liveexport

SBMR.004A Investigation of Cattle Deaths and Illness during Sea Transport from Australia Voyage 4

Final Report prepared for MLA and Livecorp
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Background

The present study was the fourth in a series of voyages investigating the causes of cattle deaths, with the overall aim of improving the welfare of cattle during sea transport.

Objectives

1. Determine the causes of cattle deaths and illness during sea transport from Australia to the Middle East.
2. Identify factors that contribute to deaths and illness of cattle during sea transport.
3. Make recommendations to reduce cattle deaths and illness during sea transport.

Methods

General: This study was undertaken by the second author (TFJ) on a ship which departed Portland with 13,291 steers and 11,122 wethers aboard. Some cattle (3309 head) and sheep (4372 head) had been loaded at the port of Adelaide on 27 and 28 March 2001. More cattle (9982 head) and sheep (6750 head) were loaded at Portland on 29 and 30 March 2001. The ship sailed from Portland at 5.00 pm on Friday 30 March, and the next day was taken as Day 1 of the voyage.

There was a wide range of cattle breeds and their crosses represented. British breed cattle and their crosses predominated; the majority were Herefords or Hereford cross. There were about 500 Aberdeen Angus types and about 700 other European breed types (Simmental, Charolais, Limousin). Of the tropically adapted breeds on board, it was estimated that there were approximately 400 Brahman types, 150 Santa Gertrudis types, and 250 Droughtmaster types.

The measured average live weight of the cattle was 450.3 kg. Weights, based on visual estimation, ranged from about 300 to 650 kg.

The ship arrived at the Egyptian port of Adabiya in the early morning of Monday 16 April (Day 17). The cattle were unloaded over a period of about 36 hrs, beginning at 7.20 am on Monday 16 and concluding at about 7.30 pm on Tuesday 17 April 2001. The sheep were unloaded next and this finished about 3.00 am on Wednesday 18 April 2001.

On Thursday 19 April 2001, the second author visited the destination feedlots at Ismailia and Port Said and examined the cattle.

Ship and Deck Layout: The ship is a converted car carrier. There are 12 livestock decks and each deck is divided into 4 holds, except for decks 1-5 which have only 2 holds each. The pens are laid out lengthways within each hold in 3 paired lanes separated by walkways. A schematic representation is provided in Appendix 1. Decks 1-10 and most of deck 11 were used for cattle on this voyage, with the sheep loaded on Deck 12 and on part of hold 4 on deck 11. There were approximately 1400 pens available to accommodate the cattle and the pens varied in area from 7 sq.m to 23 sq.m (average 18 sq.m).

Necropsy Technique: Cattle were necropsied as soon as possible after death (usually within 2 hours of death). A standard necropsy technique was performed and tissues from the following organs were fixed in formalin: liver, kidney, lung, small and large intestine, spleen, rumen, abomasum and heart. Any lesions in other tissues detected during the necropsy were also sampled. The brain was sampled in cases where the cause of death was not determined by gross pathological examination, or where the history suggested neurological clinical signs. A full description of gross pathology was recorded on a standardised form (Appendix 2) following each necropsy. Tissues fixed in formalin were returned to Australia for histopathological examination at the Animal Health Laboratories of the Department of Agriculture, Western Australia, South Perth.

Morbidity: The number of cattle affected with different ailments was based on pocket book records kept by the stockmen for the first 7 days. After day 7, workload for the stockmen increased dramatically and they were not able to keep accurate records. The senior author then made daily estimates of the number and type of ill stock on each deck. At the end of the voyage the head stockman provided an estimate of the number of cattle on each deck affected with the different types of ailments recognised. The stockmen also provided an estimate of the numbers or proportion of cattle under their care that had suffered the different types of ailments.

Respiratory rates: On Day 1, three pens located on decks 2, 4 and 6, containing a Brahman cross, a Droughtmaster and a Charolais were chosen for respiratory rate observations. The cattle were selected to reflect a variety of genotypes. The same cattle were observed daily.

Results

Husbandry and Environment on Ship

Husbandry: The feed used on the voyage was a commercial lupin-based pellet. Additionally, a store of bagged oaten chaff was available for offering to shy feeders, hospital pen incumbents, and those cattle with bloat. Chaff was also given to some decks of cattle after a wash-down.

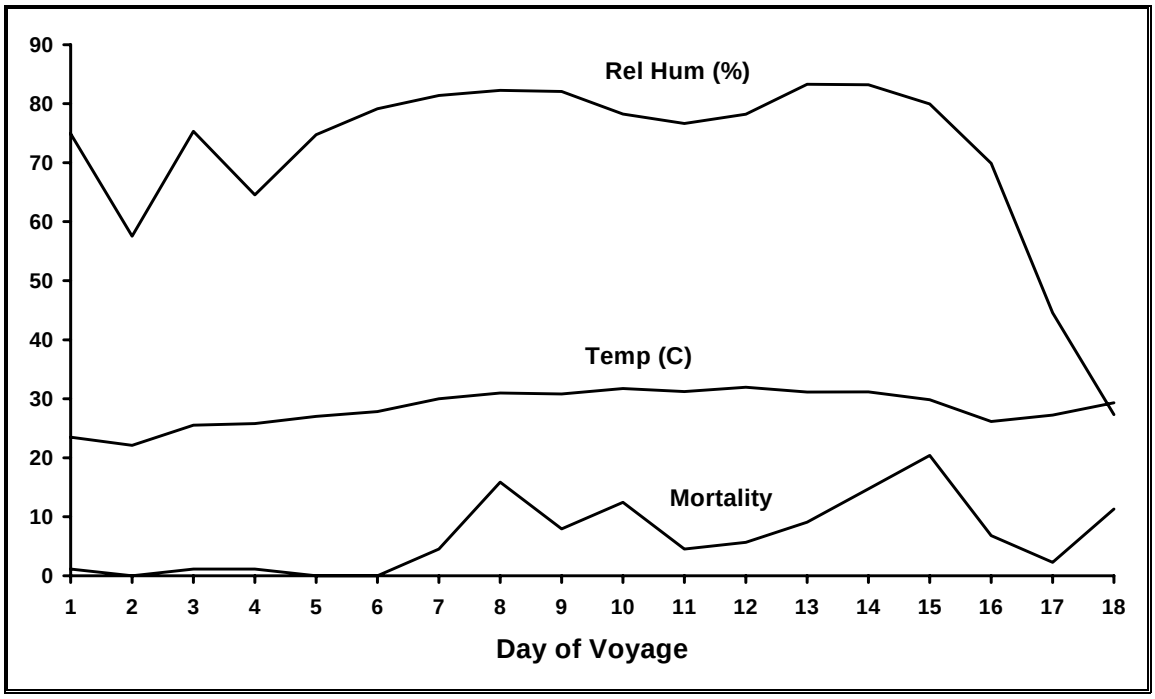
A reverse osmosis system provided ample quantities of drinking water. Electrolytes were added to the water troughs three times daily from Day 2 until arrival in Adabiya.

Average water consumption per head per day was calculated daily from changes in water levels in the bulk water tank supply. Average feed consumption per head per day was calculated every 3 days by measuring changes in feed levels in the pellet holds.

Airflow within holds: The ventilator outlets were located at cattle-head-height along the sides of the ship adjacent to Lanes A (port side) and F (starboard). The vents dispersed a forceful 30 km/hr airflow, the velocity of which dissipated rapidly with increasing distance from the outlet. Much of the airflow was deflected above the heads of the stock and ran along the ceiling of the hold. Air that passed horizontally across the pen was deflected as it reached cattle further from the outlet. Consequently, airflow was barely perceptible in sections of the central lanes. Airflow improved slightly when many cattle were "camping".

Temperature and Humidity: The average daily temperature and humidity on the cattle decks are shown in Figure 1. On the most humid days (days 9 and 13) humidity ranged from 80 to 95% depending on location. On the hottest day (day 12) temperatures ranged from 30.7 ^{o}C to 32.9 ^{o}C depending on location.

Figure 1 Daily temperature, relative humidity and mortality (per 10,00 cattle loaded) during a voyage to the Middle East



Mortalities

A total of 105 cattle died or were euthanased during the voyage, giving an overall death rate of 0.79%. The number of cattle that died or were killed each day is shown in Figure 1. A large proportion of animals that died on days 14, 15 and 16 were killed because their prognosis for recovery before discharge was unfavourable.

Cause of death

Heat stress (hyperthermia) was the main cause of death followed by lameness, injuries, pneumonia and a range of other conditions (Table 1). Thirty-three cattle were killed when the prognosis for recovery was unfavourable. These animals were mostly recumbent with severe lameness, injury or heat stress.

Table 1 Causes of death in cattle during a voyage to the Middle East

Cause of death	No	%
Heat stress	44	41.9
Lameness	17	16.2
Injuries	9	8.6
Pneumonia and/or pleurisy	10	9.5
Cellulitis(inflammation) of the limbs	6	5.7
Intestinal obstruction (phytobezoars)	4	3.8
Enteritis	2	1.9
Accidental asphyxiation	2	1.9
Perforated abomasal ulcer	1	0.9
Fatty liver disease	1	0.9
Liver failure	1	0.9
Deformed feet	1	0.9
Inanition	1	0.9
Gastrointestinal blockage	1	0.9
No diagnosis (mostly too decomposed)	5	4.8
Totals	105	100.0

The diagnoses were based on history, clinical signs, gross necropsy findings and histopathology. Some of the diagnoses overlap somewhat because several conditions were seen in some animals. For example, it was common to see apparent heat stress in animals with pneumonia and sometimes with injuries which had predisposed to wound infections and cellulitis of the limbs. However, an attempt was made to identify the most significant condition for the purpose of categorising these mortalities.

Hyperthermia

Heat stress was the most frequently recorded cause of death. Most of these (33/44) were "uncomplicated" in that no other medical condition was identified as a contributing factor. The most consistent lesion in these animals was severe acute diffuse pulmonary congestion and oedema, which probably occurred as a terminal event. These probably represent the true heat stress cases. However, some animals (10/44) were recorded as having concurrent cellulitis (inflammation, usually caused by infection) of the limbs, following abrasions and penetration injuries of the skin and feet which undoubtedly contributed to the hyperthermia. Another 5/44 heat stress cases also had significant lesions of cardiomyopathy.

Animals that died from hyperthermia tended to be very fat and have long hair coats that were matted with manure. Many of these animals showed signs of severe heat stress (panting heavily, mouth breathing) before they were killed in extremis or were found dead. Many had ante mortem rectal temperatures consistently greater than 41.5^{o}C. At post mortem, the carcass was very hot, much hotter than fat animals that had died from other causes such as pneumonia or intestinal obstruction. Core temperatures measured with a cooking thermometer were consistently greater than 43.0 ^{o}C. Most had large quantities of internal fat and some had reasonably well filled rumens. The heart was small and hard in a state of contracture and very hot. The muscles were consistently glowing pink and dry rather than red-brown and moist. Many of the animals that died of hyperthermia had swollen legs or feet which were from infected decubitus (pressure point) ulcers or penetration injuries of the feet. It is estimated that many of these animals were 5% to 10% dehydrated at the time of death. None of the tropically adapted types died of hyperthermia.

Lameness, injuries and cellulitis of the limbs

Many cattle developed infected feet and limbs secondarily to injuries from penetrations or abrasions. There was an array of lesions often affecting more than one limb including severe necrotic skin abrasions and ulcers mainly over decubitus points, cellulitis affecting whole legs, under-running of soles with necrosis of the corium, and osteomyelitis. Most of these animals were humanely killed but 3 animals died of gangrene or septicaemia. Of the 9 cases where injury caused recumbency, 5 of these were produced during discharge when cattle were "over-run" by those following. There were 6 cases where cellulitis of the limbs was considered severe enough to be the major cause of death..

Pneumonia and pleurisy

There were 6 cases of pneumonia and and 4 cases of pleurisy. All were found dead. Most of the pneumonias were of a morphological type that suggested *Pasteurella* sp as the most likely aetiological agent. However, there was one case of interstitial pneumonia, cause unknown. The post mortem findings in the pneumonia cases were very different from the pleurisy cases. The lungs of pneumonia cases were usually completely solid and discoloured and covered with strings, lumps or thin, irregular sheets of fibrin. The lungs of pleurisy cases were surrounded by a thick blanket of white-yellow fibrin, but were soft and collapsed and tended to have a greyish tinge. There was slight roughening and discolouration of the rib cage lining in patches but there was no significant gross involvement of the lung tissue.

Phytobezoars

Phytobezoars (fibre balls) were the cause of death in 4 cases and an incidental finding in 4 cases. All of these animals originated from western Victoria or southeastern South Australia. Typically the eyes were sunken and the carcass relatively cool in the hot conditions. The lower gastrointestinal tract was empty

and the rumen was usually full of fluid or fibre. A phytobezoar would be found wedged in the pylorus or duodenum.

Miscellaneous

There were surprisingly few endemic conditions encountered. One animal had clear evidence of pyrrolizidine alkaloid toxicosis in liver and kidney sections, but it was humanely killed because of lameness. Several had evidence of moderate to severe parasitic abomasitis, probably ostertagiosis. One animal with a deformed foot slipped through the inspection process and was eventually killed because of lameness. Fatty liver syndrome was diagnosed in one animal; it showed obesity, an abnormally pale coloured and friable liver, an empty rumen and a lack of other findings.

A peculiar and possibly unique lesion was seen in nine animals. These had severe fibrinoid vasculitis confined to the medium sized arteries in the submucosa of the small intestine and occasionally in the large intestine. Strangely, these lesions were not associated with mucosal pathology and there was often little change in other tissues to suggest a possible aetiology. The causes of death in these animals were: lameness, killed (4), lameness killed with pyrrolizidine alkaloidosis (1), hyperthermia (1), hyperthermia with parasitic abomasitis (1), deformed foot with parasitic abomasitis (1). The lesion is possibly associated with an acute allergic reaction but the allergen is unknown. The lesion is also similar to that produced in pigs by experimental exposure to shiga toxin type 2e, derived from certain strains of *Escherichia coli* and considered to be the cause of oedema disease.

Chronological order

The chronological order of the causes of deaths is given in Table 2.

Table 2 Chronological order of cause of deaths during a voyage to the Middle East

	Days of Voyage																		
Diagnosis	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total
Heat Stress								12	7	8	3	3	3	5	1	2			44
Lameness										2		1	3	1	8	2			17
Injuries	1						1	1						1				5	9
Pneumonia and/or pleurisy										1		1		1	4	1	1	1	10
Cellulitis of the limbs														2	1	1		2	6
Intest obstruction (phytobezoars)													2	2					4
Enteritis							2												2
Accidental asphyxiation											1							1	2
Perforated abomasal ulcer				1															1
Fatty liver disease																		1	1
Liver failure								1											1
Deformed feet													1						1
Inanition															1				1
Gastrointestinal blockage															1				1
No Diagnosis			1				1								2		1		5
Total	1	0	1	1	0	0	4	14	7	11	4	5	9	12	18	6	2	10	105

Note Day 18 was during unloading at destination port

Location on ship

The number of deaths on each deck and in each hold are shown in Table 3. The number of deaths in each lane on each deck is shown in Table 4.

Decks 4 and 5 had the highest percentage of deaths (1.56% and 1.93%) and deck 2 the lowest with no deaths recorded. Hold 2 had the greatest percentage of deaths (1.16%) and hold 4 the least (0.37%).

Lanes C and D had the highest number of deaths (21, 26) and lane F the least (8).

Table 3 Number of deaths according to deck and hold aboard ship

		Hold				
Deck		**4**	**3**	**2**	**1**	Totals
	dead	0	3	0	3	6
11	loaded	160	455	476	390	1481
	% dead	0.00%	0.66%	0.00%	0.77%	0.41%
	dead	1	4	7	2	14
10	loaded	509	439	496	411	1855
	% dead	0.20%	0.91%	1.41%	0.49%	0.75%
	dead	4	7	3	3	17
9	loaded	509	493	481	385	1868
	% dead	0.79%	1.42%	0.62%	0.78%	0.91%
	dead	3	7	9	1	20
8	loaded	550	462	506	388	1906
	% dead	0.55%	1.52%	1.78%	0.26%	1.05%
	dead	1	0	3	3	7
7	loaded	535	422	473	301	1731
	% dead	0.19%	0.00%	0.63%	1.00%	0.40%
	dead	1	1	3	1	6
6	loaded	415	234	211	257	1117
	% dead	0.24%	0.43%	1.42%	0.39%	0.54%
	dead	0	0	12	0	12
5	loaded		275	346		621
	% dead		0.00%	3.47%		1.93%
	dead	0	1	10	0	11
4	loaded		283	424		707
	% dead		0.35%	2.36%		1.56%
	dead	0	1	5	0	6
3	loaded		273	446		719
	% dead		0.37%	1.12%		0.83%
	dead	0	0	0	0	0
2	loaded		246	398		644
	% dead		0.00%	0.00%		0.00%
	dead	0	4	2	0	6
1	loaded		245	397		642
	% dead		1.63%	0.50%		0.93%
	dead	10	28	54	13	105
Total	loaded	2,678	3,827	4,654	2,132	13,291
	% dead	0.37%	0.73%	1.16%	0.61%	0.79%

Table 4 The number of deaths in each lane on each deck

	Lane						
Deck	**A**	**B**	**C**	**D**	**E**	**F**	**Total**
11				5		1	6
10	2		2	6	2	2	14
9	2	5	4	4	1	1	17
8	4	1	2	5	6	2	20
7	2	1		1	2	1	7
6	2	2	2				6
5	2	2	6			2	12
4	1	3	2	4	1		11
3		1	1	1	3		6
1	1	1	2	1	1		6
Total	16	15	21	26	16	8	105

Morbidity

Estimates of the number of cattle affected with different ailments during the voyage are shown in Table 5.

Table 5 Various conditions of ill health seen during a voyage of cattle to the Middle East

Condition	% affected
Hyperthermia	70
Snotty nose	25
Lameness/swollen legs	24
Scours	8
Miscellaneous	3

Signs of hyperthermia included panting, mouth breathing and loss of appetite, and were most pronounced during the most humid weather (Days 8 to 15). The British and European breed cattle were affected much more than the tropically-adapted types. Even animals with just a hint of Bos indicus infusion appeared to be unaffected by the heat. Clinical signs were more pronounced in fatter, long-coated animals.

Most cases of heat stress and pneumonia seemed to occur in the central lanes where ventilation (airflow) was weaker compared to the outside lanes. The more crowded pens of cattle were observed to show the stronger signs of heat stress.

'Snotty noses' began to appear on day 3 of the voyage and swept through the ship affecting thousands of animals over the next week. Most recovered quickly but there were some residual cases which showed necrosis of the muzzle epithelium, and would slobber (salivate) profusely. They also had ocular and nasal discharges. The nasal discharges would often be heavily blood stained and were initially serous but would progress to become mucopurulent. Some developed severe respiratory distress that responded to antibiotic treatment.

There were many cases of lameness caused by trauma and/or infection. Washing down the decks occurred every 3 to 4 days. This unavoidably caused disturbance among the cattle and probably contributed to some of the injuries that occurred. Lameness and swollen legs were also caused by punctured, overworn and under run soles, and infection of abrasions and ulcers of the lower limbs.

The miscellaneous category included: animals with the head caught in pen bars (0.8%), shy feeders (0.6%), pink eye (0.5%), pneumonia (0.3%), knuckling of hind legs (0.3%) and bloat (less than 0.1%).

Respiratory Rates

Respiratory rates in the pens under observation increased with increasing heat and humidity in all cattle. Respiratory rates were highest in the Charolais, in-between for the Droughtmasters, and lowest for the Brahmans (Table 6). The tropically adapted cattle had a high respiratory rate but a barely discernible respiratory effort when at the same time the Charolais had a similar respiratory rate but they were panting heavily, mouth breathing, and rocking with the respiratory effort. The difference between the Charolais and the tropically adapted breeds was particularly noticeable between days 7 and 15. Fluctuations in humidity appeared to have more effect on respiratory rate (and animal comfort) than ambient temperature.

Table 6 Daily respiratory rates for individuals of various breeds during a voyage to the Middle East

	Pen 1 (Deck 6, B12)			Pen 2 (Deck 4, C6)			Pen 3 (Deck 2, E8)		
Day	Brahman	D'master	Charolais	Brahman	D'master	Charolais	Brahman	D'master	Charolais
1	40	40	40	40	40	40	40	40	40
2	40	40	40	40	40	40	40	40	40
3	52	44	40	40	60	48	40	60	40
4	40	40	40	40	40	40	40	40	40
5	40	60	100	40	60	100	40	60	120
6	40	40	100	40	40	100	40	40	60
7	80	80	120	80	80	120	80	80	120
8	80	80	120	80	80	120	80	100	120
9	80	80	120	100	100	120	80	100	120
10	80	80	120	100	100	120	80	100	120
11	80	80	100	60	100	100	60	100	100
12	60	100	120	80	100	140	80	100	140
13	60	100	100	80	100	120	80	100	100
14	60	100	100	80	100	120	80	100	100
15	60	100	100	80	100	120	80	100	100
16	60	80	80	80	100	100	80	80	80

D'master refers to Droughtmaster

Discussion and Conclusions

Main causes of death and ill health

This was a relatively high mortality voyage on a ship that has recorded low death rates on previous occasions. It is significant that there was a very high proportion of Bos taurus cattle that were loaded from a southern port during autumn. Shipments from southern ports have three times the risk of death on voyages from Australia compared to shipments from northern ports. It is also well recognised that Bos indicus cattle handle the heat and humidity on ships much better than Bos taurus cattle.

The main causes of death on this voyage were hyperthermia followed by lameness, injuries and pneumonia. There are many factors that are likely to contribute to hyperthermia including: southern port of loading, genotype (Bos taurus), individual animal factors (such as fatness, liveweight, length of hair on coat), concurrent disease (infections, lameness), ventilation and stocking density on the ship. The relative importance of many of these factors is not known, although the risks associated with southern ports and genotype are well recognised.

If a decision is made to ship cattle from south eastern Australia then the increased risk of deaths from hyperthermia must be acknowledged, and all possible action should be taken to reduce the risk. This includes preventive management at all stages of the export process beginning with careful selection of the stock at purchase to avoid fat, long-coated animals, through assembly, loading, shipping and discharge. An emergency management plan to deal with a heat stress incident is also highly desirable for individual ships and for the industry overall.

Two factors that appeared to predispose to mortality on this voyage, and possibly others from southern ports, are ventilation and stocking density. Ventilation is the subject of a separate investigation and is not discussed further in the present study. Regarding stocking density, it was felt that there was crowding in some pens even though the overall density was within the AMSA requirements and the stockmen distributed animals to even out apparent overcrowding. It was observed on this voyage that some cattle had difficulty rising to their feet or gaining access to adequate drinking water, and it was felt that this contributed to some cases of hyperthermia. It is considered that there should be further review of the appropriate density of cattle on shipments from southern Australia.

The next major cause of deaths on this voyage was lameness. A combination of ship and cattle factors are considered to have contributed to this problem. Some animals were showing signs of lameness or had deformed hooves when loaded. Others had soft feet which, together with a heavy liveweight, would render them more susceptible to becoming lame because of the flooring on this ship. Careful selection of stock at purchase, and management before loading together with close inspection during the loading process will reduce numbers of unsuitable animals that board the ship. It should be noted however, that this vessel has frequently recorded very few deaths on long voyages when cattle were loaded at northern ports. This indicates that the flooring *per se* is not the only factor involved and that acceptable results can be obtained with the existing flooring on this ship. Nevertheless, research should be undertaken to determine the most suitable flooring for cattle on long voyages with a view to adoption on all ships.

Breed

The observations that the Bos taurus cattle had higher respiratory rates than the Bos indicus cattle on this voyage are consistent with the findings on other voyages. These observations, together with the higher death rates in Bos taurus cattle confirm that they do not handle the heat and humidity as well as Bos indicus cattle. Whenever possible, Bos indicus cattle should be selected in preference to Bos taurus cattle for long voyages to the Middle East.

In addition, the length of the hair coat may be a significant factor in the poorer performance of some Bos taurus cattle. Long-coated animals have a greater chance of becoming matted with manure during shipping and would have less opportunity to give off heat than animals with shorter coats or clean coats.

Bottom rail in pens

Many cattle were caught by the head or limbs because of the location of the bottom rail in the pens. Heads were stuck between the two bottom rails, and limbs and feet were stuck under the bottom rail. Removal of the bottom rail would prevent these mishaps with no reduction in security of the pen. A stuck animal overexerts itself trying to escape, and many cattle were injured or overheated by the time of release.

Treatment race

The diagnosis and treatment of some cattle would be improved with the construction of a treatment race on each deck as there is on deck 7 of this ship. Occasionally individual cattle require close examination or treatment where pen inspection and treatment with a Westergun are inappropriate. Feet may need to be examined, wire may need to be removed from around a leg, intravenous antibiotics or anti-inflammatories can be administered, a wound or eye may need topical application of treatment.

Spreading saw dust

The practice of spreading saw dust in the pens by the stockmen is potentially dangerous. The stockmen enter the crowded pen, with a knife they slash open 3 or 4 bags of saw dust which have already been thrown in by the crew, and empty the bags in the middle of the pen for the cattle to spread with their feet. There is a high risk of even an experienced stockman, getting badly injured from a kick to the head or body. A severe penetrating knife wound could easily occur.

Recommendations

1. Bos indicus and Bos indicus-infused cattle should be sourced in preference to Bos taurus cattle at all times of the year. Cattle should be sourced from northern areas of Australia in preference to southern areas whenever possible.

2. For shipments from southern ports in Australia, fat Bos taurus cattle with long (winter) coats should not be exported if possible. If such animals cannot be avoided, special conditions must be provided to reduce the risk of death from hyperthermia.

3. The loading density standards for cattle exported from southern ports in Australia, contained in the Australian Livestock Export Standards, should be reviewed particularly for ports in south east Australia.

4. The role of different surfaces on pen floors should be investigated to determine the most suitable flooring for cattle on long voyages.

5. The bottom rail in cattle pens on ships should be removed permanently if it causes animals to get caught, either by the legs or by the head. Australian Maritime Safety Authority standards and any other relevant standards should be revised if necessary.

6. Consideration should be given to the installation of a treatment race on each deck to allow sick or injured animals to receive treatment if necessary.

7. The possible beneficial effects of reducing feed intake and other relevant risk reduction strategies during high risk periods for heat stress should be investigated.

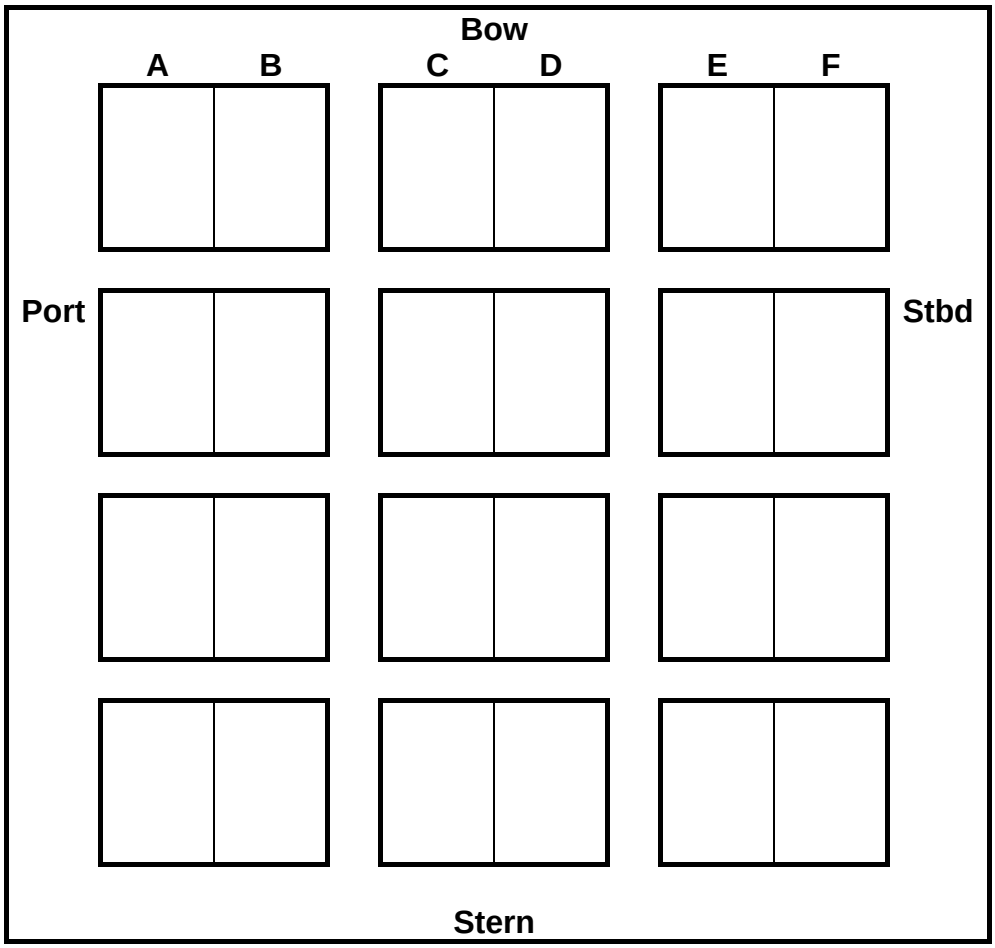
8. A heat stress emergency management plan should be developed for each ship and for the industry overall.

9. The distribution of saw dust in cattle pens is a potentially dangerous situation for the stockmen, either from the cattle or knives used to slash the saw dust bags. A risk minimisation procedure should be developed and included in the Stockman Accreditation Program.

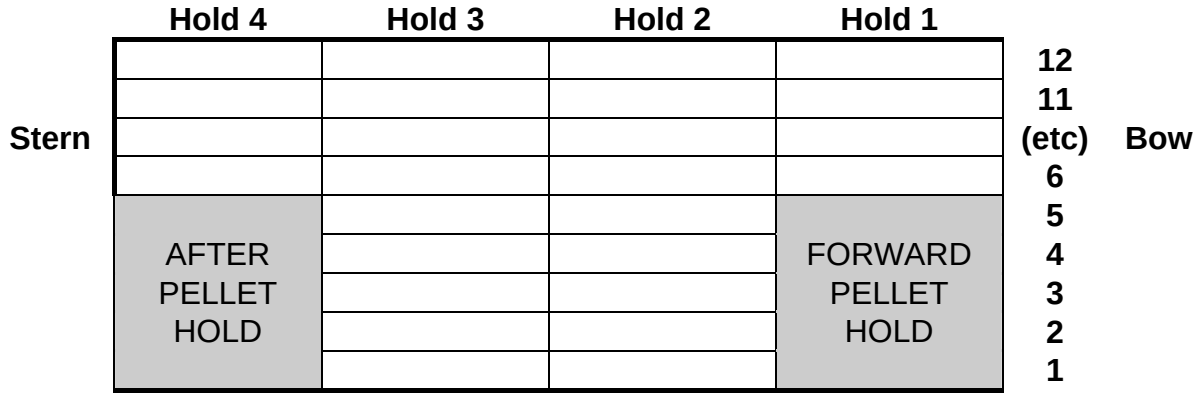
Appendix 1

Schematic Layout of Animal House

Floor plan



Side view



Deck 1cement
Deck 2 –5 steel mesh over wood
Deck 6 cement
Deck 7 steel mesh (broad) over steel
Deck 8 steel mesh over steel
Deck 9 - 11 non-slip (rough particles in bitumen) over steel
Deck 12 sheep deck = wood

Appendix 2

Necropsy form

NECROPSY NUMBER: .....

Date.....Animal ID.....Group.....Age.....

Deck.....Pen.....Condition score.....

PM Interval.....Lab. No.....

History/Clinical signs

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Samples Submitted

In formalin: Adrenal, rumen, abomasum, duodenum, jejunum, ileum, caecum, colon, MLN, spleen, liver, lung, heart, kidney, muscle;

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Gross Necropsy Findings

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Tentative Diagnosis

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