



**Australian Government**

**Australian Quarantine and Inspection Service**

## **Investigation into the reportable sheep mortality level on a sea voyage from Fremantle, Western Australia to Bahrain, Kuwait and the United Arab Emirates (UAE), August 2010.**

### **1. Purpose**

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

### **2. Summary**

There was one consignment of 69 024 sheep and one consignment of 598 cattle on this voyage. In the consignment of sheep loaded at Fremantle on 9 and 10 August 2010, there were 1407 mortalities recorded which equates to a mortality of 2.04%. In the consignment of cattle loaded Fremantle on 10 August 2010, there were no mortalities recorded. This investigation only reports on the consignment of sheep loaded in Fremantle which exceeded the reportable mortality limit of 2%. The main cause of mortality in the sheep was heat stress due to high temperatures and humidity experienced in the Persian Gulf.

### **3. Background**

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

1. Report from the exporter
2. End of Voyage and daily reports from the AQIS accredited veterinarian (AAV) who accompanied the consignment on board the vessel.
3. Records from the AAV who prepared the consignment.
4. Report from the Master of the vessel.
5. Report from the Australian Maritime Safety Authority (AMSA).
6. Report from the AQIS regional certifying officer.
7. Records from the registered premises.

**Table 1 Chronology of events showing cumulative mortality (count and percentage) by day**

<b>Date</b>	<b>Day</b>	<b>Event</b>	<b>Cumulative voyage mortality count</b>	<b>Cumulative Mortality %</b>
09 - 10/08/2010		69 024 Sheep loaded in Fremantle.	0	0.00%
11/08/2010	1	24 Mortalities	24	0.03%
12/08/2010	2	16 Mortalities	40	0.06%
13/08/2010	3	11 Mortalities	51	0.07%
14/08/2010	4	20 Mortalities	71	0.10%

Date	Day	Event	Cumulative voyage mortality count	Cumulative Mortality %
15/08/2010	5	19 Mortalities	90	0.13%
16/08/2010	6	24 Mortalities	114	0.17%
17/08/2010	7	20 Mortalities	134	0.19%
18/08/2010	8	16 Mortalities	150	0.22%
19/08/2010	9	19 Mortalities	169	0.24%
20/08/2010	10	18 Mortalities	187	0.27%
21/08/2010	11	21 Mortalities	208	0.30%
22/08/2010	12	25 Mortalities	233	0.34%
23/08/2010	13	16 Mortalities	249	0.36%
24/08/2010	14	48 Mortalities Vessel arrived in Bahrain and commenced unloading sheep.	297	0.43%
25/08/2010	15	89 Mortalities Vessel completed unloading sheep in Bahrain and departed for the Kuwait.	386	0.56%
26/08/2010	16	570 Mortalities Vessel travelled between Bahrain and Kuwait	956	1.39%
27/08/2010	17	257 Mortalities Vessel arrived in Kuwait and commenced unloading sheep.	1213	1.76%
28/08/2010 to 31/08/2010	18 to 21	194 Mortalities Vessel unloaded sheep in Kuwait and the UAE.	1407	2.04%

The reportable mortality trigger for sheep is 2.0% (or 3 animals whichever is greater). The reportable mortality level was triggered on day 21 of the voyage (31 August 2010) as the vessel completed unloading in the UAE.

## 4. Findings

### 4.1 Preparation in the Registered Premises

The 69 024 sheep exported from Fremantle were assembled at a registered premises near Perth, Western Australia. Between 26 July and 3 August 2010, 76 422 sheep were received at the registered premises. There were 46 mortalities recorded in the registered premises during the assembly period which equates to a mortality of 0.06%. Mortalities were not confined to any particular group of sheep. In addition there were 391 sheep rejected from the consignment during the preparation period in the registered premises.

An AQIS veterinary officer and AQIS accredited veterinarian inspected the sheep on 8 August 2010 at the registered premises. Both the AQIS veterinary officer and AQIS accredited veterinarian were satisfied with the general health and condition of the sheep.

### 4.2 Loading onto the Vessel

The loading records indicate the stocking density and the amount of fodder loaded was in accordance with the ASEL. Sheep from this consignment were loaded onto decks 1–4 and 6–9 of the vessel.

During the loading process, 641 sheep were rejected from the consignment by the AQIS accredited veterinarian. The AQIS accredited veterinarian's records show that 30% of rejections were due to pink eye, 10% were due to lameness and 40% were due to scabby mouth infection. The remaining 10% of rejections were due to other causes such as injuries and diarrhoea.

### **4.3 Conditions during the Journey**

Figure 1 shows the wet bulb temperature for each deck and each day, 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>.

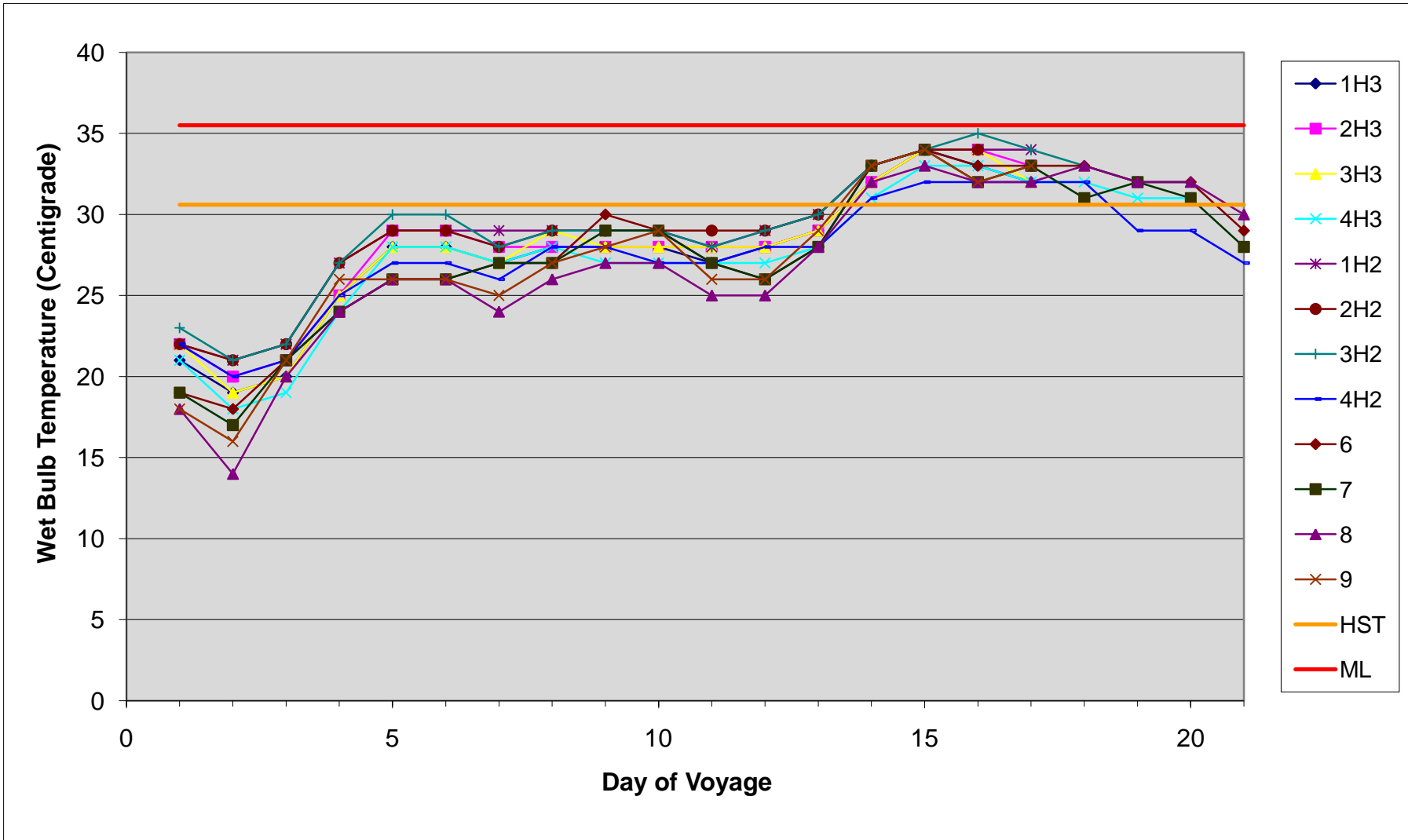


Figure 1 Wet bulb temperatures by deck and day, heat stress threshold (HST) and mortality limit (ML).

The vessel entered the Persian Gulf on day 14 of the voyage and remained therein until the end of the voyage. The available information indicates that the sheep were exposed to temperatures above the heat stress threshold on days 14–20 of the voyage. During days 14–20 of the voyage, the vessel was travelling in the Persian Gulf or discharging livestock in Bahrain and Kuwait. Figure 1 shows that the recorded mid morning wet bulb temperatures did not exceed the mortality limit on any day of the voyage. The veterinarian commented in his end of voyage report that wet bulb temperatures were 34–35°C on most decks from day 14 onwards. The veterinarian also reported that the entire consignment experienced ‘severe heat stress’ from day 14 onwards which resulted in very high sheep mortalities.

#### 4.4 Mortality by Cause

The causes of mortality were reported on the veterinarian’s daily reports and end of voyage report, but were not recorded for each individual deck. Post mortems were performed each day, up to and including day 14 of the voyage. From day 14 onwards the vessel was unloading in port or within the Persian Gulf and post mortems could no longer be performed.

According to the veterinarian’s reports, 1072 post mortem examinations were undertaken during the voyage and a diagnosis was reached in 1049 or 98% of these. Excluding mortalities which were decomposed, or those upon which no post mortem was performed and those in which no diagnosis was reached, the veterinarian concluded that more than 80% of the mortalities during the voyage were due to heat stress. The veterinarian did not report any health conditions which predisposed the sheep to heat stress.

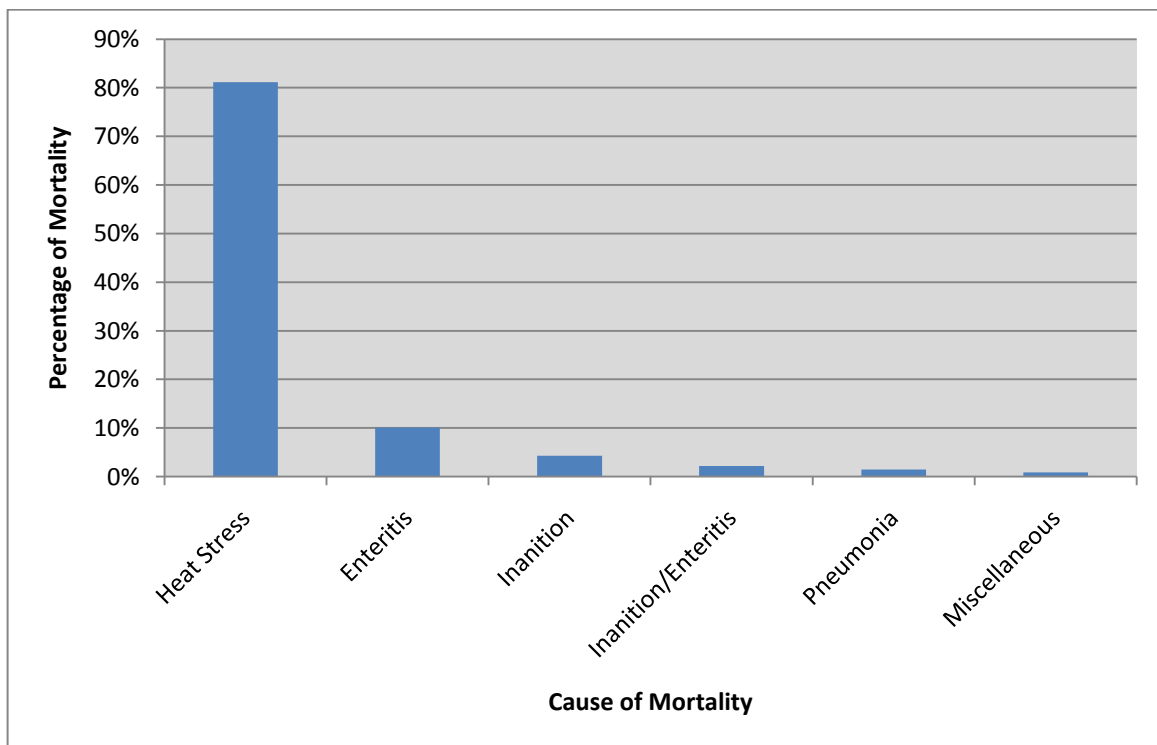


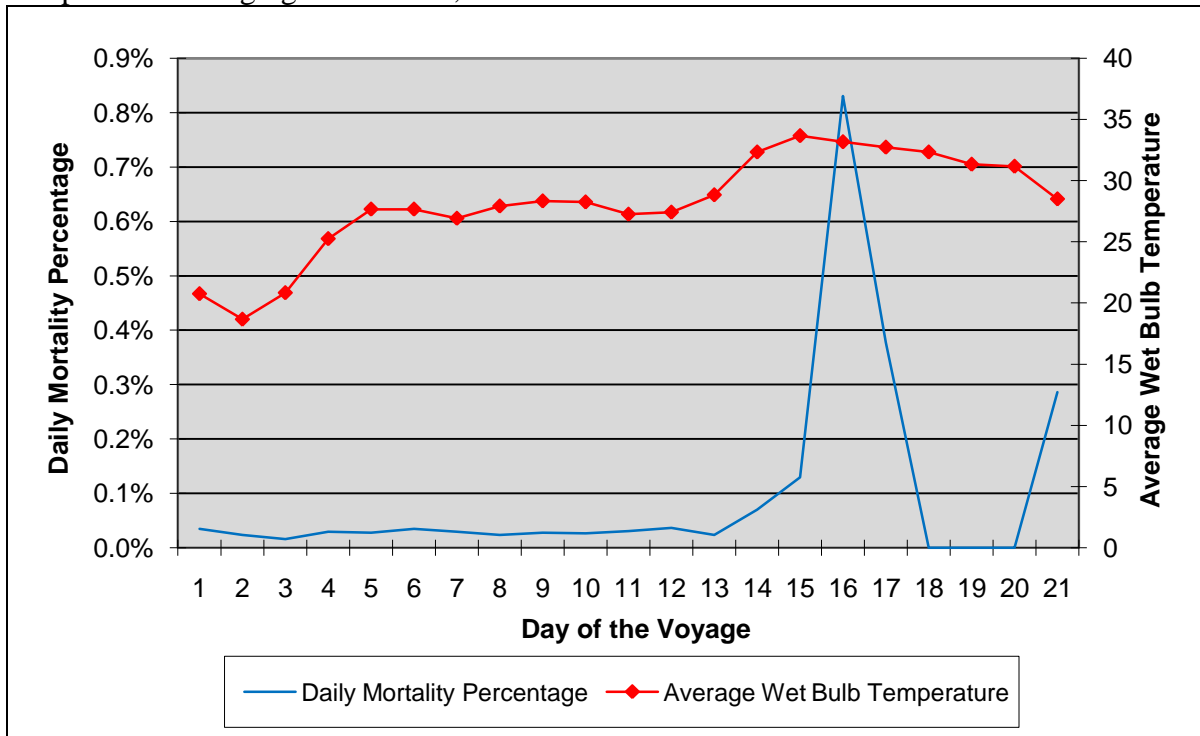
Figure 2 - Percentage of diagnosed mortality assigned to each cause

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>.

#### 4.5 Mortality by Day

Figure 3 shows the percentage of sheep that died each day (this is not a cumulative mortality) and the average wet bulb mortality across all decks of the vessel. It can be seen

that as the average wet bulb temperature markedly increased from day 13 onwards, the daily percentage mortality sharply increased. The available information suggests that the very marked increase in mortality from day 14 to day 17 was due to an increase in mortality caused by heat stress. Mortalities occurred but were not removed and counted from day 18 until day 20 as the priority of the Master and crew was to complete unloading sheep as quickly as possible. A final mortality count was not completed until after the vessel had completed discharging in Jebel Ali, UAE.



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

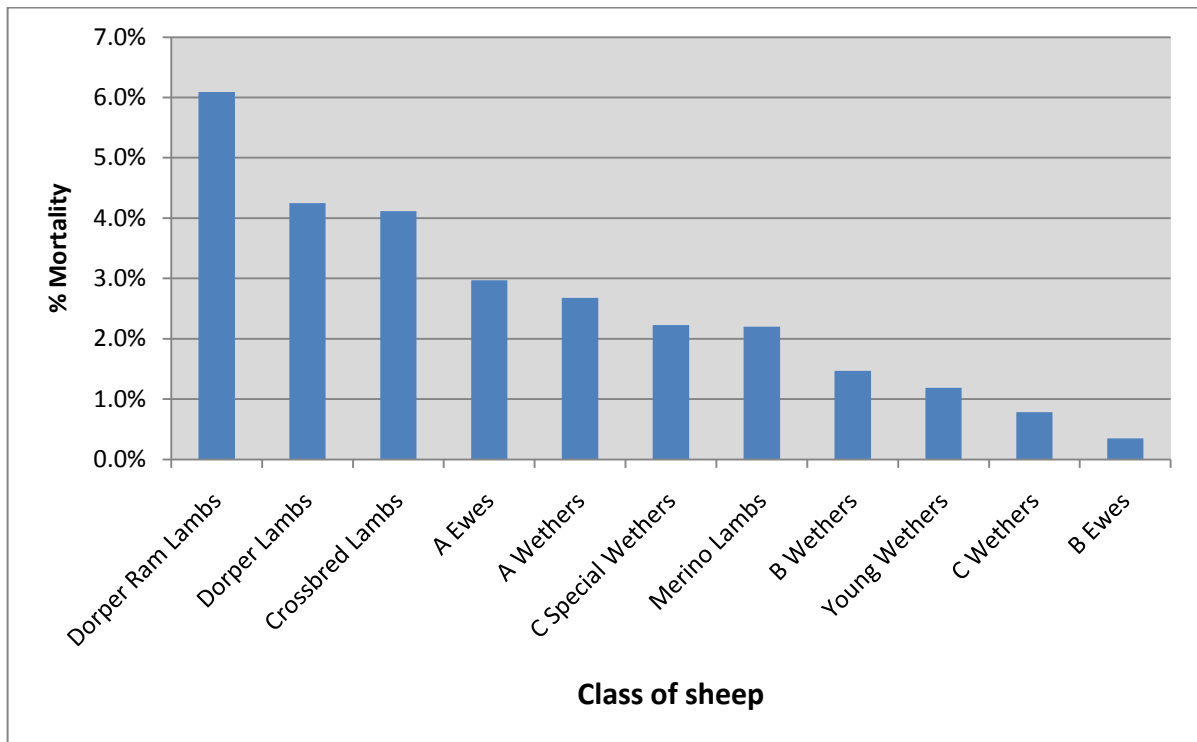
**The blue lines indicate the percentage of sheep that died each day (not cumulative)  
 The red line indicates the average wet bulb temperature across all decks**

The veterinarian’s reports indicate that heat stress accounted for more than 80% of mortalities during the voyage, and was the overwhelming cause of mortality after day 13 of the voyage. This observation is consistent with the available information which shows that 82% of the total voyage mortality occurred from day 14 until day 21 of the voyage.

#### 4.6 Mortality by Class

Figure 4 shows the mortality percentage for each class of sheep. Class of sheep may refer to the age, breed and sex of sheep (i.e. lamb, ewe or ram) as well as the commercial class of

sheep (i.e. an A class wether is larger than a B class wether which is larger than a C class wether). There were Dorper breed and Crossbred sheep loaded on the vessel, though the majority were Merinos.

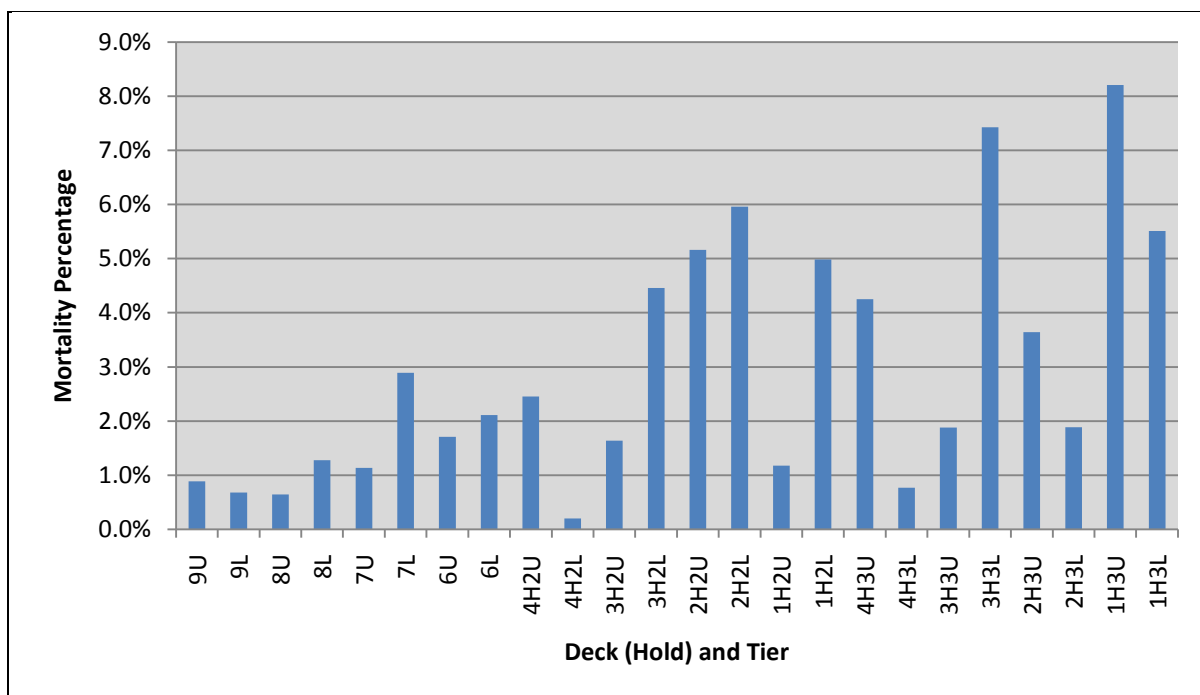


**Figure 4 - Mortality percentages for each class of sheep arranged in order of decreasing mortality rate.**

#### 4.7 Mortality by Deck

Figure 5 shows mortality by deck. This vessel has nine decks of which deck 5 was loaded only with cattle for this voyage. Decks 1–4 and 6–9 have upper and lower tiers. Decks 6–9 are open, relying on both natural and artificial ventilation, whereas decks 1–4 are fully enclosed and rely entirely on artificial ventilation.

Decks 1–4 on this vessel are split into two holds (or sections) and are designated hold 2 and hold 3. The holds are entirely separate. Hold 2 is closest to the front of the vessel and hold 3 is closest to the rear of the vessel. In figure 5, the mortality percentage for each deck and hold (where applicable) as well as tier is shown. For example, 1H3U shows the mortality percentage experienced by the sheep loaded on deck 1, hold 3, upper tier and 7L shows the mortality percentage experienced by the sheep loaded on deck 7, lower tier.



**Figure 5 - Mortality percentage by deck.**

U = Upper tier, L = Lower tier, H2 = Hold 2 and H3 = Hold 3

#### 4.8 Discussion of Mortality by Cause, Deck and Class

Up until day 13 of the voyage, the cumulative mortality percentage for the entire vessel was 0.36%. Over the following 8 days, until day 21, a further 1158 mortalities occurred which brought the cumulative mortality percentage for the voyage to 2.04% of the sheep loaded. The veterinarian reported that heat stress accounted for more than 80% of diagnosed mortalities that occurred during the voyage. Up until day 13 of the voyage, the veterinarian reported that mortalities had occurred due to causes other than heat stress, but did not report any apparent health conditions which predisposed the remaining sheep to heat stress.

Figure 5 shows that the sheep located on the open decks experienced a lower percentage mortality than those located on the enclosed decks. The sheep located on the open decks experienced an average percentage mortality of 1.34%, whereas those located on the enclosed decks experienced an average percentage mortality of 3.41%. The reported average daily wet bulb temperature for the enclosed decks was higher than that for the open decks.

Figure 4 shows that the sheep classes with the highest mortality percentages were the Dorper Ram lambs, the Dorper lambs and the Crossbred lambs which all exceeded 4% mortality. The veterinarian's daily voyage reports indicated that the highest mortalities were recorded amongst the sheep classes housed in the enclosed decks, which included the Dorper Ram lambs, Dorper lambs and Crossbred lambs.

The sheep located on deck 1, hold 3, upper tier, experienced the highest percentage mortality of 8.2%, though until day 14 of the voyage this tier had experienced no mortalities. Likewise, the sheep located on deck 3, hold 3, lower tier experienced a percentage mortality of 7.43%, though until day 14 of the voyage this tier had experienced a cumulative mortality percentage of 0.59%. A similar pattern of mortality was repeated on other decks. There is insufficient information available to determine if the differences in mortality percentages was due to sheep or deck factors, or both.



The B ewes experienced the lowest percentage mortality of all classes of sheep and the veterinarian reported that they were the first to be discharged in Bahrain, the first discharge port in the Middle East. The B ewes were the only class of sheep to be entirely unloaded in Bahrain whereas sheep of every other class were unloaded in more than one port. Every other class of sheep experienced between three and six further days of extreme heat and humidity. The majority of the C wethers were also unloaded at Bahrain and this is reflected in the percentage mortality of less than 1.0%.

## **5. Management of the livestock during the voyage**

The veterinarian reported that the majority of the sheep were not affected by any apparent health or welfare issues before the vessel arrived in Bahrain, though a number of individuals were treated for conditions such as diarrhoea, reduced appetite, eye infections and lameness. After the vessel arrived in Bahrain, the veterinarian reported that the stocking density was reduced where possible by taking advantage of all available space, as well as any further space that became available after unloading was completed at each port. 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 upon return to Australia**

An AMSA investigation into the incident found no evidence that a deficiency of livestock services was a contributing factor to the high mortality.

## **7. Conclusion**

Heat stress without any apparent predisposing factors was the main cause of mortalities during this voyage. The highest mortalities were recorded amongst the sheep classes housed in the enclosed decks. There was variation between decks of the vessel and classes of sheep, and there is insufficient information available to determine if the differences in mortality percentages was due to sheep or deck factors, or both. The sheep experienced up to seven consecutive days of extreme environmental conditions from the time of arrival in Bahrain, the first port of discharge, until the vessel arrived in Jebel Ali, UAE, the final port of discharge.

## **8. Recommendations**

8.1. The livestock export industry to implement, before 1 May 2011, revised Heat Stress Risk Assessment (HSRA) software that better addresses the risk of mortality due to heat stress in livestock 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.

## **9. Actions**

AQIS placed the following conditions on a subsequent consignment of sheep exported from Fremantle to the Middle East on this vessel by this exporter in October 2010. These conditions were designed to reduce the risk of mortality due to heat stress:

- Sheep on all decks must be loaded with 10% additional space above the ASEL table A4.1.5.
- The exporter must provide to AQIS an updated load plan and HSRA prior to issuance of an export permit.

## **10. Results**

The result for the consignment of sheep with these conditions applied was 421 mortalities reported out of 67 920 sheep loaded which equates to a mortality of 0.6%.

The exporter has regularly shipped similar consignments of sheep to the Middle East. Since January 2005 this exporter has exported over 6 million sheep to the Middle East on 113 voyages with an average mortality of 0.9%.

## **11. 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.