



**Australian Government**

**Australian Quarantine and Inspection Service**

## **Investigation into the reportable sheep mortality level on sea voyage from Adelaide and Portland Australia to Kuwait and Bahrain, July 2010.**

### **1. Purpose**

To report on the investigation into the cause of mortalities in sheep exported by sea to Kuwait and Bahrain, and to make recommendations with the objective of reducing the likelihood of a recurrence.

### **2. Summary**

For this voyage, one exporter submitted two notices of intention to export, one for a consignment of sheep loaded in Adelaide and one for a consignment of sheep loaded in Portland. In the consignment of 25 310 sheep loaded in Adelaide on 16 July 2010, there were 527 mortalities recorded which equates to a mortality rate of 2.08%. In the consignment of 52 213 sheep loaded in Portland on 18 July, there were 1914 mortalities which equates to a mortality rate of 3.67%. The reportable mortality rate for sheep is 2%. This investigation relates to both consignments.

The main causes of mortality for this voyage were found to be heat stress and enteritis. The available information indicates that enteritis was a problem in some groups of sheep and that these sheep experienced significant mortalities due to both enteritis and heat stress. In other groups heat stress was the main cause of mortality without any apparent predisposing factors.

**Note** – Enteritis is defined as inflammation of the intestines and, in live export sheep, it is commonly caused by infection with *Salmonella*. Signs of enteritis include diarrhoea, poor appetite and fever<sup>2,3</sup>.

### **3. Background**

The investigation into the mortality was completed by reviewing the following information:

- 3.1. Report from the exporter.
- 3.2. End of Voyage and daily reports from the AQIS accredited veterinarian (AAV) who accompanied the consignment on board the vessel.
- 3.3. Records from the AAV who prepared the consignment.
- 3.4. Report from the master of the vessel.
- 3.5. Report from the Australian Maritime Safety Authority (AMSA).
- 3.6. Report from the AQIS regional certifying officer.
- 3.7. Records from the registered premises.

Table 1 below shows the daily mortality count (DMC), cumulative mortality count (CMC) and cumulative mortality percentage (CM %) for the consignment loaded in Adelaide, the consignment loaded in Portland and a total for both consignments.

**Table 1 Date, day of voyage, daily mortality count (DMC), cumulative mortality count (CMC) and cumulative mortality percentage (CM %) presented for the consignment loaded in Adelaide, the consignment loaded in Portland and the total for both consignments.**

Date	Day	Event	Adelaide			Portland			Total		
			DMC	CMC	CM %	DMC	CMC	CM %	DMC	CMC	CM %
16 July		25,310 sheep loaded in Adelaide									
17 July	1		0	0	0.00%	0	0	0.00%	0	0	0.00%
18 July	2	52,213 sheep loaded in Portland	2	2	0.01%	0	0	0.00%	2	2	0.00%
19 July	3		4	6	0.02%	10	10	0.02%	14	16	0.02%
20 July	4		4	10	0.04%	24	34	0.07%	28	44	0.06%
21 July	5		6	16	0.06%	32	66	0.13%	38	82	0.11%
22 July	6		2	18	0.07%	30	96	0.18%	32	114	0.15%
23 July	7		4	22	0.09%	32	128	0.25%	36	150	0.19%
24 July	8		3	25	0.10%	37	165	0.32%	40	190	0.25%
25 July	9		3	28	0.11%	33	198	0.38%	36	226	0.29%
26 July	10		2	30	0.12%	43	241	0.46%	45	271	0.35%
27 July	11		10	40	0.16%	71	312	0.60%	81	352	0.45%
28 July	12		22	62	0.24%	70	382	0.73%	92	444	0.57%
29 July	13		24	86	0.34%	80	462	0.88%	104	548	0.71%
30 July	14		29	115	0.45%	51	513	0.98%	80	628	0.81%
31 July	15		17	132	0.52%	72	585	1.12%	89	717	0.92%
1 August	16		19	151	0.60%	69	654	1.25%	88	805	1.04%
2 August	17		22	173	0.68%	56	710	1.36%	78	883	1.14%
3 August	18		8	181	0.72%	52	762	1.46%	60	943	1.22%
4 August	19		14	195	0.77%	51	813	1.56%	65	1 008	1.30%
5 August	20		132	327	1.29%	448	1 261	2.42%	580	1 588	2.05%
6 August	21	Vessel arrived in Kuwait and commenced discharging sheep	135	462	1.83%	366	1 627	3.12%	501	2 089	2.69%
7 August	22		39	501	1.98%	145	1 772	3.39%	184	2 273	2.93%
8 August	23		3	504	1.99%	75	1 847	3.54%	78	2 351	3.03%
9 August	24	Discharging sheep in Kuwait completed, vessel sailed to Bahrain	16	520	2.05%	21	1 868	3.58%	37	2 388	3.08%
10 August	25	Vessel arrived in Bahrain and discharged sheep	7	527	2.08%	46	1 914	3.67%	53	2 441	3.15%

The reportable mortality trigger for sheep is 2% (or 3 animals whichever is greater). The reportable mortality level was triggered on day 20 of the voyage (5 August 2010) for the Portland consignment while the vessel was in the Persian Gulf. The reportable mortality level was triggered on day 24 of the voyage (9 August 2010) for the Adelaide consignment while the vessel was in the Persian Gulf, sailing between Kuwait and Manama, Bahrain.

There were 131 additional mortalities which were not assigned to a consignment and for which no detailed information (including location on vessel, date of mortality and cause of death) is available. These additional mortalities bring the total voyage mortality to 2572 mortalities out of the 77 523 sheep loaded, giving an overall mortality rate of 3.32 % for the two consignments combined. The analysis of the mortality in this report includes only the 2441 mortalities for which detailed information is available.

## **4. Findings**

### **4.1. Preparation in the Registered Premises**

#### ***Adelaide***

The sheep exported from Adelaide were assembled at one registered premises. There were 27 241 sheep received at the registered premises on 9 July 2010. There were 36 mortalities recorded in the registered premises during the assembly period which equates to a mortality rate of 0.13%. The mortalities were not confined to any particular paddock or group.

During the loading process, 671 sheep were rejected from the consignment including 642 sheep rejected at the registered premises and 29 sheep rejected at the wharf. The AQIS accredited veterinarian's (AAV's) records show that 85% of rejections were due to pink eye, 10% were due to diarrhoea and 5% were due to miscellaneous reasons including lameness and injury.

The report received from the exporter did not identify any health problems or unusual mortalities during the pre-export preparation period. Weather conditions were mild during the preparation period with mid-afternoon temperature ranging from 12.2 °C to 16.1 °C and some light rain recorded. The records provided by the registered premises indicate that the sheep ate well during the preparation period and did not show any signs of health problems. An AQIS veterinarian inspected the consignment in Adelaide on 15 and 16 July, but did not note any health problems other than those identified, and for which sheep were rejected by the AAV.

#### ***Portland***

The sheep exported from Portland were assembled at two separate registered premises. There were 26 549 sheep received at the first registered premises on 10 and 11 July 2010. There were 40 mortalities recorded in the registered premises during the assembly period which equates to a mortality rate of 0.15%. During the loading process, 893 sheep were rejected from the consignment, including 843 sheep rejected at the registered premises and 50 sheep rejected at the wharf. The AAV's records show that 222 lambs were rejected for diarrhoea and 118 wethers were rejected for lameness. A further 503 sheep were rejected from the consignment, 60% of these rejections were due to lameness, 30% were due to diarrhoea and 10% were due to miscellaneous reasons including pinkeye.

There were 27 941 sheep received at the second registered premises on 12 July 2010. There were 19 mortalities in the registered premises during the assembly period, which equates to a mortality rate of 0.07%. During the loading process, 464 sheep were rejected from the

consignment including 435 sheep rejected at the registered premises and 29 sheep rejected at the wharf. The AAV's records show that 85% of rejections were due to pink eye, 10% were due to diarrhoea and 5% were due to miscellaneous reasons including lameness and injury.

The report received from the exporter did not identify any health problems or unusual mortalities during the pre-export preparation period. Weather conditions were mild during the preparation period with mid-afternoon temperature ranging from 10.7 °C to 15.7 °C and some light rain recorded. The records provided by the registered premises indicate that the sheep ate well during the preparation period and did not show any health problems. An AQIS veterinarian inspected the consignment in Portland on 17 and 18 July and did not note any health problems other than those identified, and for which sheep were rejected by the AAV. The onboard veterinarian reported that sheep with diarrhoea were noticed during the loading of the vessel.

#### **4.2. Loading onto the Vessel**

The loading records indicate the stocking density of the sheep was in accordance with the Australian Standards for the Export of Livestock (ASEL). The records also indicate that the amount of fodder loaded was in accordance with the ASEL.

#### **4.3. Conditions During the Journey**

Figure 1 shows the wet bulb temperature for each deck and each day (from the veterinarian's daily reports) as well as the heat stress threshold (HST) and mortality limit (ML) for adult merino sheep. Heat stress threshold is the maximum ambient wet bulb temperature at which heat balance of the deep body temperature can be controlled using available mechanisms of heat loss. Mortality Limit is the wet bulb temperature at which the animal will die. For adult merino sheep the heat stress threshold is 30.6°C and the mortality limit is 35.5°C<sup>1</sup>.

The temperatures recorded on the daily reports indicate that sheep on some decks were exposed to temperatures at, or above, the heat stress threshold for a prolonged period (day 11 to 20). The vessel crossed the equator on day 14 and entered the Persian Gulf on day 20. The veterinarian's end of voyage report stated that while passing into the Persian Gulf on the evening of day 19, wet bulb temperature on all decks exceeded 35°C and that the resulting conditions caused a large number of mortalities and significant compromise to the welfare of the sheep that survived these conditions. Heat stress mortalities occurred on days 20 to 22 and across the two consignments, 1 265 sheep, or 51.8% of mortalities occurred on these three days.

The veterinarian's report indicated that the stocking densities for this voyage were in accordance with the ASEL. However, it was the veterinarian's opinion that ASEL minimum stocking densities are insufficient for sheep exported to the Middle East in July and August, and that this was an important factor contributing to mortality. The veterinarian recommended a review of the ASEL minimum stocking densities for sheep exported to the Middle East in July and August.

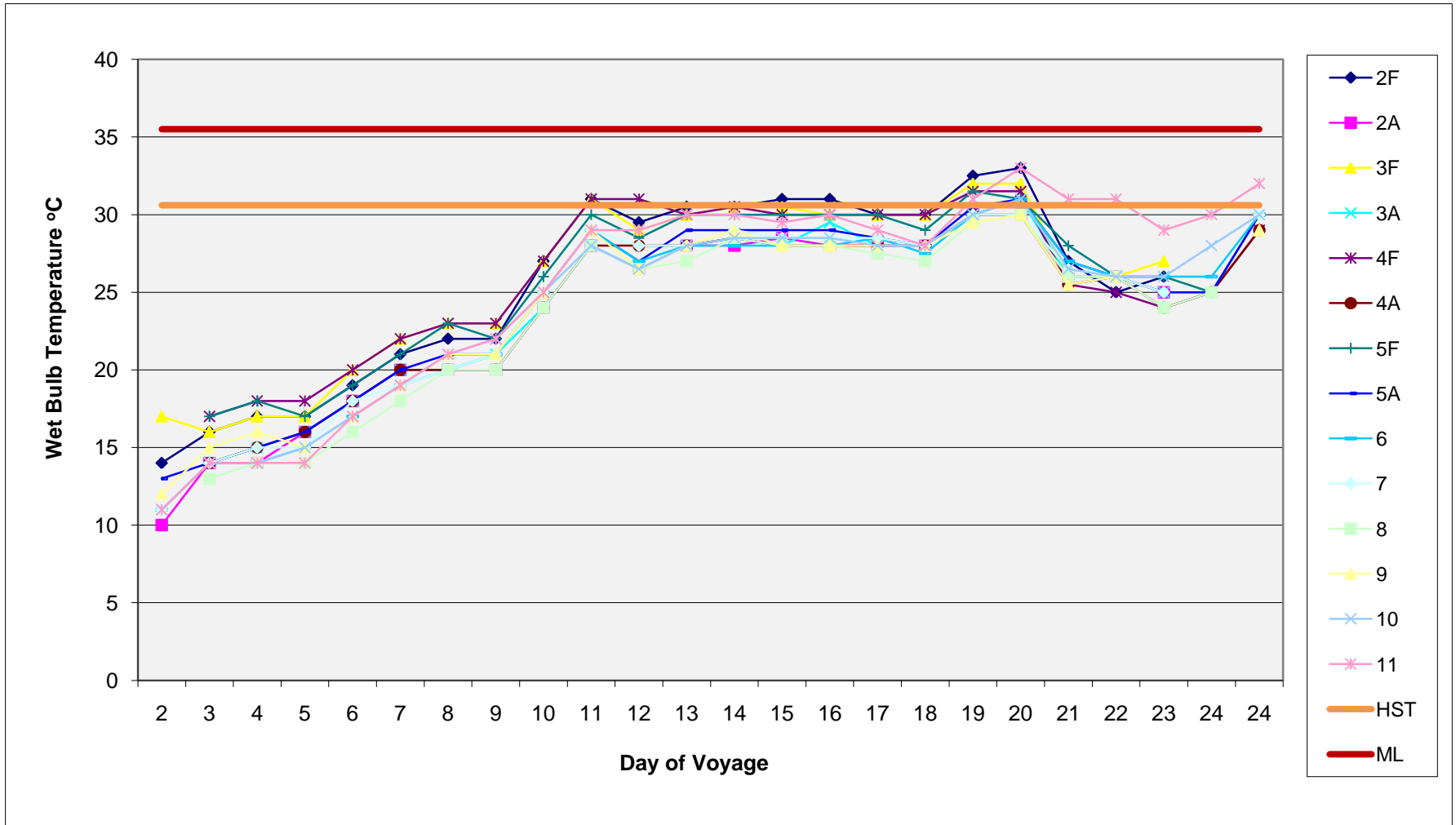


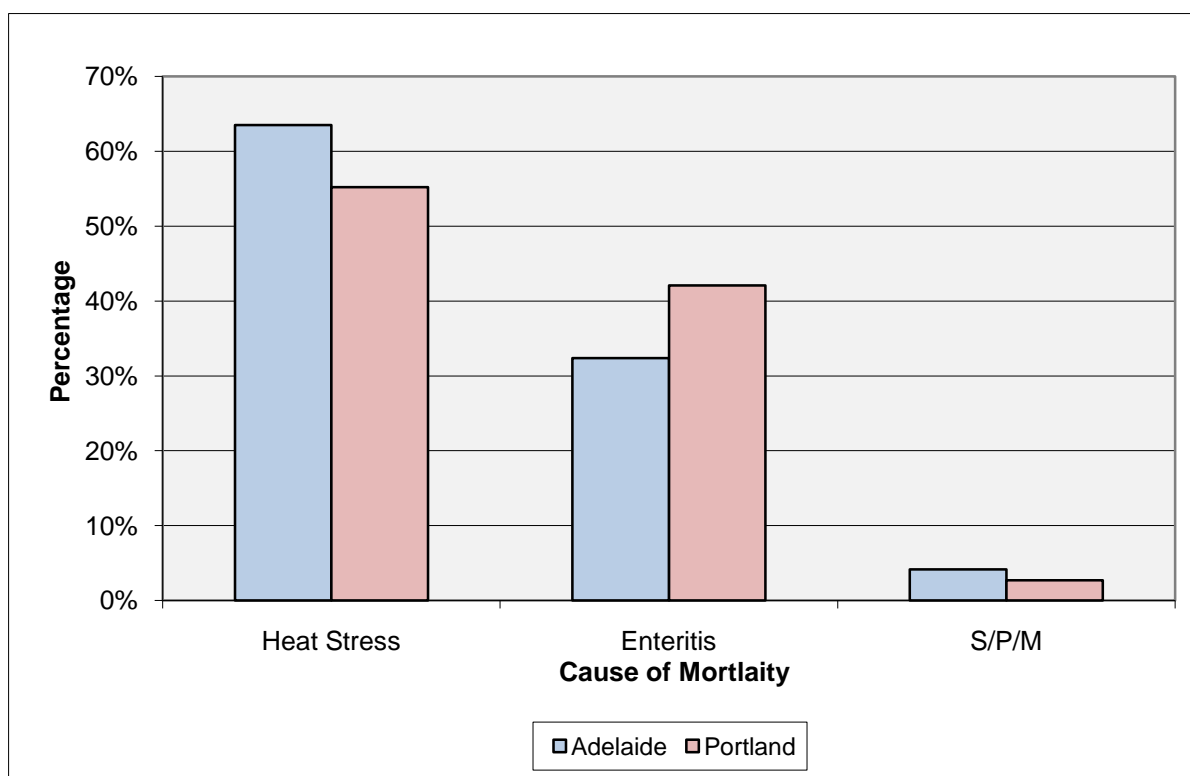
Figure 1 Wet bulb temperatures by deck and day, heat stress threshold (HST) and mortality limit (ML).

#### 4.4. Mortality by Cause

Cause of mortality was reported in the veterinarian's daily reports and end of voyage report. Postmortems were performed each day, up to and including day 22 of the voyage. From day 23 onward the vessel was in port discharging sheep and post-mortems could no longer be performed.

The veterinarian assessed the cause of mortality for all sheep that died up to, and including day 22 of the voyage. The veterinarian reached a diagnosis in 90.9% of these assessed mortalities. The veterinarian reported the following causes of mortality; 57% (1265) due to heat stress; 40% (887) due to enteritis; and 3% (67) due to pneumonia, misadventure or septicaemia. Enteritis caused by Salmonella has previously been identified as an important cause of mortality in live export sheep<sup>2,3</sup>, and the veterinarian reported that the cases of enteritis on this voyage were consistent with salmonellosis.

Figure 2 shows the percentage of diagnosed mortality by cause for sheep loaded in Adelaide and sheep loaded in Portland. Heat stress was the most common cause of mortality in sheep loaded in both Adelaide and Portland. It is apparent that enteritis accounted for a higher percentage of mortality in the sheep loaded in Portland than in the sheep loaded in Adelaide. The veterinarian commented that some of the heat stress mortalities occurred in sheep that were already suffering from enteritis.

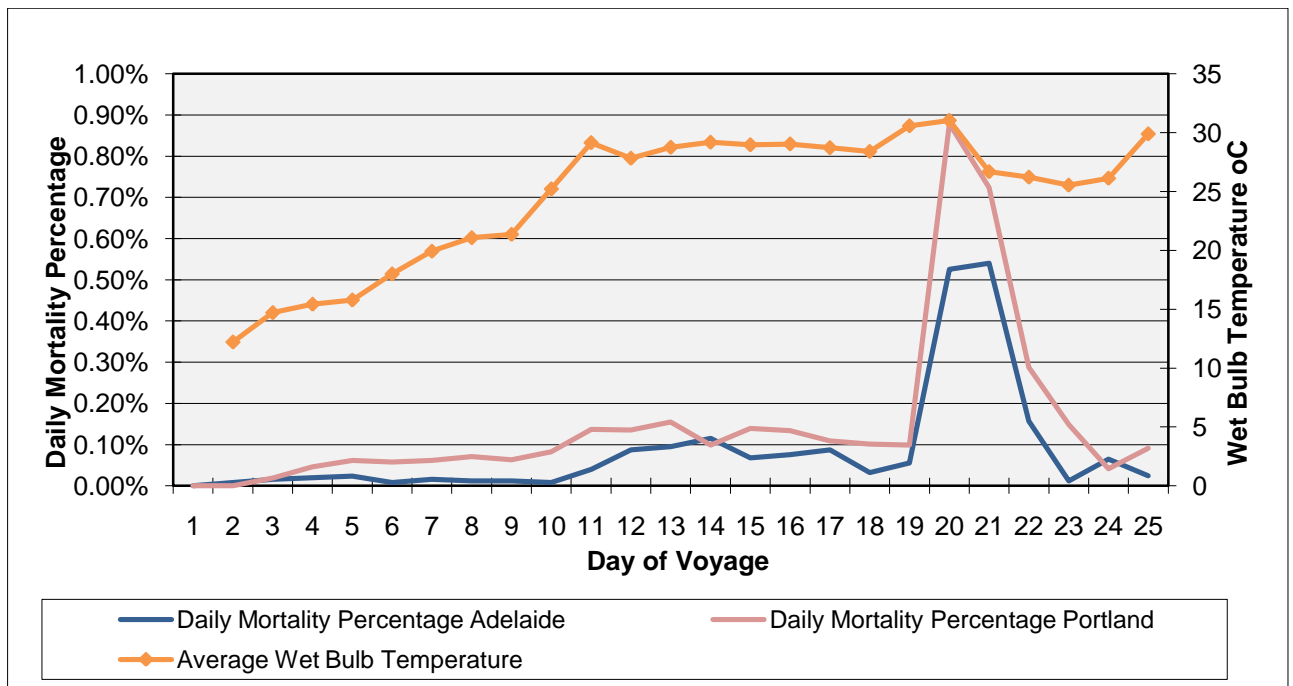


**Figure 2 - Percentage of diagnosed mortality assigned to each cause**

S/P/M = Septicaemia / Pneumonia / Misadventure

#### 4.5. Mortality by Day

Figure 3 shows the percentage of sheep loaded in Adelaide and Portland that died each day (this is not a cumulative mortality) and the average wet bulb temperature across all decks of the vessel. The figure shows a clear spike in mortality associated with the period of highest recorded wet bulb temperature from days 20 to 22.



**Figure 3 - Daily percent mortality and temperature**

**The pink and blue lines indicate the percentage of sheep loaded in Adelaide and Portland that died each day (not cumulative).**

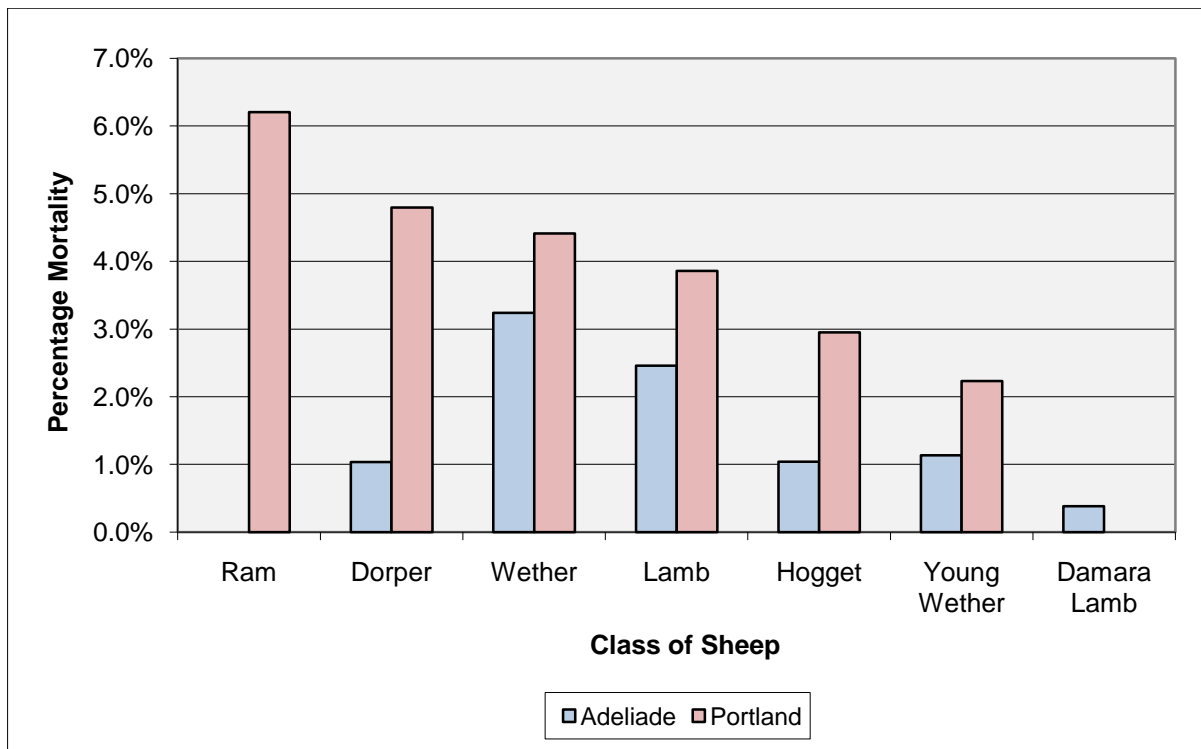
**The orange line indicates the average wet bulb temperature across all decks.**

The veterinarian’s reports indicated that enteritis was the dominant cause of mortality up to day 19 of the voyage. Over 50% of total mortality occurred from day 20 to 22, with all mortalities occurring on these days diagnosed as heat stress mortalities.

#### 4.6. Mortality by Class

Figure 5 shows the mortality percentage for each class of sheep. Class of sheep can refer to the age, sex or breed of the sheep. There were Damara and Dorper breed sheep included in this consignment. All remaining sheep were Merinos.

Mortality exceeded the reportable level of 2% in all classes of sheep loaded in Portland with the rams, Dorpers and wethers all recording mortality in excess of 4%. Of the sheep loaded in Adelaide, only the wethers and lambs recorded mortality in excess of the reportable level.

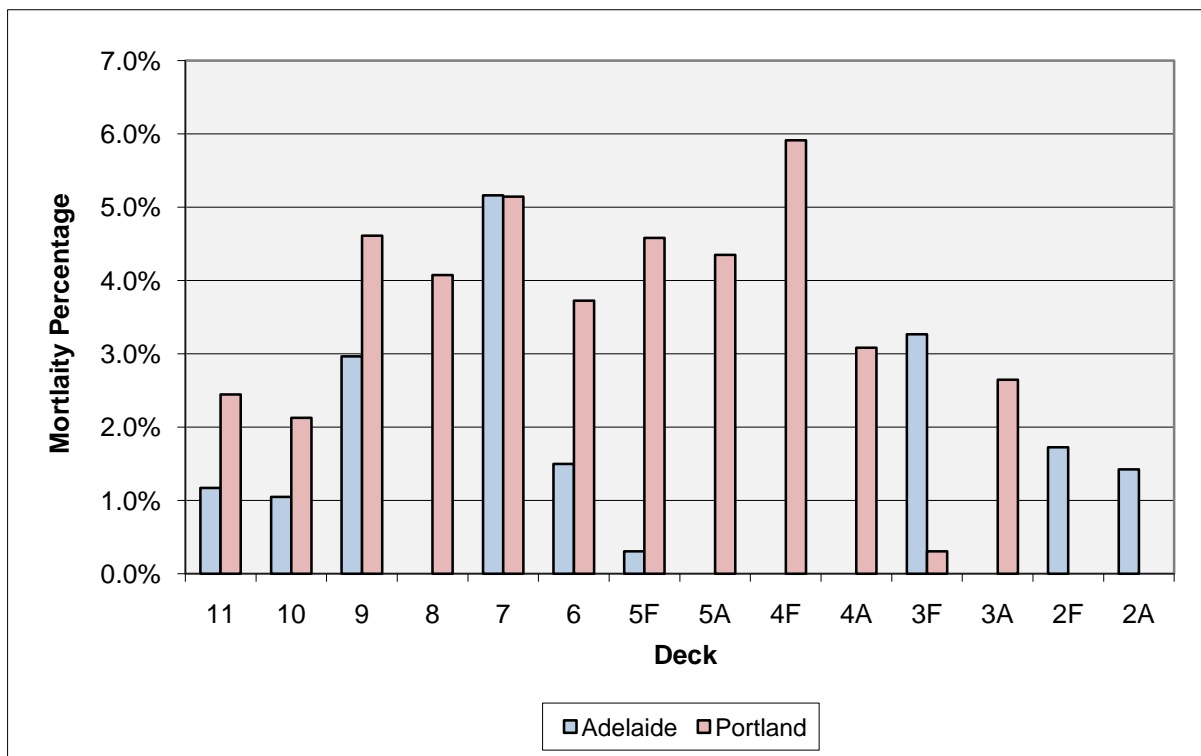


**Figure 5 - Mortality percentages for each class of sheep loaded in Adelaide and Portland.**

Note - There were no mortalities recorded in the rams loaded in Adelaide. There were no Damara lambs loaded in Portland.

#### 4.7. Mortality by Deck

Figure 6 shows mortality by deck. In this graph, 'F' stands for forward deck which is at the front of the ship and 'A' stands for aft deck which is at the rear of the ship.



**Figure 6 Mortality percentage by deck for sheep loaded in Adelaide and Portland**

F = forward, A = Aft



#### **4.8. Discussion of Mortality by Cause, Day, Class and Deck**

Deck 4 forward had the highest mortality rate. Deck 4 forward was loaded with lambs from Portland. On day 19 (before the heat stress event), mortality on this deck was at 1.02% and the final mortality for this deck was 5.91%. For these sheep, 77.39% of mortality was due to heat stress. Deck 4 forward had the highest average wet bulb temperature (averaged across all days) of all decks for this voyage. In these sheep, heat stress was the most important cause of mortality. Similar outcomes were recorded in the Portland wethers loaded on deck 8 and the Adelaide lambs loaded on deck 3 forward.

Deck 7 had the second highest mortality rate. Deck 7 was loaded with rams and heavy wethers from both Adelaide and Portland. The rams loaded in Portland had the highest mortality rate of any class. On day 19, mortality rate on deck 7 had exceeded the reportable mortality level of 2% (2.97% for sheep loaded in Portland and 2.03% for sheep loaded in Adelaide). The final mortality for this deck was 5.16% for the sheep loaded in Portland and 5.15% for the sheep loaded in Adelaide. For the sheep loaded on deck 7, 37.2% of mortality was due to heat stress. In these sheep, both enteritis and heat stress were important causes of mortality. Similar outcomes were recorded in Adelaide and Portland wethers loaded on deck 9, Portland wethers loaded on deck 5 and in the Portland lambs loaded on deck 4 aft.

#### **5. Management of the Livestock During the Voyage**

The veterinarian's report indicated that in the early stages of the voyage, enteritis was a problem in the sheep loaded on decks 6, 7, 8, 9 and 11. The veterinarian reported that these groups were medicated with oxytetracycline, which was administered in water to groups of sheep, and by injection to some individuals.

The veterinarian also reported that sheep were spread out to all available areas of the ship, including the hospital pens, in an attempt to combat the extreme environmental conditions. The stocking density was reduced after unloading was completed in Kuwait to take advantage of the extra space that became available. The available information indicates that the onboard management of the livestock was compliant with Standard 5 of the ASEL.

#### **6. AMSA Evaluation of the Vessel**

The pre-loading inspection of the vessel by AMSA at Port Adelaide did not find any deficiencies in the livestock services.

#### **7. Conclusion**

The main causes of mortality for this voyage were heat stress and enteritis. The available information indicates that enteritis was a problem in some groups of sheep and that these sheep experienced significant mortalities due to both enteritis and heat stress. In other groups heat stress was the main cause of mortality without any apparent predisposing factors.

## **8. Recommendations**

8.1. The Livestock Export Research and Development Committee to urgently review ASEL table A4.1.5 to determine if the minimum pen area for sheep exported into northern hemisphere summer is sufficient.

8.2. The livestock export industry to implement, before 1 May 2011, revised heat stress risk assessment software that better addresses the risk of mortality due to heat stress in sheep exported during the northern hemisphere summer.

If revised software is not implemented by 1 May 2011, AQIS should consider implementing additional space requirements for sheep exported to the Middle East during the northern hemisphere summer.

8.3. AQIS to consider implementing more rigorous pre-export inspection procedure, for sheep assembled in paddocks from May to October, to reduce the risk of sheep with diarrhoea being loaded onto the vessel.

It is noted that the livestock export industry is currently undertaking research projects to develop salmonellosis and inanition treatment strategies for sheep during live export, and investigating the feasibility of a salmonella vaccine for live export sheep. This reportable mortality event reiterates the need for such research.

## **9. Actions**

The exporter proposed additional risk management procedures for a subsequent consignment of sheep exported from Adelaide and Portland to the Persian Gulf in August 2010. AQIS accepted the exporter's proposals and approved the consignment subject to the following conditions. These conditions were designed to reduce the risk of mortality due to enteritis and heat stress.

- The exporter must provide to AQIS a declaration stating that pastoral and station sheep have not been prepared for export for this consignment.
- The exporter must provide to AQIS an updated load plan and HSRA prior to issuance of an export permit.
- Sheep must be loaded with the following extra space above the ASEL table A4.1.5:
  - Rams – 20%
  - All other classes of sheep – 15%
- The on board veterinary supplies must include an additional 100kg of oxytetracycline.
- 6 MT of chaff must be loaded.

In addition to these conditions, AQIS veterinary officers inspected the sheep twice during the assembly period.

### ***Result***

The result for the August 2010 consignment was 1242 mortalities reported out of 69 952 sheep loaded which equates to a mortality rate of 1.78%.

AQIS placed the following conditions on a subsequent consignments of sheep exported from Adelaide and Portland to the Persian Gulf by this exporter in October 2010.

- The exporter must provide to AQIS a declaration stating that pastoral and station sheep have not been prepared for export for this consignment.
- The exporter must provide to AQIS an updated load plan and HSRA prior to issuance of an export permit.
- Sheep must be loaded with 10% additional space above the ASEL table A4.1.5.
- No rams are to be loaded.
- The on board veterinary supplies must include an additional 100kg of oxytetracycline powder.
- The exporter must load 3 MT of chaff on the vessel.

In addition to these conditions, AQIS veterinary officers inspected the sheep twice during the assembly period.

### ***Result***

The result for the October 2010 consignment was 387 mortalities reported out of 35 427 sheep loaded which equates to a mortality rate of 1.09%.

The exporter has regularly shipped similar consignments of sheep to the Middle East. Since January 2005, this exporter has exported over 2.4 million sheep to the Middle East on 51 voyages with an average mortality of 1.07%.

## **10. References**

1. Maunsell Australia Pty Ltd. 2003. LIVE.116 Development of a heat stress risk management model. Meat and Livestock Australia.
2. Richards, R., R. Norris, et al. (1989). "Causes of death in sheep exported live by sea." Australian Veterinary Journal 66(2): 33-38.
3. Kelly, A. P. (1996). Mortalities in sheep transported by sea. Faculty of Veterinary Science. Melbourne, University of Melbourne. PhD.