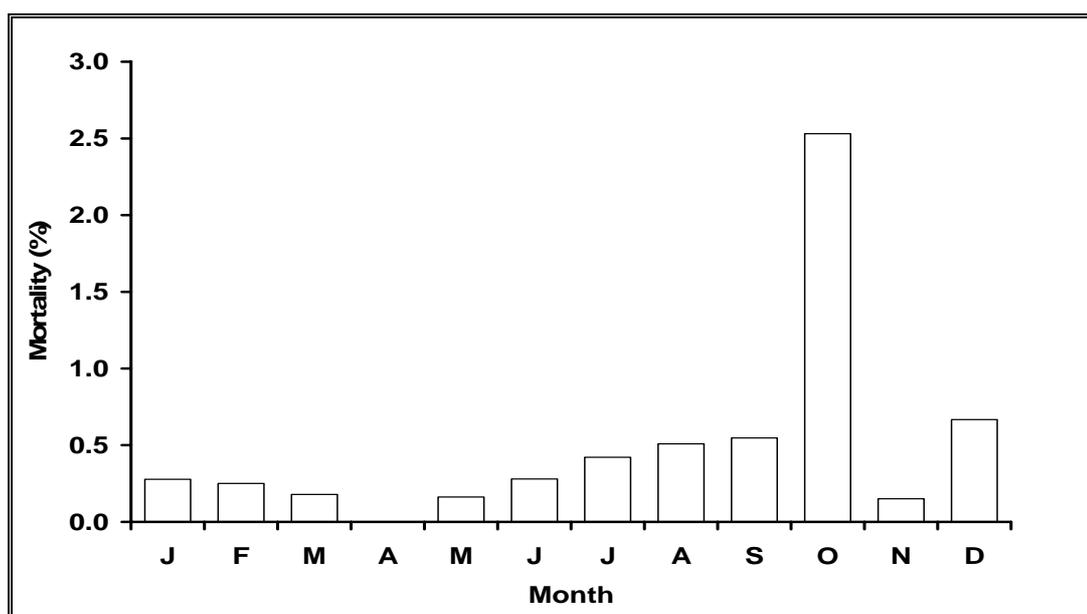
## National livestock exports mortality summary 2006

**Table 10** Number of voyages in nil, low, medium and high mortality categories for shipments from various ports to the Middle East for 2006

Port	Mortality rate				Total
	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	
Fremantle	10	16	5	2	33
Adelaide	1	0	0	0	1
Portland	2	1	1	2	6
Port Hedland	0	3	0	0	3
<b>Total</b>	<b>13</b>	<b>20</b>	<b>6</b>	<b>4</b>	<b>43</b>

### 4.2.2.2 Time of year

Monthly mortality rates from southern ports were below 0.5% throughout the year except for September, October and December (Figure 6). The result for October was due to a high mortality voyage and would have been nil otherwise. There were no voyages to the Middle East from northern ports in 2006.



**Figure 6** Monthly mortality rate of cattle on voyages from southern ports to the Middle East for 2006

## National livestock exports mortality summary 2006

### 4.2.2.3 Voyages from southern ports 1999 to 2006

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.

Cattle exports from Fremantle rose by 50%, while the mortality rate remained the same. Exports from Adelaide continued to fall.

Though the mortality rate of cattle exported from Portland rose markedly in 2006, if one exceptionally high mortality voyage was excluded the rise would have only been up to 0.20% (Table 11).

**Table 11** Mortality rates for cattle loaded at Fremantle, Adelaide or Portland from 1999 to 2006

Year	Fremantle			Adelaide			Portland		
	Voys (No.)	Cattle (No.)	Dead (%)	Voys (No.)	Cattle (No.)	Dead (%)	Voys (No.)	Cattle (No.)	Dead (%)
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†

\* 0.74% if one high mortality voyage is excluded

† 0.20% if one high mortality voyage is excluded

### 4.2.2.4 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 were 10 voyages in the medium or high categories, of which 4 were performed by ship 35 and 2 by ship 32.

**Table 12** Number of voyages in nil, low, medium and high mortality categories for shipments to the Middle East for 2006

Ship (code)	Mortality rate				Total
	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	
32	3	0	1	1	5
33	0	6	1	0	7
34	7	0	1	0	8
35	0	1	2	2	5
37	1	2	0	0	3
38	2	5	1	0	8
59	0	6	0	1	7

## National livestock exports mortality summary 2006

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Total	13	20	6	4	43
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### 4.2.2.5 Class of cattle

In 2006 the highest mortality rates occurred in adult bulls (0.56%) followed by dairy cows (0.50%) and beef heifers (0.35%) (Table 13). With the exclusion of one exceptionally high mortality voyage, the adult bull mortality rate would have been 0.34%.

**Table 13** Mortality rates, number of voyages and number of cattle in various classes exported to the Middle East in 2006

Class	Voyages (No.)	Cattle (No.)	Mortality rate (%)	Mortality rate range (%)
Steer adult*	13	8,569	0.32	0.0 - 1.7
Bull adult*	36	102,251	0.56	0.0 - 4.3
Bull calf	2	2,735	0.07	0.0 - 0.1
Cow beef	1	2,776	0.04	n/a
Cow dairy	6	1,392	0.50	0.0 - 0.7
Heifer beef	2	285	0.35	0.0 - 0.6
Heifer dairy	6	1,289	0.23	0.0 - 0.8

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

## National livestock exports mortality summary 2006

### 4.2.3 South-East Asia

Approximately 0.45 million cattle were exported to South-East Asia in 2006 (Table 14) and the mortality rate remained the same as 2005. No mortalities were reported on 40% of the voyages to the region. The mortality rate has remained below 0.1% since 2000.

**Table 14** Mortality rates, number of voyages and number of cattle exported to South-East Asia from 1995 to 2006

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

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

#### 4.2.3.1 Port of loading

Most cattle exported to South-East Asia in 2006 were loaded at Darwin followed by Broome and Wyndham (Table 15). The mortality rate was highest for cattle exported from Fremantle followed by Port Hedland.

The voyages from each port were classified into various mortality categories as shown in Table 16. All except three voyages were in the nil or low categories, while there was one voyage in the high category involving the port of Fremantle.

**Table 15** Mortality rates, number of voyages and number of cattle exported from various ports to South-East Asia in 2006

Port	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)
Townsville	2	12,781	0.10	0.1 – 0.2
Karumba	3	3,943	0.00	n/a
Darwin	85	226,157	0.07	0.0 – 0.5
Wyndham	19	51,982	0.06	0.0 – 0.2
Broome	30	82,897	0.12	0.0 – 0.6
Port Hedland	3	6,823	0.13	0.0 – 0.2
Geraldton	12	22,719	0.06	0.0 – 0.2
Fremantle	9	39,409	0.23	0.0 – 1.0

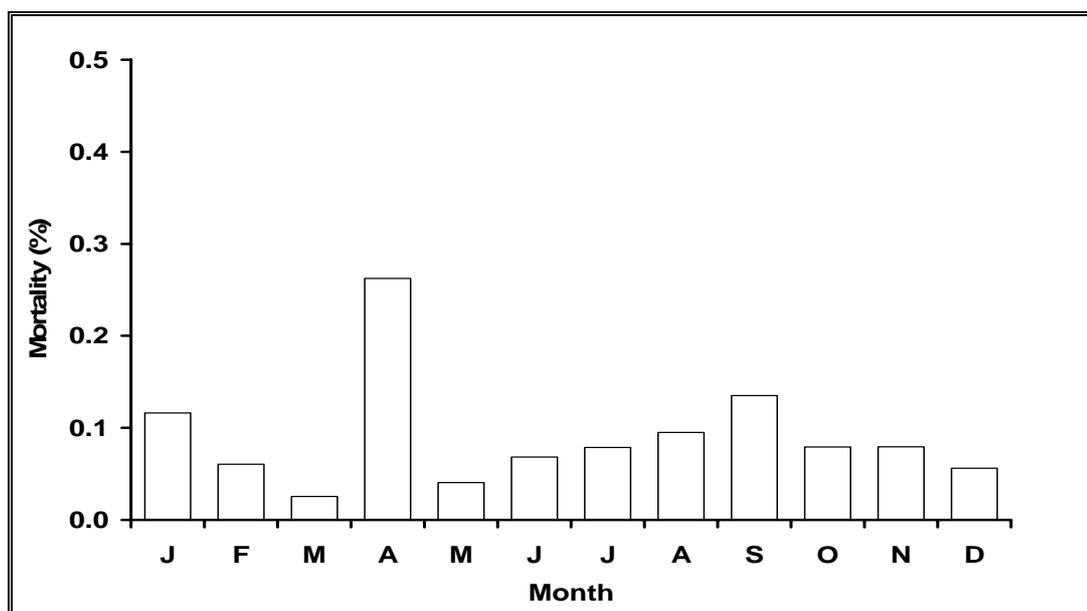
## National livestock exports mortality summary 2006

**Table 16** Number of voyages in nil, low, medium and high mortality categories for shipments from various ports to South-East Asia for 2006

Port	Mortality rate				Total
	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	
Townsville	0	2	0	0	2
Karumba	3	0	0	0	3
Darwin	38	46	1	0	85
Wyndham	7	12	0	0	19
Broome	9	20	1	0	30
Port Hedland	1	2	0	0	3
Geraldton	5	7	0	0	12
Fremantle	2	6	0	1	9
<b>Total</b>	<b>65</b>	<b>95</b>	<b>2</b>	<b>1</b>	<b>163</b>

### 4.2.3.2 Time of year

Monthly mortality rates for voyages to South-East Asia were below 0.1% throughout the year except for January, April and September (Figure 7). There were 9 voyages to the South-East Asia from a southern port in 2006.



**Figure 7** Monthly mortality rate of cattle on voyages from all ports to South-East Asia for 2006

## National livestock exports mortality summary 2006

### 4.2.3.3 Ship

The voyages of each ship from Australia to South-East Asia were classified into various mortality categories as shown in Table 17. Most voyages of most ships were in the nil or low mortality categories, with one voyage in the high category involving ship 40.

**Table 17** Number of voyages in nil, low, medium and high mortality categories for shipments to South-East Asia for 2006

Ship (code)	Mortality rate				Total
	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	
5	2	1	0	0	3
37	0	12	0	0	12
40	0	11	0	1	12
88	12	4	0	0	16
90	13	4	0	0	17
100	9	11	0	0	20
103	1	1	0	0	2
109	7	8	0	0	15
112	3	5	0	0	8
113	2	12	0	0	14
114	1	6	2	0	9
115	0	1	0	0	1
117	12	7	0	0	19
119	3	5	0	0	8
121	0	7	0	0	7
Total	65	95	2	1	163

### 4.2.3.4 Class of cattle

The highest mortality rates on voyages to South-East Asia in 2006 occurred in dairy cows (0.92%) followed by beef cows (0.28%) (Table 18). There were 27 voyages involving approximately 65,000 cattle for which load numbers could not be determined by class.

**Table 18** Mortality rates, number of voyages and number of cattle in various classes exported to the South-East Asia in 2006

Class	Voyages (No.)	Cattle (No.)	Mortality rate (%)	Mortality rate range (%)
Steer adult*	126	220,621	0.04	0.0 – 0.6
Bull adult*	92	30,762	0.25	0.0 – 2.6
Bull calf	0	446	0.00	n/a
Cow beef	50	38,586	0.28	0.0 – 2.6
Cow dairy	1	759	0.92	n/a
Heifer beef	113	86,317	0.05	0.0 – 0.8
Heifer dairy	3	4,661	0.15	0.0 – 0.3

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

## National livestock exports mortality summary 2006

### 4.2.4 North-East Asia

The number of cattle exported to North-East Asia has continued to decrease since 2004. Numbers fell by 28% in 2006 compared to 2005 (Table 19). The mortality rate has remained relatively constant at about 0.1% since 2001.

**Table 19** Mortality rates, number of voyages and number of cattle exported to North-East Asia from 1995 to 2006

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

#### 4.2.4.1 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 to mainly China and South Korea. Consignments from two ports went to Eastern Russia.

**Table 20** Mortality rates, number of voyages and number of cattle exported from various ports to North-East Asia for 2006

Port	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)
Fremantle	4*	1,794	0.61	0.0 - 1.3
Portland	4*	9,895	0.16	0.1 - 0.2
Brisbane	15	21,983	0.03	0.0 - 0.1
Newcastle	2	1,829	0.16	0.2 - 0.2

\* One split-loaded voyage excluded: mortalities could not be determined by consignment (port of loading). Total mortality for this voyage was 0.28%.

## National livestock exports mortality summary 2006

### 4.2.4.2 Ship

The voyages of each ship from Australia to North-East Asia were classified into various mortality categories as shown in Table 21. There was one voyage in the high category, performed by ship 5.

**Table 21** Number of voyages in nil, low, medium and high mortality categories for shipments to North-East Asia for 2006

Ship (code)	Mortality rate				Total
	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	
5	0	3	0	1	4
59	1	1	0	0	2
87	6	4	0	0	10
100	1	2	0	0	3
112	1	0	0	0	1
113	0	1	0	0	1
114	1	0	0	0	1
119	0	2	0	0	2
121	1	1	0	0	2
Total	11	14	0	1	26

### 4.2.4.3 Class of cattle

Death rates for each class of cattle exported to North-East Asia during 2006 are presented in Table 22. The North-East Asian cattle trade comprised mainly dairy heifers exported to China and steers exported to Japan.

In 2006 the highest mortality rates occurred in dairy cows (0.19%) followed by dairy heifers (0.17%). Load numbers for one nil mortality voyage could not be determined by class.

**Table 22** Mortality rate, number of voyages and number of cattle in the classes exported to North-East Asia in 2006

Class	Voyages (No.)	Cattle (No.)	Mortality rate (%)	Mortality rate range (%)
Steer adult*	15	20,845	0.09	0.0 - 1.3
Bull adult*	1	6	0.00	n/a
Cow dairy	2	2,130	0.19	0.0 - 0.2
Heifer beef	3	2,580	0.16	0.0 - 0.2
Heifer dairy	7	10,812	0.17	0.0 - 0.3

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

## National livestock exports mortality summary 2006

### 4.2.5 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). The number of cattle again fell substantially in 2006, while the mortality rate rose by 33% compared with 2005.

**Table 23** Mortality rates, number of voyages and number of cattle exported to China from 1995 to 2006

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

#### 4.2.5.1 Port of loading

Nearly all of the cattle exported to China in 2006 were loaded at Portland (Table 24).

**Table 24** Mortality rates, number of voyages and number of cattle exported from various ports to China for 2006

Port	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)
Portland	3*	6,741	0.13	0.0 - 0.2
Fremantle	2*	637	0.00	n/a

\* One split-loaded voyage excluded: mortalities could not be determined by consignment (port of loading). Total mortality for this voyage was 0.28%.

#### 4.2.5.2 Class of cattle

Recording of mortality rates for each class of cattle exported to China was introduced in July 2003. The results for 2006 are presented in Table 25. The majority of cattle exported to China continued to be dairy heifers.

**Table 25** Mortality rate, number of voyages and number of cattle in the classes exported to China in 2006

Class	Voyages (No.)	Cattle (No.)	Mortality rate (%)	Mortality rate range (%)
Bull adult*	1	6	0.00	n/a
Heifer dairy	6	9,834	0.16	0.0 - 0.3

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



## National livestock exports mortality summary 2006

### 4.2.6 Mexico

Numbers of cattle exported to Mexico in 2006 fell by 35% compared with 2005 (Table 26), while the mortality rate fell by 19%. Mortality rates have continued below 0.5% since 2001, with the exception of 2002. All of the cattle exported to Mexico in 2006 were dairy heifers.

**Table 26** Mortality rates, number of voyages and number of cattle exported to Mexico from 1995 to 2006

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

#### 4.2.6.1 Port of loading

The majority of cattle exported to Mexico in 2006 were loaded at Portland (Table 27). The Portland mortality rate was similar to 2005, while that for Fremantle fell by approximately 80% compared with 2005.

**Table 27** Mortality rate, number of voyages and number of cattle exported from various ports to Mexico in 2006

Port	Voyages (No.)	Cattle (No.)	Mortality rate overall (%)	Mortality rate range (%)
Portland	4	9,633	0.23	0.1 - 0.4
Fremantle	3	1,659	0.12	0.0 - 0.2

#### 4.2.6.2 Ship

The voyages of each ship from Australia to Mexico were classified into various mortality categories as shown in Table 28. Most voyages were in the low mortality category.

**Table 28** Voyage numbers in nil, low, medium and high mortality categories for shipments to Mexico in 2006

Ship (code)	Mortality rate				Total
	Nil 0.0%	Low >0.0–0.5%	Medium >0.5–1.0%	High >1.0%	
38	1	1	0	0	2
100	1	1	0	0	2
103	0	1	0	0	1
121	0	2	0	0	2

## National livestock exports mortality summary 2006

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Total	2	5	0	0	7
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4.3 Goats

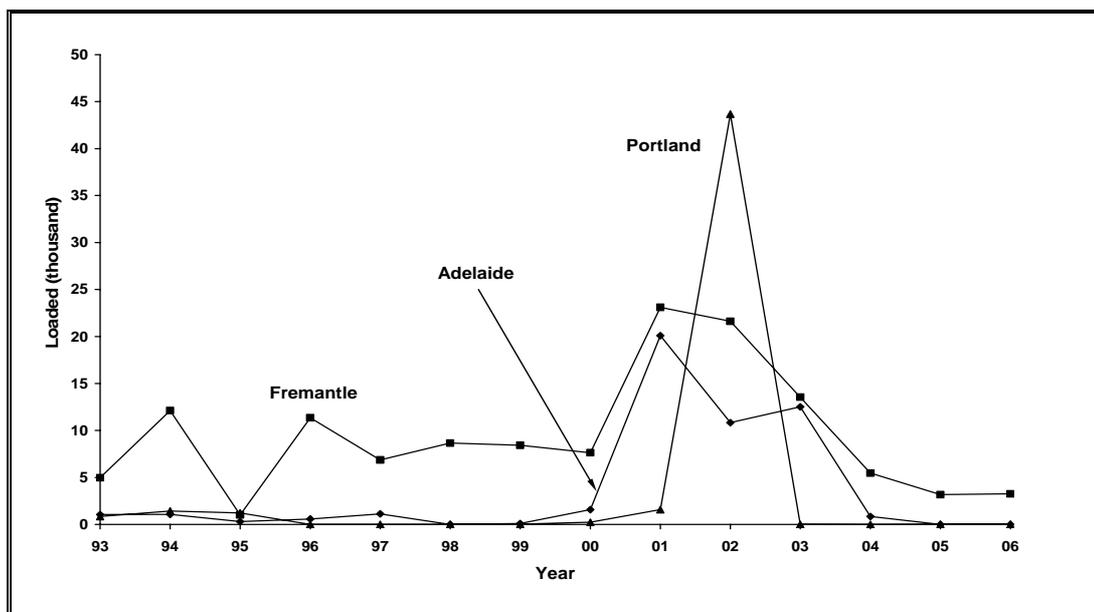
4.3.1 Overview

All goats exported by sea from Australia during 2006 were sent to South-East Asia. The overall mortality rate among the 25,353 goats was 0.49% (Table 29). This was significantly below the mortality rate of 0.77% in 2005 ( $P < 0.05$ ), and represents a new record low.

**Table 29** Mortality rates, number of voyages and number of goats exported by sea during 2006

Parameter	SE Asia
Voyages (No.)	24
Goats (No.)	25,353
Mortality rate overall (%)	0.49
Mortality rate range (%)	0.0 – 3.0

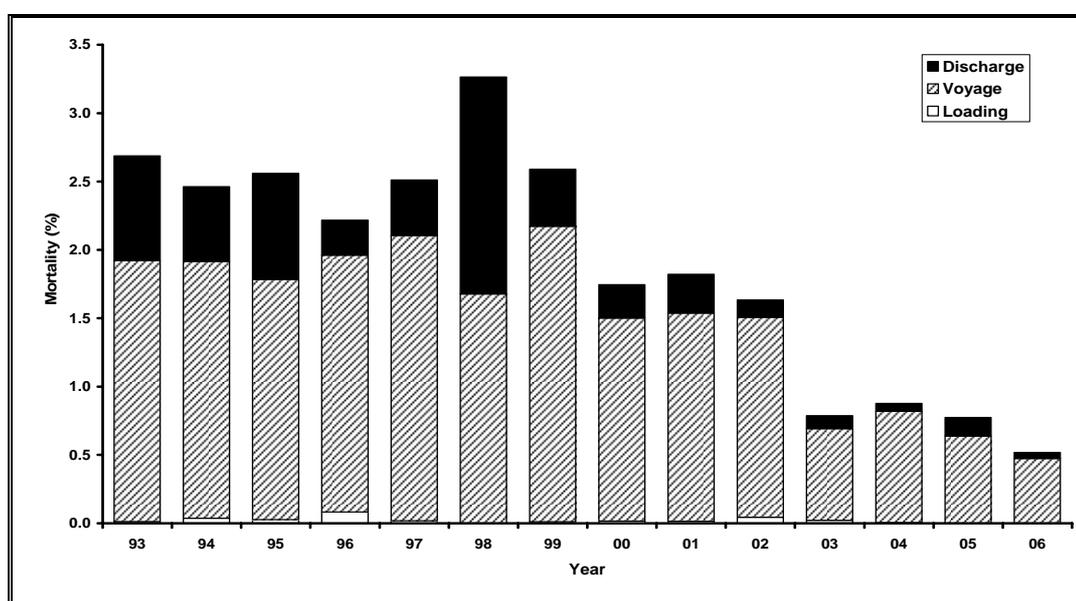
The number of goats exported annually to all destinations from Fremantle, Adelaide and Portland since 1993 is shown in Figure 8.



**Figure 8** Number of goats (x1000) exported by sea from Fremantle (Western Australia), Adelaide (South Australia) and Portland (Victoria) since 1993

## National livestock exports mortality summary 2006

The mortality rate of goats exported from Australia in 2006 decreased by 36% compared to 2005 (Figure9).



**Figure 9** Annual mortality of goats exported by sea from all ports in Australia to all destinations since 1993

### 4.3.2 Middle East

Large numbers of goats were exported by sea to the Middle East in 2001 and 2002 (Table 30) but have since fallen to nil. No further description of this particular trade is given in this report.

**Table 30** Mortality rates, number of voyages and number of goats exported by sea to the Middle East from 1993 to 2006

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

## National livestock exports mortality summary 2006

### 4.3.3 South-East Asia

The number of goats exported by sea to South-East Asia increased substantially in 2001 and 2002 compared to previous years, but has fallen substantially since then (Table 31). The mortality rate in 2006 fell to 0.49% and represents a new record low.

**Table 31** Mortality rates, number of voyages and number of goats exported by sea to South-East Asia from 1993 to 2006

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

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

#### 4.3.3.1 Port of loading

For voyages to South-East Asia in 2006, most goats were exported from Darwin, followed by Geraldton and Fremantle (Table 32). Mortality rates were highest from Geraldton and Broome.

The voyages from each port were classified into various mortality categories as shown in Table 33. Two voyages out of 24 were in the high category. They originated from Darwin and Geraldton.

**Table 32** Mortality rates, number of voyages and number of goats exported from various ports to South-East Asia for 2006

Port	Voyages (No.)	Goats (No.)	Mortality rate overall (%)	Mortality rate range (%)
Darwin	12	16,295	0.10	0.0 – 2.3
Broome	3	2,182	0.64	0.5 – 0.9
Geraldton	4	3,621	1.80	0.4 – 3.0
Fremantle	5	3,255	0.40	0.2 – 0.8

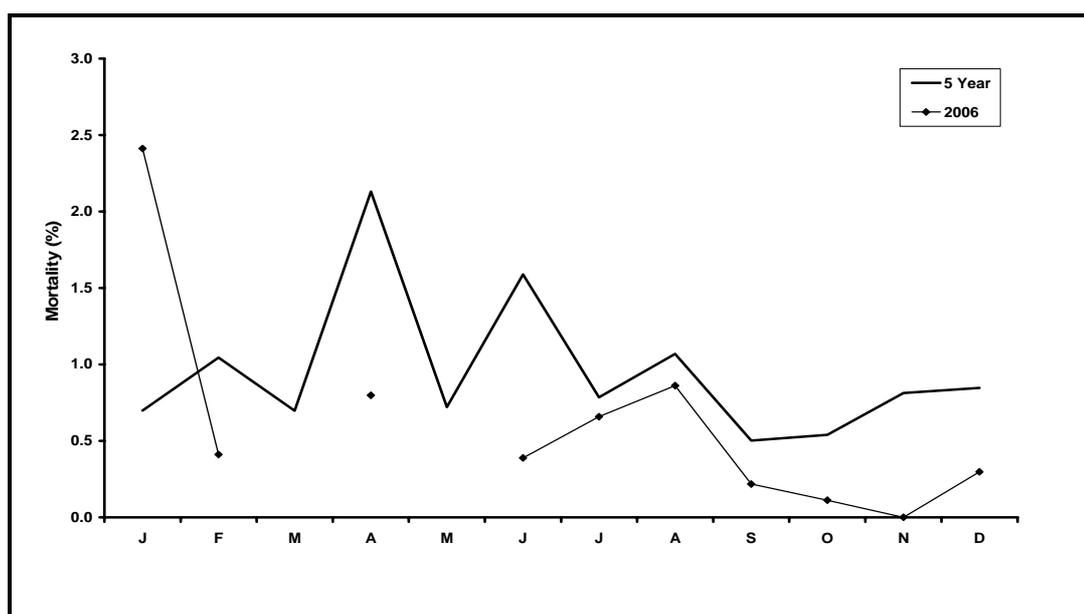
## National livestock exports mortality summary 2006

**Table 33** Number of voyages in low, medium and high mortality categories for shipments from various ports to South-East Asia for 2006

Port	Mortality rate			Total
	Low <1.0%	Medium 1.0–2.0%	High >2.0%	
Darwin	12	0	1	13
Broome	3	0	0	3
Geraldton	2	1	1	4
Fremantle	5	0	0	5
<b>Total</b>	<b>22</b>	<b>1</b>	<b>2</b>	<b>25</b>

### 4.3.3.2 Time of year

The monthly mortality rate during 2006 and the 5-year monthly “average” (proportion of all mortalities divided by number loaded) in all goats exported to the South-East Asia are shown in Figure 10. There were no goats exported during March or May 2006.



**Figure 10** Monthly mortality during 2006 and 5-year monthly average for the period 2002-2006 for goats exported to South-East Asia

### 4.3.3.3 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 34 shows the number of voyages in the various mortality categories for each ship. Most voyages of most ships were in the low mortality category. There were two voyages in the high category; involving ships 117 and 119.

## National livestock exports mortality summary 2006

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**Table 34** Number of voyages in low, medium and high mortality categories for shipments to South-East Asia for 2006

Ship (code)	Mortality rate			Total
	Low <1.0%	Medium 1.0–2.0%	High >2.0%	
5	1	0	0	1
37	1	0	0	1
40	3	0	0	3
88	4	0	0	4
90	2	0	0	2
100	0	1	0	1
112	1	0	0	1
113	1	0	0	1
114	6	0	0	6
115	1	0	0	1
117	0	0	1	1
119	2	0	1	3
<b>Total</b>	<b>22</b>	<b>1</b>	<b>2</b>	<b>25</b>

## 5 Conclusions and recommendations

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

## 6 Bibliography

Nil

## 7 Appendices

### 7.1 Appendix 1 - Sheep and cattle mortalities: research summary

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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.

## 7.2 Appendix 2 - Published studies

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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

## National livestock exports mortality summary 2006

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- 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

### 7.3 Appendix 3 - Acknowledgements

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