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National Data Recording System for the Live Sheep Export Industry

Report No. 1

January to June 1989

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Contents

Introduction

In recent years, a large research programme has been undertaken in Western Australia and Victoria to define the immediate and predisposing causes of deaths during the export of live sheep from Australia to the Middle East. Part of the programme involved a study of ship Master's Reports for voyages loaded at Fremantle from 1985 to 1988.

Analysis of the Master's Reports identified several factors that contributed to mortality aboard ship, including season (quarter of the year) loaded, voyage duration, ship and deck type (open and enclosed decks).

However, limitations were recognized and it was recommended that a national data recording system be established. The system involves collection of daily mortality according to class of stock and deck on ship and incorporates an interview of the ship's officers on return to Australia after each voyage.

Three types of report are generated from the recording system.

First is a report to the ship's officers immediately after each voyage which contains comparisons of mortality by class, deck, tier, deck type (open and enclosed decks) and other analyses appropriate for that ship.

Second is a report summarizing findings across the industry during a period of about six months that will be distributed to various organizations associated with the livestock export industry.

Third, specific findings will be included in technical reports and scientific publications.

The present report provides summary information on the export of livestock from Australia to the Middle East and South East Asia for the first half of 1989. The report concentrates on sheep but provides some information on the export of goats and cattle (excluding export from the Northern Territory and Queensland).

Numbers of livestock exported

To the Middle East and South East Asia

The numbers of sheep exported in each of the major classes are summarized in Table 1. Of the 2,819,236 sheep exported to the Middle East, 84% were adult wethers. Similar proportions of each class were exported from each port.

By destination country (sheep only)

Saudi Arabia was the largest importer of Australian sheep (Table 2), accounting for about 44% of the total exported in the first six months of this year.

Table 1. The number and class of sheep and the number of goats and cattle exported by sea from Fremantle, Adelaide and Portland in the six months to June 30, 1989.

		Fremantle Middle East	Fremantle SE Asia	Adelaide M. East	Portland M. East	Total
Wethers	- adult	1,061,235	8,460	674,940	611,997	2,356,632
	- hogget	18,116	0	8,159	37,005	63,280
	- lambs	81,842	300	2,898	67,526	152,566
Rams	- adult	37,133	9,750	14,137	17,526	78,546
	- lambs	86,543	0	48,288	21,437	156,268
Ewes	- adult	3,525	170	4,080	3,067	10,842
	- lambs	0	1,102	0	0	1,102
Total	- sheep	1,288,394	19,782	752,502	758,558	2,819,236
	- goats	7,780	152	3,181	3,523	14,636
	- cattle	630	513	941	298	2,382

Table 2. The destination country and number of live sheep exported from Fremantle, Adelaide and Portland in the six months to June 30, 1989.

Country	Fremantle	Adelaide	Portland	Total
Bahrain	35,000	15,250	63,250	113,500
Kuwait	290,505	182,910	213,802	687,217
Oman	90,081	29,008	46,862	165,951
Qatar	153,140	0	8,000	161,140
Saudi Arabia	450,978	508,620	292,929	1,252,527
Singapore	19,782	0	0	19,782
Yemen South	41,940	0	0	41,940
U.A.E.	226,750	16,714	133,715	377,179
Total	1,308,176	752,502	758,558	2,819,236

Mortality rates

Sheep

The mortality figures have been divided into three stages in this recording system. The first stage includes mortalities during the period to the completion of loading. The second stage begins after loading is completed and ceases on arrival at the first destination port. Subsequent mortalities are included in the third stage. Figure 1 shows sheep mortality data from a previous report (Norris and Higgs, 1989) for 1985 to 1988 and from the recording system for the first six months of 1989. The change from using the Master's Report discharge mortality (for 1985 to 1988) to the total mortality after arrival at the first port (for 1989) has the effect of decreasing the 'voyage' mortality and increasing the 'discharge' mortality. Over all stages the result is not affected.

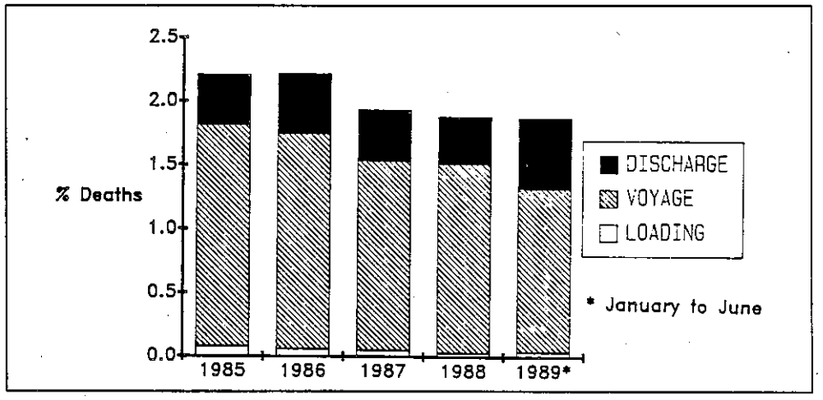

Figure 1. Annual mortality (%) for sheep exported live from Fremantle to the Middle East.

The graph of mortality by class (Figure 2) demonstrates the importance of considering the class of sheep when interpreting any mortality information (see also Table 3).

The mortality rate in any voyage will be strongly influenced by the class of sheep being carried. A vessel carrying a high proportion of hoggets is likely to have a lower voyage mortality than a similar vessel carrying wethers or ram lambs.

Table 3. The percentage mortality by class of sheep for the voyage to the first destination port from Fremantle, Adelaide and Portland.

Sheep		Fremantle Middle East	Fremantle SE Asia	Adelaide* M. East	Portland† M. East
Wethers	- adult	1.28	0.17	0.96	1.66
	- hogget	0.49	n/a		0.48
	- lambs	0.68	0.00		2.25
Rams	- adult	0.80	0.00	1.80	0.17
	- lambs	1.61	n/a		2.06
Ewes	- adult	1.16	0.00		
	- lambs	n/a	0.00	n/a	n/a
Total	- sheep	1.22	0.07	1.02	1.66

* Data from 1 voyage only
† Data from 2 voyages only
n/a Not applicable (no sheep of this class were loaded)

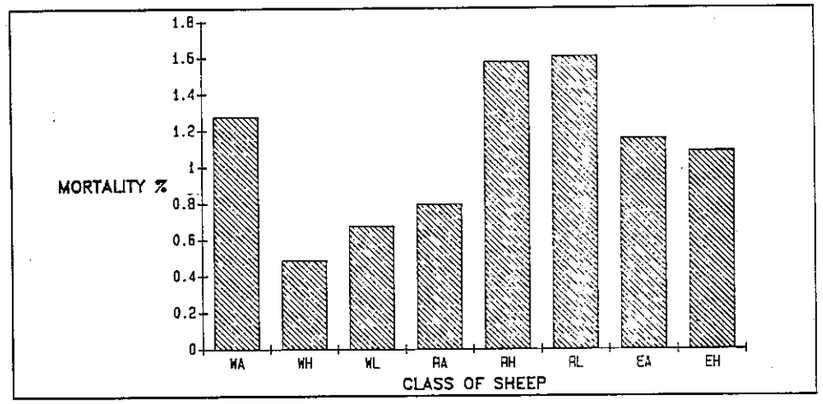

Figure 2. Mortality by class of sheep for 27 voyages from Fremantle to the first port of discharge in the Middle East during the first six months of 1989.
WA = wether adults WH = wether hoggets WL = wether lambs
RA = ram adults RH = ram hoggets RL = ram lambs
EA = ewe adults EH = ewe hoggets

Goats

The format of the Master's Report was changed in 1987 to allow the inclusion of mortality according to species. The results given in Table 4 are incomplete for 1987 as mortality records were not maintained by species on all voyages.

Table 4. The total goat mortality during all stages of shipping (loading, voyage and discharge) from Fremantle, Adelaide and Portland to the Middle East and South East Asia from 1987 to June 30, 1989.

Goats	Fremantle Middle East	Fremantle SE Asia	Adelaide M. East	Portland M. East
1987*				
No. of voyages	5	7		
No. loaded	1,692	703	n/a	n/a
No. dead	14	3		
Per cent dead	0.83	0.43		
1988				
No. of voyages	7	8		
No. loaded	7,653	1,130	n/a	n/a
No. dead	348	30		
Per cent dead	4.55	2.65		
1989 (January to June)				
No. of voyages	8	4	4	3
No. loaded	7,780	152	3,181	3,523
No. dead	373	0	83/1,445 (1)†	183/2058 (2)†
Per cent dead	4.79	0	5.74	8.89

* Data incomplete for this year.
† Number of voyages.
n/a Not available.

Cattle

Cattle are exported from three Western Australian ports (Fremantle, Broome and Wyndham) to South East Asia, with the majority being loaded at the northern ports. All cattle exported from Western Australia to the Middle East are loaded at Fremantle.

On some occasions cattle are included in predominantly sheep consignments from Adelaide and Portland to the Middle East. Cattle are also exported to South East Asia and Japan from other States of Australia. However, summary figures (Table 5) are only provided for ships loaded in Western Australia, Adelaide and Portland. (The data are incomplete for 1987, as for the goat mortality records.)

Cattle mortality rates were much lower than sheep and goat mortality rates in similar voyages to both the Middle East and South East Asia.

Table 5. The total mortality during all stages of shipping (loading, voyage and discharge) to the Middle East and South East Asia from 1987 to June 30, 1989 for cattle loaded at Western Australian ports, Adelaide and Portland.

Cattle	W.A. all ports Middle East	W.A. all ports SE Asia	Adelaide M. East	Portland M. East
1987*				
No. of voyages	8	21		
No. loaded	2,406	7,634	n/a	n/a
No. dead	18	13		
Per cent dead	0.75	0.17		
1988				
No. of voyages	13	29		
No. loaded	4,427	7,303	n/a	n/a
No. dead	19	12		
Per cent dead	0.43	0.16		
1989 (January to June)				
No. of voyages	1	13	4	2
No. loaded	630	3,825	941	298
No. dead	0	5	0/502 (1)†	n/a
Per cent dead	0	0.13	0	

* Data incomplete for this year.
† Number of voyages.
n/a Not available.

Mortality by quarter of the year

Results are shown in Table 6 for all classes of sheep and all stages of shipping (loading to the end of discharge) to the Middle East.

The extra length of voyages from Portland and Adelaide compared to Fremantle must be taken into consideration when direct comparisons of mortality by port of origin are made.

Cumulative death rate increases with voyage duration and therefore may contribute to higher mortality in voyages from Portland and Adelaide compared with Fremantle.

Table 6 contains mortality data for sheep exported from three Australian ports. Different ships make different numbers of voyages from these ports and this must be considered when making direct comparisons between ports.

A statistical comparison of mortality by quarter of the year in which the ship was loaded was made by matching ship, loading and destination ports, class of sheep (wethers) and number of voyages for each ship. There was no difference in the mortality rates between the first and second quarters of the year for ships loaded in Fremantle.

Table 6. Mortality for all stages of shipping (loading, voyage and discharge) and all classes of sheep loaded at Fremantle, Adelaide and Portland for the first and second quarters of 1989.

All sheep	Fremantle	Adelaide	Portland
January to March			
No. of voyages	13	5	5
No. loaded	648,638	365,038	469,223
No. dead	12,551	7,406	9,825/398,956 (4)†
Per cent dead	1.93	2.02	2.46
April to June			
No. of voyages	18	6	5
No. loaded	639,755	387,464	289,335
No. dead	11,749	3,553/264,162 (4)†	2,598/103,177 (1)†
Per cent dead	1.84	1.35	2.52

† Number of voyages.

Mortality by ship (for adult wethers)

For comparison between ships, death rates in one class of sheep to the first port in the Middle East were considered. Results for each port of origin may vary due to differences in the voyage duration and possibly other factors. Therefore, the results are presented separately and refer to voyages loaded at Fremantle (Table 7a), Adelaide (Table 7b) and Portland (Table 7c).

The excellent record of ship 12 is consistent with previous analyses of Master's Reports. The reasons may be that the wethers carried were predominantly young adults (three years old) and the voyage duration was relatively short.

Table 7a. Number of voyages in low, medium and high mortality rate categories (wethers only, to first port of discharge) for ships loaded at Fremantle.

Ship (code)	Mortality rate Low < 1.0%	Medium 1.0 - 2.0%	High > 2.0%	Total
1	2	1	1	4
2	-	1	-	1
3	-	1	-	1
4	-	-	3	3
8	1	-	-	1
9	-	2	1	3
10	-	4	-	4
11	-	1*	-	1
12	4	-	-	4
14	1	1	1	3
15	3	1	-	4
20	-	1*	-	1
23	-	1	-	1
Total	11	14	6	31

* Includes mortality for all classes of sheep loaded.

Table 7b. Number of voyages in low, medium and high mortality rate categories (all classes of sheep, to first port of discharge) for ships loaded at Adelaide.

Ship (code)	Mortality rate Low < 1.0%	Medium 1.0 - 2.0%	High > 2.0%	Total
2	1	-	-	1
7	-	1	-	1
8	1	-	-	1
10	-	1	-	1
11	-	1	-	1
13	-	1	-	1
20	1	1	-	2
27	1	-	-	1
Total	4	5	0	9*

* Data was available for 9 of the 11 voyages made from Adelaide.

Table 7c. Number of voyages in low, medium and high mortality rate categories (all classes of sheep, to first port of discharge) for ships loaded at Portland.

Ship (code)	Mortality rate Low < 1.0%	Medium 1.0 - 2.0%	High > 2.0%	Total
2	-	1	-	1
3	-	1	1	2
11	-	-	1	1
23	-	-	1	1
Total	0	2	3	5*

* Data was available for 5 of the 10 voyages made from Portland.

Spatial pattern of mortality

By comparing death rates in different areas of the ship an assessment can be made of the extent and significance of ship factors in the cause of mortality.

It is anticipated that estimates of the cost of extra mortality in enclosed decks, upper tiers and any other areas of importance will be provided in a future report when their significance has been determined.

Valid comparisons were not possible for all voyages because the same class of sheep was not loaded in each of the areas being compared.

Deck

Examination of mortality records collected by deck and tier has not so far revealed any consistent pattern for individual ships. Large ranges of mortality between decks (for one class of sheep) have been seen in some voyages (range 0.8% to 9.1% in one voyage). Records from other voyages of the same ship have not shown such a large range of mortality rate. Mortality was not consistently high or low on the same deck between voyages.

However, it is likely that inadequate ship design will contribute to increased mortality during extreme weather conditions. Ventilation efficiency becomes important during periods of high temperature and humidity and may be limiting on some decks but not others.

On one ship a sudden rise in mortality on one deck corresponded to an increase in temperature from 27°C to 35°C. About 46% of the total voyage mortality for this deck occurred on that day but the mortality on other decks increased only marginally.

Investigation revealed that although this deck was almost completely enclosed the ventilation was entirely passive. Two other voyages of this ship did not show the same high mortality on this deck but the temperature and relative humidity did not rise above 30°C and 85% respectively.

Further records of mortality from voyages conducted during periods of high temperature and humidity will help clarify this area.

Open and enclosed decks

Wether mortality rates for open and enclosed decks are summarized in Table 8.

Death rates in enclosed decks were frequently greater than in open decks, during the middle and late stages of voyages to the Middle East (Figure 3). The data supplied in the Master's Report gives some indication of the day-to-day variation in temperature and relative humidity.

In the example shown (Figure 3) there was no sudden change in either temperature or relative humidity as recorded in the Master's Report. However, the daily ranges of both temperature and relative humidity are not well described by such simple records.

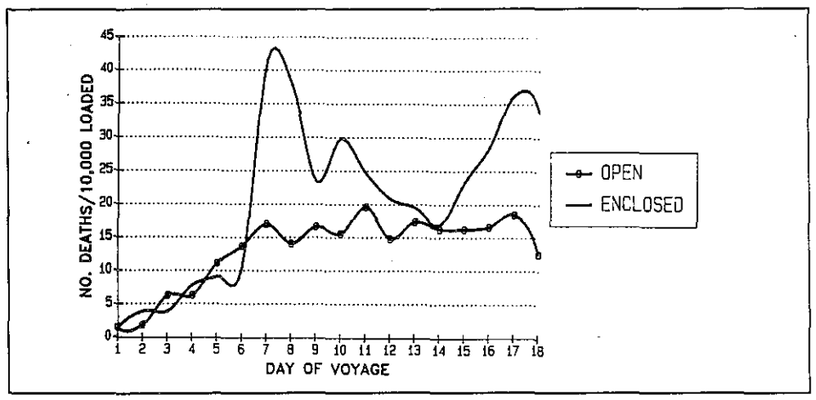

Figure 3. Wether mortality by deck type and day (ship 9) for a voyage to the Middle East.

Typically, the range of both parameters will decrease around a higher average value during the period near the equator and in the Persian Gulf (during the northern hemisphere summer).

It is difficult to gain an indication of the daily weather conditions over each 24 hour period from one reading of each of temperature and relative humidity. In addition, there will be some variation in the ambient conditions in different parts of the ship. The role of temperature and relative humidity, in the cause of mortalities aboard ship, should therefore not be discounted when sudden rises are not recorded in the Master's Report.

Table 8. The number of shipments by vessel where wether mortality to the first port was higher (P < 0.05), similar (P > 0.05) or lower (P < 0.05) for deck type (open/enclosed).

Ship (code)	Relative mortality rate between deck types			
	Open>enclosed	Not different	Enclosed>open	Totals
1	1	2	1	4
4	-	1	1	2
8	-	-	1	1
9	-	1	2	3
12	-	4	-	4
14	-	-	3	3
15	-	1	3	4
Total	1	9	11	21

Upper and lower tiers

Comparisons of mortality in upper and lower tiers included only decks loaded with one class of sheep (usually adult wethers).

Results across the industry suggest that the higher mortality rate in upper tiers (the "tier effect") was not consistent between ships, between decks, or between successive voyages of the same ship. However, there were more voyages with significantly higher mortalities in the upper tiers than voyages with significantly higher mortalities in the lower tiers (Table 9).

Mortality in upper and lower tiers was matched for class (wethers) on three voyages of one ship (3). Of the 16 tier comparisons possible, mortality rates were significantly higher in the upper tiers in seven and not significantly different in nine. Mortalities were about 50% greater in the upper tiers on those occasions when a significant difference was found.

Table 9. The number of shipments by vessel where wether mortality to the first port was higher in upper tiers (P < 0.05), not different (P > 0.05) or higher in lower tiers (P < 0.05).

Ship (code)	Relative mortality rate between tiers			
	Upper>Lower	Not Different	Lower>Upper	Totals
1	-	1	1	2
3	2	1	-	3
4	-	3	-	3
8	-	1	-	1
9	1	1	1	3
10	1	2	-	3
14	2	1	-	3
15	1	3	-	4
23	1	-	-	1
Total	8	13	2	23

Forward and aft sections

Results of mortality by class of sheep and section of the ship were recorded on three vessels.

The mortality was higher in the forward section on two voyages (P < 0.05), not different on five voyages (P > 0.05) and higher in the aft section on one voyage (P < 0.05). No consistent pattern has emerged for any individual ship.

The daily mortality in forward and aft sections on one voyage is shown in Figure 4. This graph is similar to Figure 3, which shows mortalities in open and enclosed decks for another ship.

Unfortunately no data is available for a comparison of temperature, humidity or airflow between the two sections of the ship. Ventilation of the forward and aft sections of the ship, particularly in the open decks, may differ depending on the ship's course and the wind speed and direction.

Further examination of the mortality records in forward and aft sections, supplemented with temperature, relative humidity and wind data will be needed to clarify this area.

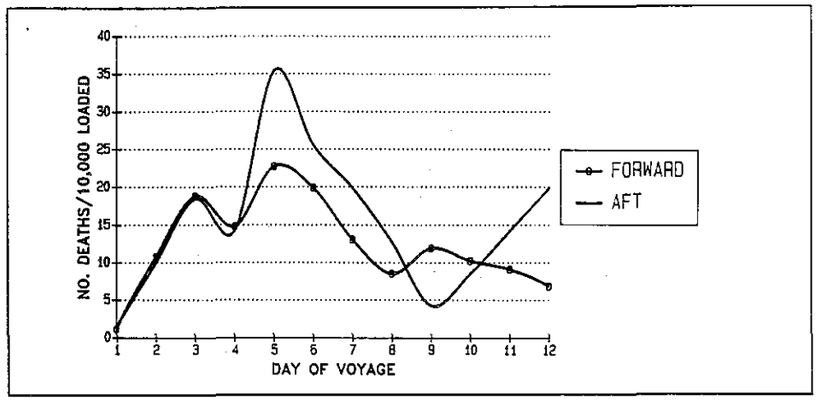

Figure 4. Wether mortality by day and section (ship 1) for a voyage to the Middle East.

High mortality voyages and epidemic spikes

The high but decreasing mortality during the first six days at sea of one shipment from Portland (Figure 5) suggested a carry-over problem emanating from the feedlot. Further investigation indicated that feedlot mortalities were increasing to rates approaching 20 per 10,000 sheep per day. Salmonellosis was the major cause of death both in the feedlot and aboard ship.

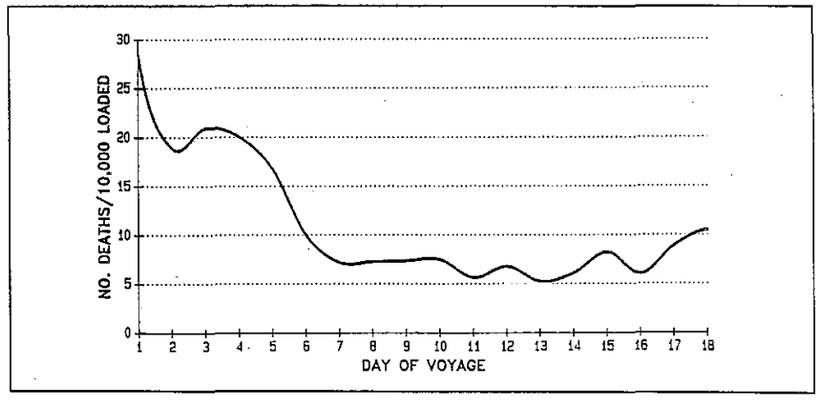

Figure 5. Sheep mortality by day for a voyage (ship 3) from Portland to the Middle East.

The graph of mortality by day for a voyage from Portland (Figure 6) showed a marked rise in mortality on day 9, with a subsequent decrease to a level lower than that recorded earlier in the voyage.

Mortalities are recorded in the morning on each day of the voyage. Therefore, mortalities recorded on day 9 correspond to deaths which occurred during the day and night of day 8. The cause of this epidemic should therefore be sought in the days prior to and including day 8.

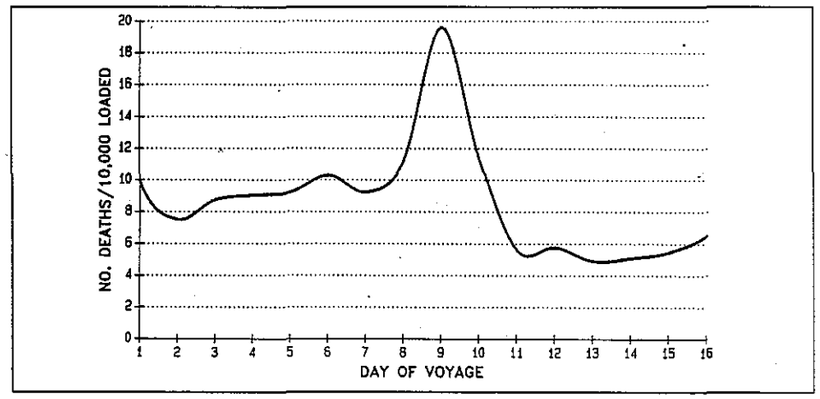

Figure 6. Sheep mortality by day for a voyage (ship 3) from Portland to the Middle East.

Three factors considered in attempting to explain the increase in mortality on day 9 were spatial distribution, ambient environment and the use of antibiotics. First, the increase in mortality was evenly distributed across the sheep-house. Second, the sheep-house temperature rose by 5°C to 30°C on day 8 with humidity remaining at or above 92% from days 6 to 9. Third, antibiotics were added to the drinking water on all decks on days 6, 7 and 8.

Examination of Master's Reports has shown that sudden rises in temperature, in combination with high humidity, have corresponded to sudden increases in mortality rates. Also, five of 41 shipments in which antibiotics were used had two to six-fold increases in mortality after two days of treatment. Of the remaining shipments which used antibiotics, 26 showed no reduction in mortality and 10 showed a decrease in mortality.

The cause or causes of the epidemic in this case have not been determined. However, a possible explanation is that the contributing factor(s) advanced the death of sheep that were likely to die in the following few days. This would explain the reduced mortality rate seen subsequent to the sudden increase in mortality. The same phenomenon was seen in a voyage of ship 9 (Figure 4, aft section).

Discharge mortality

Factors that may influence mortality include the class of sheep being discharged, the duration in port, the ship being discharged and the time of year.

The significance of this stage of the export process is highlighted by the effect on the total mortality results. On one voyage of ship 15, with a single port discharge, 58% of the total mortalities occurred during the period after arrival at the destination port.

The summary figures in Table 10 show a large range in mortality at port 5. Discharge is often prolonged at this port (Norris and Higgs, 1989). Average discharge rates of 400 sheep per hour for whole consignments were recorded during the report period.

In contrast, records of discharge at port 8 show rates of up to 2,500 sheep per hour for whole consignments. The export of young wethers to port 1 is likely to contribute significantly to the low result for discharge at that port.

Table 10. The number of shipments by port of discharge (single port voyages only) in low, medium and high death rate categories during discharge.

Port of discharge (code)	Discharge mortality rate < 0.1%	0.1 to 0.5%	> 0.5%	Total%
1	2	2	-	4
2	-	-	1	1
4	-	5	1	6
5	1	2	1	4
8	-	2	1	3
9	-	1	-	1
Total	3	12	4	19

Table 11. Total discharge mortality rate and range by port of discharge for single port voyages only.

Port of discharge (code)	Discharge mortality rate Total%	Range%	Number of voyages
1	0.10	0.03 - 0.24	4
2	1.09		1
4	0.41	0.29 - 0.63	6
5	0.41	0.03 - 0.86	4
8	0.34	0.26 - 0.57	3
9	0.42		1
Total	0.39	0.03 - 0.86	19

Research update

This is the first issue of the NDRS Report, so a general update of research is presented rather than the results of specific trials and experiments.

Research conducted over the last five or six years in Victoria, South Australia and Western Australia has given a very clear definition of the animal health problems associated with transporting live sheep by sea.

The major source of loss between the farm gate and delivery at overseas ports is the deaths during the shipping phase. The major causes of death on board ship are persistent failure to eat (inanition) and salmonellosis.

The major indirect indicator for deaths from both of these causes is failure to eat pellets in the feedlot (shy-feeding).

The largest source of variation in shipboard death rates is the farm of origin (line) of the sheep. Death rates of up to 20% have been recorded in individual lines of sheep.

A number of things will modify the shipboard death rate, including:

- Trough length and position in the feedlot.
- Feeding hay in the feedlot. This delays adaptation to pellets and encourages the spread of salmonellosis.
- Loading sheep onto the ship. Some 85% of feedlot shy-feeders start eating when they are loaded so it would be unwise to withold all shy-feeders from export.
- The ship. Some ships have consistently high death rates and others have consistently low death rates.
- Duration of voyage and ports of call. The longer the voyage and the greater the number of ports of discharge the greater the death rate in non-discharged sheep.
- Tier. There is a much higher death rate in upper tier pens on some ships on some voyages.
- Salmonellosis. The proportion of deaths from salmonellosis on board ship is low in some voyages and high in others; research suggests that conditions and length of time spent in the feedlot are largely responsible.

Recent research has investigated the reasons for high death rates in some lines of sheep. Preliminary results in both Victoria and Western Australia suggest that there is no regional source effect, neither does there appear to be a connection with the distance sheep are trucked to the feedlot.

However, one or two factors have been identified.

Sheep that die of inanition on board ship are much fatter than sheep that die for other reasons. Recent work has shown that the fattest lines of sheep tend to have the highest death rates during shipping and there is also evidence that fat sheep within lines have an increased risk of death.

Age of sheep and season of the year are involved. Hoggets have much lower death rates than older wethers and shipboard death rates are much higher in the second half of the year than in the first half.

There are no doubt other reasons for high death rates in some line of sheep and research is now directed at finding those reasons. A vaccine for salmonellosis is being tested and initial results are promising.

Published studies

A number of studies relevant to the live sheep export industry are published in the scientific literature. This list is not intended to b complete but includes some recent publications for those who seek further technical information.

McDonald, C.L., Rowe, J.B., Gittins, S.P., Smith, J.A.W. (1988). Feed additives for attracting sheep to eat a pelleted diet during assembly for live export. *Australian Journal of Experimental Agriculture* **28**: 719-23.

Norris, R.T., Higgs, A.R. (1989). Shipboard mortality in sheep exported live from Western Australia to Singapore and the Middle East in 1988 - analysis of Master's reports. Western Australian Department of Agriculture.

Norris, R.T., Richards, R.B. (1989). Deaths in sheep exported by sea from Western Australia - analysis of ship Master's reports. *Australian Veterinary Journal* **66**: 97-102.

Richards R.B., Norris R.T., Dunlop R.H., McQuade, N.C. (1989) Causes of death in sheep exported live by sea. *Australian Veterinary Journal* **66**: 33-38.

Round, M.H. (1989). Effects of duration of introductory feeding a barley content of pelleted diets on the feed intake and liveweigl of export sheep. *Australian Journal of Experimental Agricultur* **29**: 169-172.

Acknowledgements

Many people assisted in the collection of this information and I a indebted to the ships' Masters and Officers who willingly documented the data.

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The exporting and shipping companies gave their support in launching the system and I am grateful for their contribution.

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