liveexport

Assessing the welfare and feeding behaviour of horned and polled sheep and cattle during export

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Abstract

The social and feeding behaviours of sheep and cattle segregated according to whether they had horns were investigated during live shipment, to determine the effects of mixing animals with and without horns within specification. Two voyages, one each of Merino sheep and *Bos indicus*-cross cattle, were monitored using video surveillance and retrospective analysis of footage from specific times to determine the number of interactions and feeding events within two pens each of polled, horned (up to one full curl in sheep or 12cm in cattle), and mixed animals. Concurrently, shipboard personnel recorded behaviour, daily feed intake, daily injury, death and disease of these animals. There was no evidence from the video footage that mixing polled and horned animals within specification resulted in negative health or behaviour outcomes for these animals. This was also the conclusion from the real-time observations made by shipboard personnel, although there were some differences in absolute number of interactions recorded by the two methods. Further observational studies of similar design were conducted on 15 short haul cattle voyages with shipboard personnel recording behaviour, daily feed intake, injury and death of animals in the experimental pens. Eleven of these voyages yielded data for analysis, and there was no indication from the records of any difference between experimental pens. The data collected thus supported the original interpretation of the Australian Standards for the Export of Livestock such that animals with horns within specifications did not need to be segregated from polled animals. This project also developed a successful technique for long term video monitoring of shipped animals.

Executive summary

This project was initiated by MLA and LiveCorp in response to industry concern regarding the re-interpretation of the section of the Australian Standards for the Export of Livestock which considered the transporting of sheep or cattle with and without horns. The original interpretation of this standard allowed animals with horns within specification (cattle - less than 12 cm and blunt, and sheep - less than one full curl and a shape that will not cause eye damage or restrict feeding) to be transported mixed with polled animals, if that was appropriate. However, the Australian Quarantine & Inspection Service (AQIS) uncovered an anomaly where, although it allowed the mixing of horned animals within the specification for selection, the standards for land transport, assembly and loading, and shipboard transport, stipulated the segregation of “animals with, from animals lacking horns”.

The assumption always was that “animals lacking horns” meant horns within specification as intended in the original industry standards and best practice. However, as a result of the re-interpretation, sheep and cattle were segregated according to whether they were polled or not throughout the live export process, which could require additional drafting, separation of previous social groups, and remixing with other animals. It was considered by industry that the additional handling and mixing required to segregate the animals could create added stress and risk of injury.

This project used both retrospective viewing and analysis of video recordings and real-time observation by on-board veterinarians or stockmen, made on commercial sheep and cattle shipments, to record the number of interactions occurring in 2 pens each of polled, horned, or mixed animals. The video system used allowed recording for the duration of a long-haul voyage, with two cameras set per pen to record a frame every 30 seconds. One sheep shipment and one cattle shipment were recorded, and the number of interactions counted at specific times on the video recording compared between groups, finding that there were no negative effects of mixing polled animals and those with horns within specifications. Recordings from real-time observation found similar results in the between group comparisons, although the number of interactions recorded in real-time were generally less than those seen on the video, and the correlations between the two methods were low for these two shipments. Fifteen other shipments used only real-time observations, of which 11 had usable data, and again there was no indication that mixing the animals had detrimental effects either on interactions or feeding behavior of the groups.

This is the first time video recording has been used in commercial long-haul voyages, and proved that useful data can be collected in this way over many days. The recorded data lost some detail but was adequate for this project; it would not be of sufficient quality to identify individual animal expressions, for instance.

The design of the project and the realities of videoing a commercial shipment, with only one videoed shipment of each species, and only one real-time observer to compare the video data to, did not allow a conclusion to be reached about the overall accuracy of real-time counting of interactions in pens of animals. A different project, which need not be on ship, could be conducted to compare the ability of various people to assess interactions in real-time compared to those interactions recorded on video.

However, there were no indications from this work that further evaluation of the behavior and welfare of mixed polled and horned animals under these specific conditions needed to be conducted, with all

methods agreeing that the between-group comparisons showed no detrimental effects on the mixed groups compared to the segregated groups.

This work thus supports the original interpretation of the guidelines, that with due consideration of other factors that influence dominance behavior in groups of animals, animals with horns within specifications may be transported on live export vessels mixed with polled animals.

Contents

1 Background

1.1 Reasons for project

The Australian Standards for the Export of Livestock (ASEL) gives guidelines for the management of horned and polled sheep and cattle during the live export process. One aspect of the Standards relates to the specification regarding horned animals selected for export. It was the opinion of the Live Export Standards Advisory Committee (LESAC) that animals with horns within nominated specifications: cattle - less than 12 cm and blunt, and sheep - less than one full curl and a shape that will not cause eye damage or restrict feeding, could be mixed in pens on board ship and on road transport. This practice has been undertaken in the industry since its inception. Animals with horns exceeding specification were still permissible on a case by case basis, but had to be segregated and attracted some added restrictions, especially with respect to stocking density.

The rationale behind the Standard was that within the environs of a livestock vessel, horns within that specification would not hinder loading or animal welfare. However, some time after the Standard was implemented, a re-interpretation by the Australian Quarantine & Inspection Service (AQIS) uncovered an anomaly where although it allowed the mixing of horned animals within the specification for selection, the standards for land transport, assembly and loading, and shipboard transport, stipulated the segregation of “animals with, from animals lacking horns”. The assumption always was that “animals lacking horns” meant horns within specification as intended in the original industry standards and best practice.

However, as a result of the re-interpretation, sheep and cattle were segregated according to whether they were polled or not throughout the live export process, which could require additional drafting, separation of previous social groups, and remixing with other animals.

It has been considered by those involved in the industry that this additional handling and mixing can create added stress and risk of injury to the animals. For instance, drafting prior to transport is a stressful procedure, causing a significant increase in plasma cortisol levels (Hargreaves *et al.* 1990). Also of consideration are the finite options for separation of groups of animals, with the concern that other animal factors which may have greater impact on social interaction within groups could not be accommodated if animals had to be segregated according to whether they were horned or not.

The industry felt that these other considerations had sufficiently important impacts on the well-being of exported animals to warrant an investigation of the potential for injury and harm within mixed groups of animals. Mixed groups of animals, some with and some without horns (within specification) were compared to segregated groups, with a view to returning to the original interpretation of the Standards if there was no indication that mixing had negative effects on the animals.

1.2 Social dominance

Within a group of production animals, social dominance is recognised as the most important component of social behaviour (Beilharz and Zeeb 1982), permitting the living together of groups of

animals (Crook, 1970). Within a pair of animals the behaviour of one may be inhibited by the other; such inhibition of one animal is possible in all possible pairs of animals in a group (Beilharz and Zeeb 1982). The direction of dominance in any pair of animals is usually initially determined by one or more aggressive interactions (Houpt, 1998), and learning is involved in maintenance of the relationship. The dominance order over the whole group is the sum of all the separate pairs of relationships (Hassenstein 1980).

The development of a social hierarchy is extremely stressful for the animals involved, indicated by increased activity of catecholamine – synthesising enzyme (Mounier *et al.* 2005). In addition to physical injury, cattle and sheep have been found to suffer from lack of rest and time lying down because of the general turmoil (Jarvis and Cockram 1995*)*. The normal pattern of standing and lying down as a group does not emerge for at least 48 hours after the group is formed. Within an established hierarchy, subtle threats replace violence in competitive situations (Houpt 1998). The animals that were most aggressive in the past to obtain their dominant positions need not be aggressive once their position is established (Beilharz and Zeeb 1982). Kondo and Hurnick (1990) found that it takes at least 4 days after strange cows are mixed that non physical (threats) replace physical interactions.

There are many factors favouring one animal over another in the initial encounter, and the possession of horns is just one of these factors. Horned animals have been found to dominate polled animals (Woodbury 1941; Bouissou 1972; Beilharz and Zeeb 1982). Other factors include age, body weight, breed, sex, and seniority in the group. There is a high correlation between social rank, body weight, and age (Beilharz *et al.* 1966; Syme and Syme 1979), with older animals (which are usually the heavier) being involved in more fights (usually between themselves), initiating more movements and showing more attention behaviours (Stolba *et al.* 1990). Heavier cattle will dominate the lighter ones (Bouissou 1965; Beilharz *et al.* 1966; Bouissou 1972; Syme and Syme, 1979), and dominance value of sheep may be positively correlated with liveweight and chest girth (Lobato and Beilharz 1979), although Houpt (1998) found that dominance was not related to weight in a group of sheep of similar age. Breed of animal may affect dominance, due perhaps to temperament as well as physical factors such as weight and height (Bouissou 1965; Purcell and Arave 1991; Grandin 1998), and male animals are usually more aggressive than the females (Soffie *et al.* 1976).

The interaction that occurs to establish and maintain a dominance hierarchy therefore has implications for psychological and physiological stress, and injury of animals. If some animals have horns and some do not, there is a concern that the potential for injury is greater than if the animals are physically matched. An alternative view is that if all the animals are similar, it will take longer for the hierarchy to be established, with resultant increase in physical interactions, and perhaps stress and injury, while that occurs. Houpt (1998) found that equally matched cows may fight for long periods, interrupting active aggression to rest in clinches, and in dominance tests the number of fights was significantly higher in the single sex, single age groups (Stolba *et al.* 1990).

If animals are maintained in constant social groups with previously established hierarchies, there should be little reason for aggressive interaction. However, situations of limited feed or restricted space for feed, water or rest may lead to dramatic increases in competition and aggression compared to when the resource is freely available (Lutz 1981 in Canali *et al.* 2001; Kongaard, 1983; Kondo and Hurnick 1990; Olofsson 1999). Under high stocking rates, avoidance is physically impossible, causing subordinates to undergo repeated alerting or alarm reactions, increased inter-animal aggression and potentially harmful mounting behaviour (Syme and Syme 1979; Metz and

Mekking 1984; Tennessen *et al*. 1985; Keeling and Duncan 1989; Kondo *et al.* 1989). Therefore, regardless of the make-up of the groups of animals, it is important to provide sufficient feed and space for all animals.

Thus there are many factors to consider in aiming for the optimum social management of animals within the live export process: those that can affect interactions between animals in a group; the potential for injury if animals are relating aggressively within a group as they establish and maintain dominance and the time it takes to produce a stable hierarchy; additional handling and drafting and mixing; the finite options for segregation of animals; as well as provision of adequate resources for all animals within the group.

This project was developed specifically in responses to the changed interpretation of the Standards with regard to the segregation or mixing of animals with horns, and compared groups of horned animals with polled animals, and with groups of mixed polled and horned animals, both sheep and cattle, using observation both in real time and retrospectively of video recordings.

2 Project objectives

2.1 Project objectives

1. Complete a review of all relevant literature pertaining to the behaviour, welfare and management of sheep and cattle with and without horns.
2. Evaluate the behaviour of mixing or segregating horned and polled sheep or cattle during commercial livestock sea voyages.
3. Make recommendations on the management of sheep and cattle on the basis of horns during the live export chain.

3 Methodology

3.1 General methods

3.1.1 Definition

In this study, horned animals are defined as cattle with a horn length less than 12cm or sheep with a horn length less than one full curl and a shape that will not cause eye damage or restrict feeding. Polled animals are those lacking horns.

3.1.2 Video Recording of Shipments

One sheep shipment and one cattle shipment from Fremantle, WA, were monitored through video recording of animals in the experimental pens, with the footage from the voyage viewed and analysed subsequently.

3.1.3 Video Equipment

The long period of continuous monitoring required for the duration of a voyage dictated the type of equipment that could be used, and a surveillance system was chosen. Two cameras (Digital CCD Colour Dome Camera, JayCar Western Australia QC3290) were fitted for each experimental pen, facing inwards from two different sides of each pen to capture as much detail as possible (Figure 1, 2). The cameras were attached to an enclosed polycarbonate box in which the connecting wires could be safely packed, then the unit was stuck onto the pen wall using silicon sealant. Each camera unit had a cable providing power, and a coaxial cable connecting it to the digital video recorders (DVRs). The cameras were initially set and launched using a Video Server computer programme to ensure they were facing the correct direction and focused, then set to record a frame every 30 seconds for the duration of the voyage.

The cameras were removed and the recording from the DVRs retrieved after the voyages. The recording was viewed directly from the DVR via a laptop using the Video Server viewing programme, which included a digital timer for all footage, so the correct sections could be viewed.

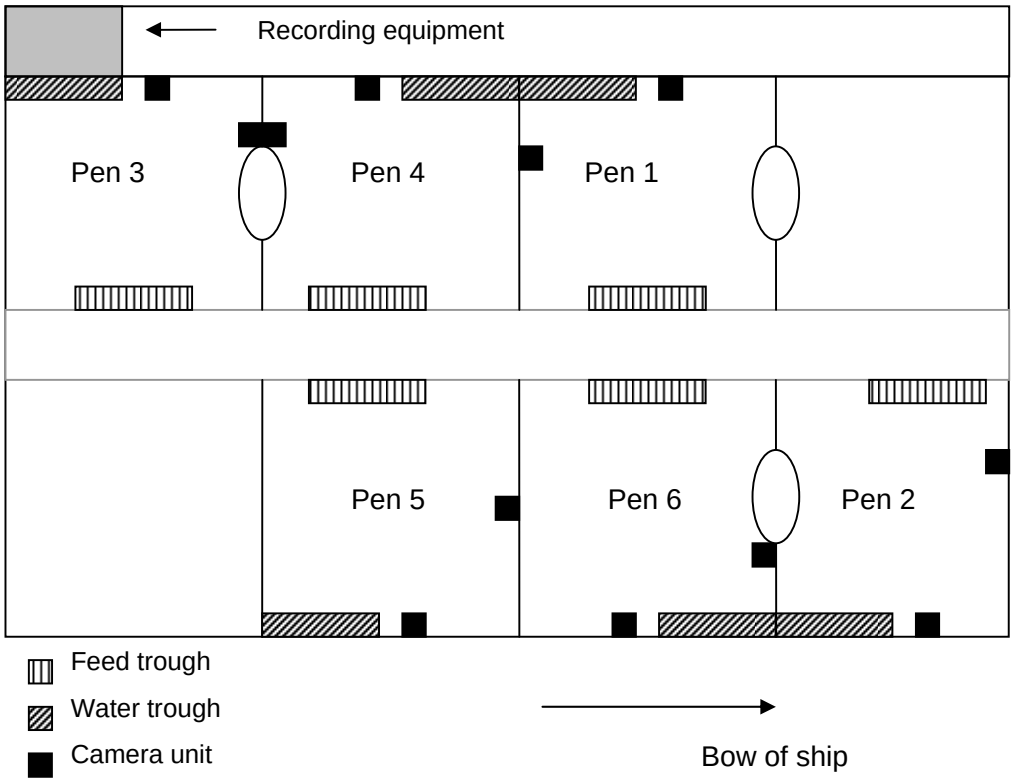

Figure 1. Layout of experimental pens on live export ship

Figure 2. Experimental pens and surveillance cameras on the ship. Cameras are circled.

For the sections of video viewed, the following records were made for both sheep and cattle pens:

- Number of feeding events: Number of animals that put head in feeder during the monitored time period.
- Number of animals lying down: Number of animals that lay down during the monitored time period.
- Number of physical interactions:
    - Number of mounting events.
    - Number of pushing events: Number of times an animal pushed passed another animal.
    - Number of bunting events: Number of times an animal pushed or bunted another animal with its head (on either the side or head-to-head).
- Number of non physical interactions (threats): A display of threatening behaviour leading to the recipient animal retreating.
- Difficulty in putting head in feeder due to horn length (horned and mixed pens).

3.1.4 Real-time Observations

A detailed proforma was developed for use by stockmen and veterinarians to record the behaviour and interactions of the animals (Appendix 1). The proforma included instructions on experimental procedure; however, shipboard personal were also briefed by the project investigator prior to the shipment for further explanation of the methodology.

The experimental animals were observed for five minutes three times per day, just after feeding out in the morning and afternoon, and in the middle of the day. These observations took place on the first four days, on 2 days thereafter midway through the voyage, and then on the day prior to unloading at the destination port. Video footage for these times was also viewed and numbers of interactions counted for comparison.

Behavioural observations were similar to those made using the video footage:

- Number of physical interactions (sum of number of pushes, mounting and bunting)
- Number of non physical threats (sum of non physical threatening behaviour causing the other animal to retreat)
- Number of feeding events
- Difficulty in putting head in feeder due to horn length (horned and mixed pens)

Daily injury, mortality and disease were recorded in each of the experimental pens during the voyage. Dry bulb temperature, humidity, wet bulb temperature and any problems with ventilation were also recorded daily. Daily feed intake (total per pen) was recorded. Shipboard personnel that were designated to record results from the trial were also asked for any additional general comments on the proforma and the trial.

3.2 Sheep Shipment

A commercial live shipment of sheep from Fremantle in January 2007 was used for the video recording. 255 four-tooth Merino wethers, from southern Western Australia, were assigned to the experiment. The sheep averaged 61 kg, condition score 2-3, and they were penned according to whether they had horns, at stocking rates that gave them the minimum pen area of 0.367 m^2/ head (ASEL 2006), as shown in Table 1.

Table 1. Pen treatment according to horn character of wethers during live shipment

Pen Number	Pen size (m^2)	Number of sheep in pen	Horn character of wethers
1	15.45	42	Mix of polled and horned
2	15.45	42	Mix of polled and horned
3	15.76	43	Horned only
4	15.76	43	Horned only
5	15.60	43	Polled only
6	15.45	42	Polled only

All pens were single tiered, enclosed and ventilated and were next to one another.

The sheep were fed a standard sheep shipper pellet at 2.2% body weight (as fed). Sheep are normally fed via automatic feeders while onboard; however, for purposes of monitoring feed intake,

feed was given manually twice a day in experimental pens. Water was available *ad libitum* in automatic watering troughs.

The cameras recorded continuous footage from when sheep were loaded (31st December; 1400 hours) till the end of the voyage, when sheep were unloaded upon reaching the Middle - East (16th January 2007; 1130 hours).

Video footage was viewed for days 1, 5, 10 and 15 for 15 minutes 4 times a day at 000; 0600, 1200 and 1800, and the observations recorded for each pen.

3.3 Cattle Shipment

A commercial live shipment of cattle from Fremantle in July/August 2007 was used for the video recording. Forty-two *Bos indicus* x *Bos taurus* bulls from Western Australia were assigned to the experiment. The bulls averaged 425 kg, condition score 3-4, and they were penned according to whether they had horns, at stocking rates that gave them the minimum pen area of 2.2 m^2/ head as shown in Table 2. This stocking rate was 20% less than the ASEL (2006) standard, due to the time of the year, with hot conditions expected during the voyage. Coincidentally, the pens were the same ones that had been used in the sheep experiment.

Table 2. Pen treatment according to horn character of cattle during live shipment

Pen Number	Pen size (m^2)	Number of cattle in pen	Horn character of cattle
1	15.45	7	Mix of polled and horned up to 12cm
2	15.60	7	Mix of polled and horned up to 12cm
3	15.76	7	Horned only (up to 12cm)
4	15.76	7	Horned only (up to 12cm)
5	15.60	7	Polled only
6	15.45	7	Polled only

Animals were fed a standard shipper pellet at 3% body weight (as fed). Water was available *ad libitum* in automatic watering troughs.

The cameras recorded continuous footage from when cattle were loaded (22nd July; 2100 hours, d0) until d13 of the voyage (4th August 2007), 2 days before reaching the destination port. The decision was made by the shipboard veterinarian to end the video monitoring at that time because the gates were opened between replicate pens to allow more room for cattle to move around, due to the hot conditions experienced during the voyage. Allowing the cattle to move freely between the pens is a standard response under such conditions.

Video footage was viewed for days 1, 3, 5, 7 and 10, for 15 minutes 4 times a day at 000; 0600, 1200 and 1800.

3.4 Observation-Only Shipments

Fifteen short- and long-haul cattle shipments nominated to be part of the experiment, with onboard stockmen using the proforma as previously described for real-time observations of cattle which had been penned as follows on each shipment:

- 2 pens of polled and horned animals, horns up to 12 cm
- 2 pens of only horned animals, horns up to 12cm
- 2 pens of only polled animals

Cattle were fed manually each day to enable determination of daily feed intake per pen.

4 Results and discussion

4.1 Sheep Shipment

4.1.1 Voyage Details

The shipment departed Fremantle on the d 0 and stopped to unload at two ports (Muscat d 11 and Bahrain d 13) before the remaining sheep, including the experimental sheep, where unloaded at the final destination port in Kuwait (d 16).

Wet bulb temperature during the voyage reached a maximum daytime average of 28˚C on d 9 (Figure 3).

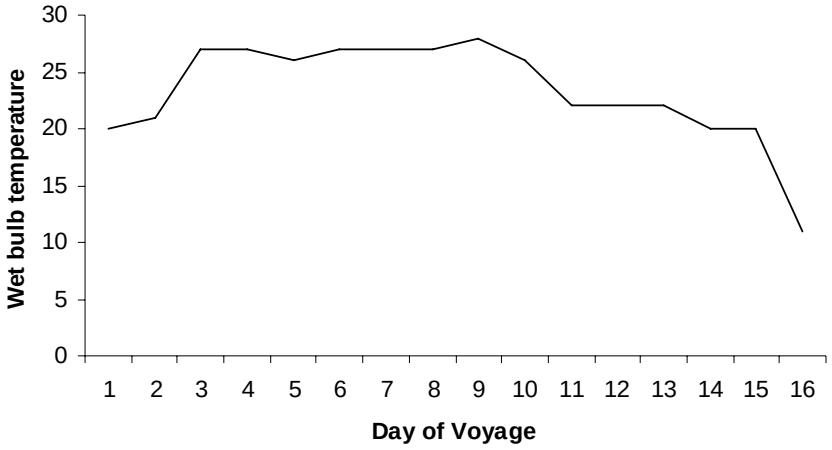

Figure 3. Wet bulb room temperature during sheep voyage

Total mortality rate for the shipment was 0.47%. There were no mortalities in the experimental pens. No injuries resulted from physical interactions within any of the experimental pens.

Feed intake (per day) was between 70 and 100% of offered feed during the voyage (Figure 4). There was no significant difference in feed intake between groups.

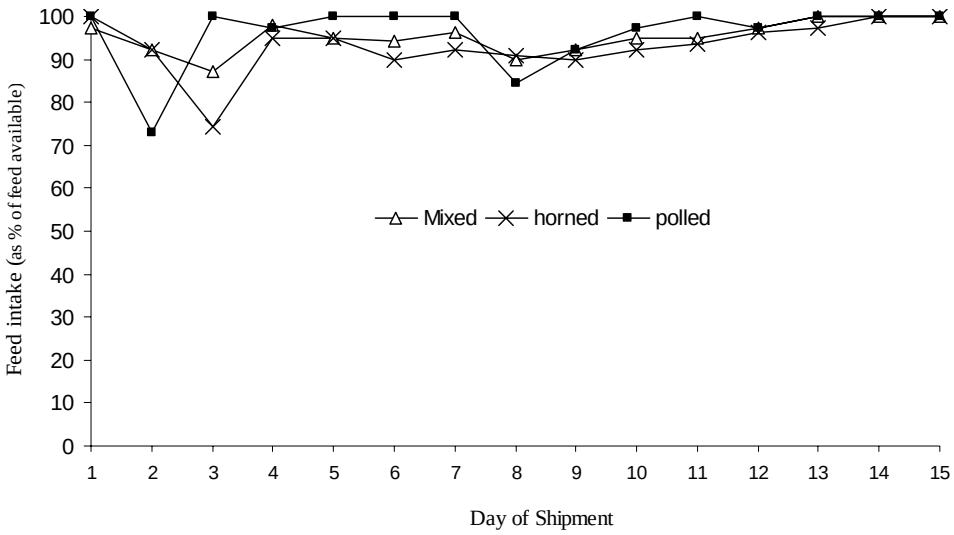

Figure 4. Mean feed intake of sheep in the mixed, horned or polled pens

4.1.2 Behavioural Observations

Analysis of video footage found no significant differences in the number of sheep lying down, feeding and pushing between each of the experimental pens (Figure 5). However, there was significantly more bunting in the horned pens than in the mixed pens ($p<0.05$). Real-time visual observations made by the onboard veterinarian found no significant differences in any of the behaviour between pen treatments.

4.1.3 Real-time Observation versus Video Footage

There were no significant differences between the groups for numbers of behavioural events recorded in real time. There were no observations recorded of sheep having difficulty in accessing feed due to horn length either by shipboard personnel or via video footage.

Comparisons of the actual number of events recorded in real time or via subsequent observation of the video were made more difficult because the precise time of real time observation was not necessarily recorded. Interactions, particularly aggressive interactions, may only take a few seconds to happen and due to the low numbers of interactions recorded, missing or including one interaction could have a large effect on numerical comparisons.

There were no significant differences in the number of threatening, non physical interactions recorded by in real time shipboard personal compared to that observed on video footage. However, there were significant differences in the number of aggressive interactions (Figure 6) and feeding events (Figure 7) recorded by shipboard personnel when compared to that observed on video footage ($p< 0.05$ and $p<0.01$ respectively).

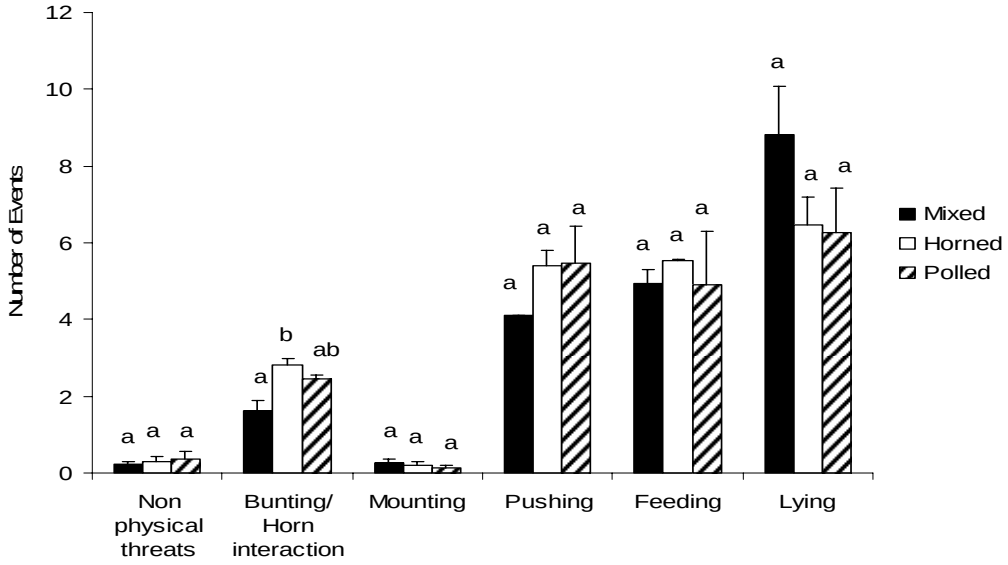

Figure 5. Mean number of events during 15 minute periods (Means are for 15 minute observational periods at 0600, 1200, 1800 and 000 on d 1, 5, 10, 15 for each treatment group ± SEM). Within each activity, different letters indicate significant difference $p < 0.05$.

The number of aggressive interactions observed via video footage was generally higher than observed in real time, most likely because video footage can be slowed down, paused and reviewed to better count the number of perhaps small interactions that may occur at the same time between several groups of animals. The relationship between number of feeding events observed in real time or via video footage was positive, although the actual number of events recorded was different, indicating that both methods detected similar trends. Feeding events take up more time and are more obvious compared to most interactions between animals, and therefore apparently more easily detected.

Threatening non-physical interactions are difficult to observe as they can be relatively small changes such as lowering of the head that result in an animal retreating. There is also added difficulty in observing small changes in behaviour in groups of animals in close proximity to each other Changes in an animal that are deemed as threatening by other animals are easily missed, resulting in a low number of non physical threats recorded by both video and real time observations.

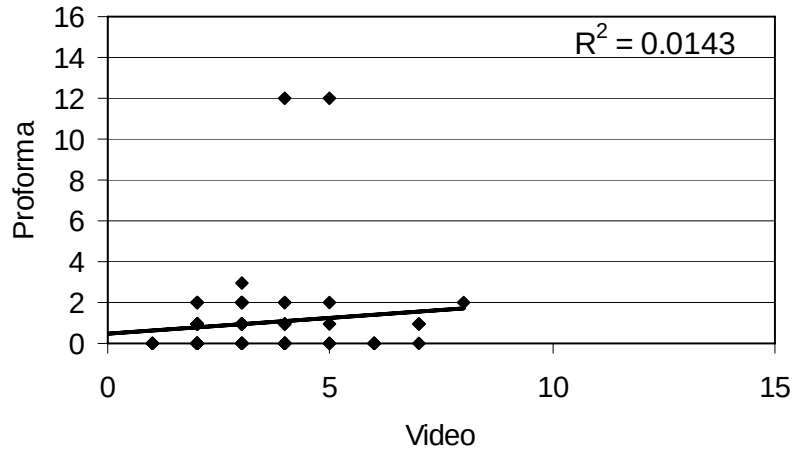

Figure 6. The number of aggressive interactions of animals in 5 minutes determined by viewing of video footage compared to real time observation by shipboard personnel using the proforma in mixed, polled and horned pens on day 1, 3, 7 and 14 of the study.

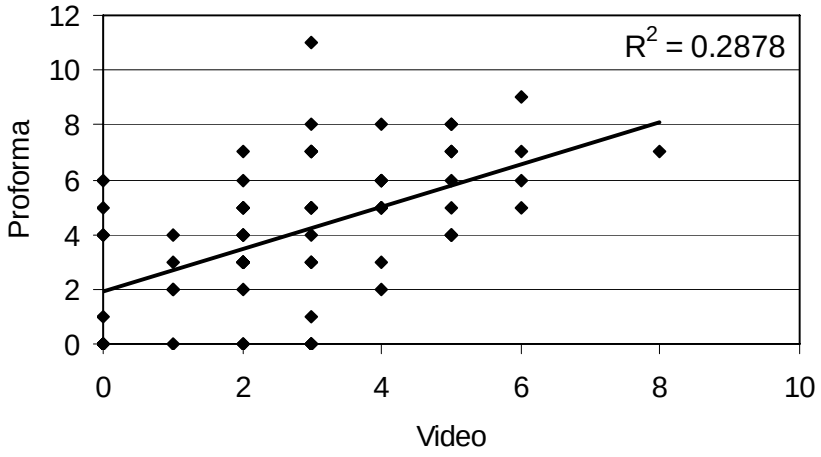

Figure 7. The number of feeding events of animals in 5 minutes determined by viewing of video footage compared to real time observation by shipboard personnel using the proforma in mixed, polled and horned pens on day 1, 3, 7 and 14 of the study.

4.2 Cattle Shipment

4.2.1 Voyage Details

The shipment departed Fremantle late on d 0 and unloaded at the destination port in Kuwait on d 15.

Wet bulb temperature during the voyage reached a maximum daytime average of 29˚C on d 7, 11 and 12 (Figure 8). Temperatures beyond day 12 were not recorded. Ventilation within the pens was considered by the shipboard veterinarian to be satisfactory throughout the voyage.

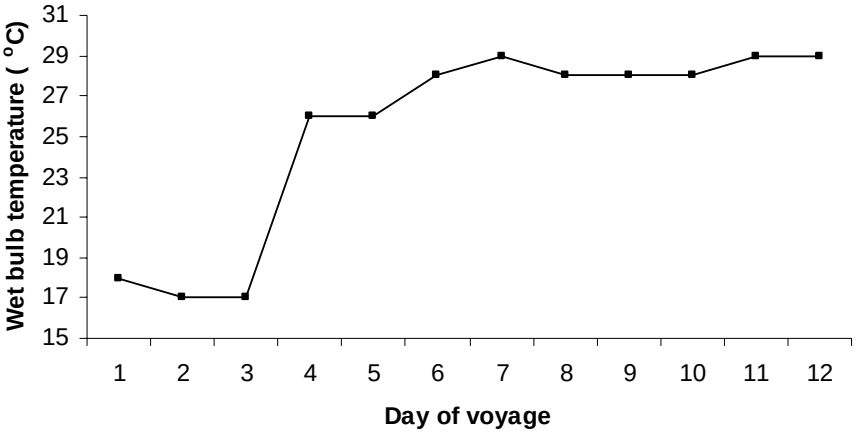

Figure 8. Average daily wet bulb temperature during the cattle voyage

There were 151 cattle in total on board this shipment and there were no mortalities. No injuries were recorded within any of the experimental pens. The only disease recorded in the experimental pens was lameness in one bull in the mixed pen (pen 1), observed on d 4. This bull was also off feed and was treated with oxytetracycline.

Feed intake (per day) increased from d 1 to 3 and then remained between 1.5 and 2.5% of initial body weight from d 3 to d 12 as shown in Figure 9. There was no significant difference in feed intake between treatments.

4.2.2 Behavioural Observations

Analysis of video footage found that there were no significant differences between treatment groups in any behaviours measured (Figure 10). There was also no significant effect of day on the behaviours observed. Real-time visual observations made by the onboard veterinarian also found no significant differences in any of the behaviour between pen treatments.

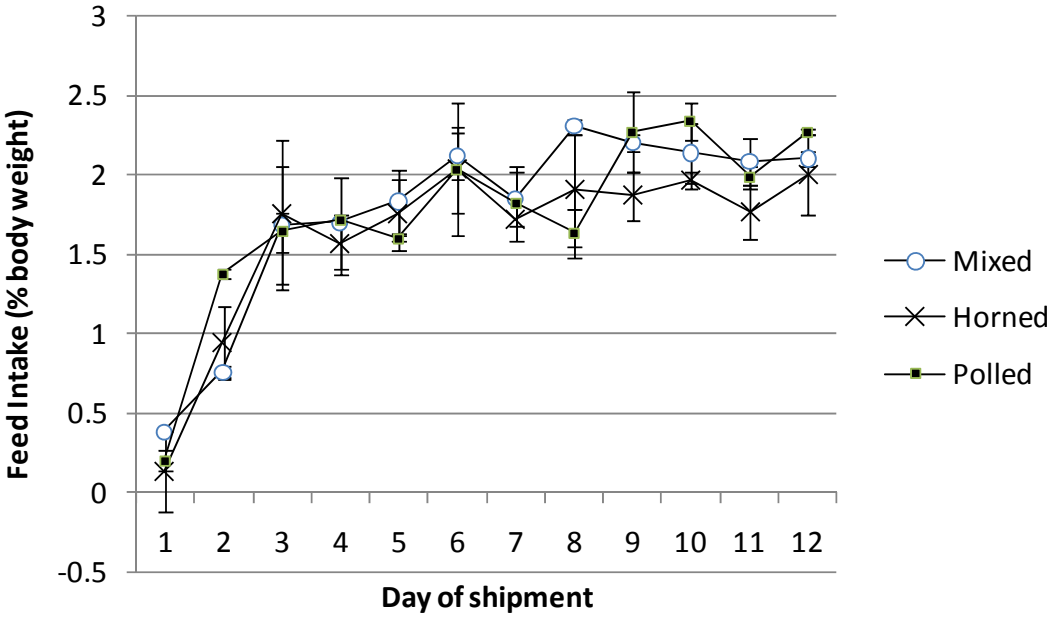

Figure 9. Mean feed intake of cattle in the mixed, horned or polled pens as a percentage of mean initial body weight (mean of 425 kg)

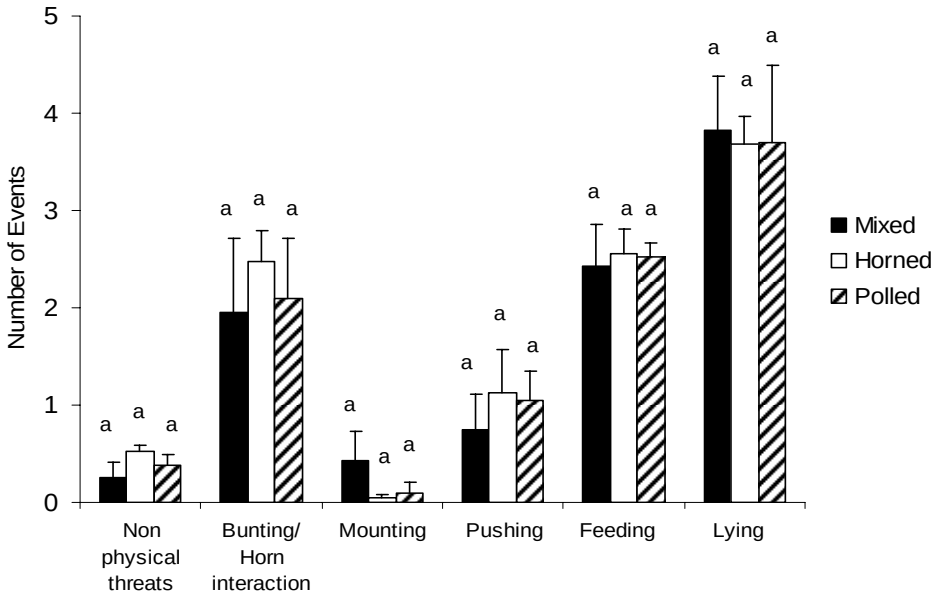

Figure 10. Mean number of events during 15 minute periods of video footage (Means are for 15 minute observational periods at 000, 0600, 1200 and 1800 on d 1, 3, 5, 7 and 10 for each treatment group ± SEM). Within each activity, treatment groups with different letters indicate significant difference $p < 0.05$.

4.2.3 Comparison Between Real-time Observations and Video Footage

There were no significant differences in the number of feeding events, number of animals lying down and number of non physical threats recorded in real time by shipboard personal compared to that observed on video footage. There were no observations recorded either by shipboard personnel or via video footage of cattle having difficulty in accessing feed due to horn length. Similar to the sheep shipment, there were significantly less aggressive interactions recorded by shipboard personnel compared to the number observed by video footage ($p < 0.01$), presumably for the same reasons as postulated for the sheep. However, for many observation periods, there was no difference between the numbers of observations recorded by either method (Figure 11) with there often being no aggressive or physical interactions recorded by either method; the statistical correlations were low (Table 3) but the nature of the data means that such a numerical comparison is flawed.

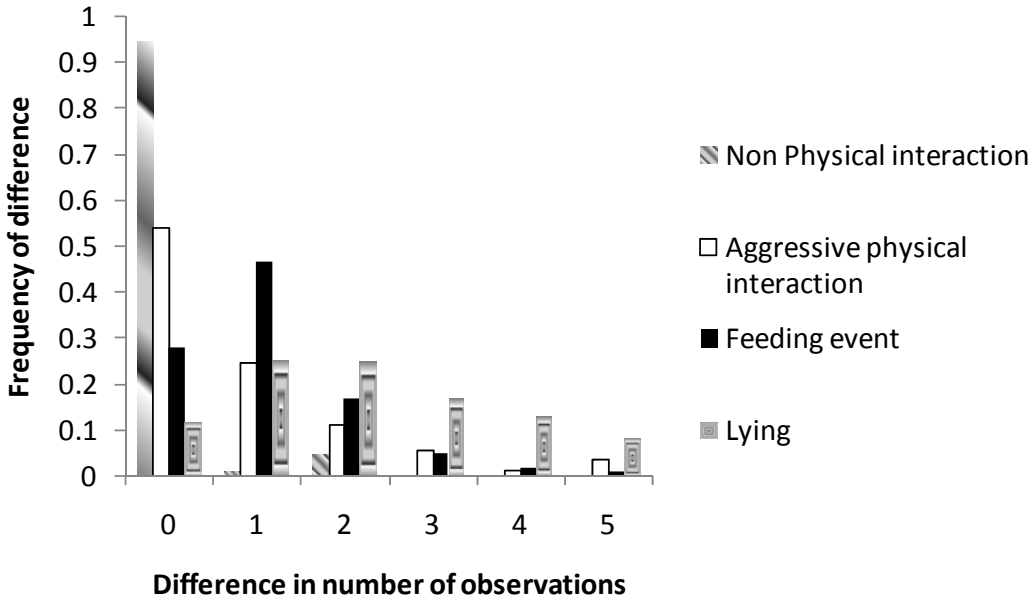

Figure 11. Frequency of the number of differences in observations using video footage compared to real time.

Table 3. Correlation between numbers of events recorded by observation in real-time versus viewing of video footage.

Event	R^2
Non-physical threats	0.005
Aggressive interaction	0.002
Lying down	0.002
Feeding	0.01

4.3 Observation-Only Shipments

4.3.1 Voyage Details

The voyages are described in Table 4. In each voyage, animal characteristics, as detailed in Table 5, were similar in each of the experimental pens.

Wet bulb temperatures for the short haul voyages reached a maximum between 27 and 29°C; the two long-haul voyages to the Middle East recorded higher maxima, up to 31°C wet bulb towards the end of the voyages.

4.3.2 Behavioural Observations

Behavioural observations from voyages 5, 11, 14 and 15 were not included in the analysis due to inadequate and incomplete recording of animal behaviour. Visual observations made by the onboard stockmen/ veterinarians on the other shipments listed in Table 2 and 3 found no significant differences in any of the behaviours between pen treatments (Figure 13).

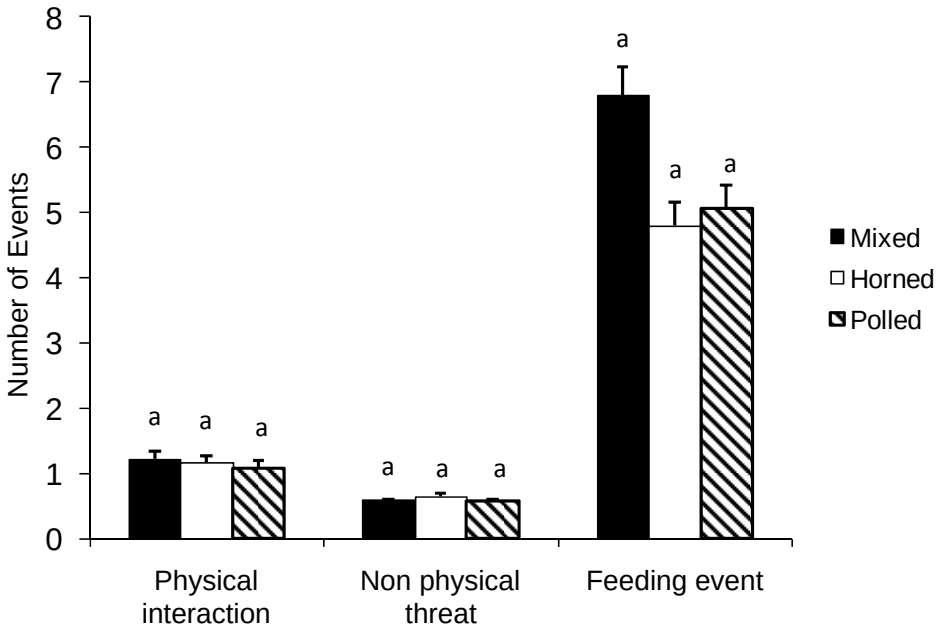

Figure 13. Number of behavioural events records on observation-only shipments for cattle (n=11 shipments)

Stockmen were asked to make any additional comments about the trial findings. The stockmen in shipment 2 expressed there to be no obvious difference between the experimental treatments. The stockman in shipment 3 expressed concern with the penning of all horned animals together due to risk of animal injury with a higher number of animals at the feeder with horns and indicated that it

would be better to pen animals in mixed horn length groups. The stockmen in shipment 13 and 14 expressed the view that mixed pens less than 12 cm had no welfare issues when compared to segregating horned from polled. The veterinarian/ stockmen on board shipments 1 and 11 expressed the view that mixed pens fed better than horned-only pens due to more head room available at the feeder in the mixed pens as there were less animals with horns. Additionally, the stockmen on board shipment 6 expressed concern that additional drafting that had to be done to separate horned and polled animals was an added stressor to the animals.

4.3.3 Death Rates, Disease and Injury

There were no mortalities in the experimental pens in any of the examined shipments. In shipment 4a there was one lame animal observed in a mixed pen and one in a polled pen, and pink eye was recorded in one animal in a polled and mixed pen. These animals were treated with antibiotics. Rhinitis was recorded in up to 2 animals in each experimental pen in shipment 13.
Respiratory heat stress was observed in a mixed pen in shipment 14.

4.3.4 Feed Intake

There was no significant difference in feed intake between treatments in any of the shipments examined. Feed intake also did not vary with day in any of the shipments examined. Mean feed intake for each voyage was above 90% of feed available in all treatments and in all shipments examined.

Table 4. Voyage details for proforma shipments (*those voyages not included in behaviour analysis)

Voyage	Month of departure	Departing from	Destination	Length of voyage (days)	Stocking rate (animal/ m^2)	Pen ventilation	Deck type
1	Feb 07	Fremantle	Jakarta	5	1.62	Natural and forced	Open
2	Feb 07	Geraldton	Sumatra	8	1.1	Forced	Enclosed
3	Mar 07	Geraldton	Jakarta	5	1.1	Forced	Enclosed
4	Feb 07	Darwin	Jakarta	4	1.1	Forced	Enclosed
5*	Feb 07	Geraldton	Malaysia	7	na	Forced	Enclosed
6	May 07	Fremantle	Jeddah, Saudi Arabia	15	1.44	Forced	Enclosed
7	Apr 07	Brisbane	Shinmoji, Japan	16	1.20	Forced	Enclosed
8	Feb 07	Fremantle	Port Kulang, Malaysia	10	1.11	Forced	Enclosed
9	Apr 07	Geradlton	Medan, Indonesia	10	1.18	Forced	Enclosed
10	Mar 07	Fremantle	Jakarta, Indonesia	6	1.2	Forced	Enclosed
11*	May 07	Broome	Jakarta, Indonesia	3	1.0	Forced	Enclosed
12	May 07	Darwin	Medan, Indonesia	9	1.31	Forced	Enclosed
13	Mar 07	Fremantle	Aqaba, Jordan	16	1.53	Forced	Enclosed
14*	Mar 07	Fremantle	Panjang, Indonesia	9	1.60	Forced	Enclosed
15*	Mar 07	Fremantle	Cilacap, Indonesia	7	1.21	Forced	Enclosed

Table 5. Details of animals in experimental pens in each of the voyages used in the study (*those voyages not included in behaviour analysis)

Voyage	Breed	Source	Sex	Age (months)	Mean weight/ head (kg)	Condition Score
1	Bos indicus X Bos taurus	South West of WA	steers	24 – 36	450	3 – 4
2	Bos indicus X Bos taurus	North West of WA	bulls	18 – 24	304	3- 4
3	Bos indicus X Bos taurus	South West of WA	steers	30	304	1
4	Bos indicus	Northern Territory	steers	18 - 24	na	2 – 3
5*	Bos taurus	na	steers	30	420	3 - 4
6	Bos indicus X Bos taurus	Eastern Wheatbelt, WA	bulls	18 - 24	280	2 - 3
7	Angus cross	South East Qld	Mix of steers and heifers in each pen	10 - 12	266	3
8	Pastoral shorthorn	North West, WA	bulls	10 – 18	300	3
9	Bos indicus X Bos taurus	Gereldton	heifers	na	318	4
10	Bos taurus	South West, WA	bulls	12 - 24	310	3 - 4
11*	Brahman	North West, WA	bulls	24	267	3
12	Bos taurus	na	heifers	na	365	4
13	Bos indicus x Bos taurus	Eastern wheatbelt	bulls	18 - 24	395	2 - 3
14*	Angus cross	na	bulls	24	465	3 - 4
15*	Santa Gertrudis X Brahman	na	bulls	24	345	na

4.4 Discussion

There was no indication from this work that mixing animals with and without horns, within specification, caused more problems than segregating them. There was no more aggressive interaction, injury, mortality or disease in the mixed pens, nor did the animals experience greater difficulty accessing feed.

The numbers of interactions were quite low for both the cattle and sheep. Previous researchers have also reported that there is minimal aggression between sheep; mostly such interaction involves pushing to gain access to the feed trough (Arnold and Maller 1974; Squires and Daws 1975; Houpt 1998). The significantly higher incidence of bunting in the all-horned pens may be because the animals had similar physical attributes, which meant establishment of the hierarchy took longer (Stolba *et al.* 1990; Houpt 1998). This was not evident with the cattle, but as these cattle were from the same mob, they may already have had an established hierarchy; it is unclear whether the sheep were from just one mob, or whether there was mixing. The *ad libitum* availability of feed and water would also have limited the reasons for competition or aggression between the animals, and the lower than usual stocking rate for the cattle (due to the expected environmental temperatures) may also have contributed to the low number of interactions.

The stockmen who provided information on the observation-only shipments supported the finding of no difference between groups, and their comments gave additional weight. There can be no independent verification of this information and the possibility could exist for subconscious bias to influence the results; however, the 11 useable reports all concurred and were backed up by the video footage. Additional voyages could be videoed, and of course there are many different social groupings and situations that could be investigated using this method, but there appears no evidence to suggest this work should be continued solely concentrating on whether animals have horns within specification.

The successful development of a non-invasive method of video surveillance of animals on the ship allowed several weeks of recording, from 12 cameras in this instance, at a quality that was adequate for general observations and indications of animal behaviour and interactions. The compression of the data on file may not allow more intricate observations, for instance of individual animal expressions.

This method of video surveillance was very effective at providing a record of the animals' interactions and behaviours for the duration of the recording, and in general agreed with the records made by stockmen and veterinarians that there was no difference between the pens. However, there were differences between the number of interactions and events counted in real time compared to those counted on the video footage and the correlations between the methods were therefore low; there were significantly less aggressive interactions counted in real time compared to the video footage analysis. This may have been due to some experimental design flaws. The time of real time observation should have been recorded to the second to allow precise comparisons, because interactions between animals can be brief and may have been missed or included if a slightly different time was examined on the video. Additionally, it can be

difficult to see all interactions in a large group if several events happen at the same time, particularly non-physical threats which are quite subtle. A more useful and flexible system might have been to use grades of interaction rather than absolute numbers of events, as it is anticipated that the overall impression of a group of animals might be similar over time. Finally, the comparison of just one observer in real time to the counted events on the video does not give adequate information about other observers. This experimental protocol was not designed to decide whether real-time observation is a valid and accurate alternative to the more expensive and time-consuming videoing of the animals; this different question could be answered by having many observers compared to video footage analysis for several precisely defined times, either using a scoring or grading system, or absolute numbers of interactions.

Such work could be a useful adjunct to this project, because video monitoring was extremely time-consuming for the set up and viewing of the footage, and the results for the overall between-group comparisons were the same as the real time observation, indicating that experienced stockmen are very capable of assessing animals on a whole group basis. Comparisons of real-time and video observations could be useful in validating such skills as well as training.

5 Success in achieving objectives

This project has developed a successful video surveillance system for use on live export vessels for several weeks, which is extremely useful in monitoring animal behaviour. Analysis of the footage did not show behaviour benefits of segregating polled animals from those with horns (within specification).

The proforma also provided useful results, which supported the conclusion from the video recordings. In general the veterinarians and stockmen provided clear and fully completed results. There were often additional comments included by the onboard stockmen and veterinarians on their views of the project and penning regimes. These comments were generally constructive and overwhelmingly in favour of allowing mixed groups of horned and polled animals.

The cooperation and assistance of the ship personnel was greatly appreciated, for both the video recording, and the real-time observation and recording.

6 Impact on meat and livestock industry – now and in five years time

The development of a video recording system that can be used on live export vessels can allow recording of voyages to provide information about the state of animals on those voyages, to demonstrate their behaviour under various conditions, as well as in a

variety of commercially applied experimental protocols. This will be useful in for industry to illustrate the conditions of the animals, and in working to make further improvements.

The finding that it appears unnecessary to segregate animals just because they possess horns within specification, from polled animals, provides weight to the original interpretation of the standards, whereby such animals were allowed to travel in mixed groups. This prevents unnecessary additional drafting of animals, and allows stockmen to separate groups of animals based on factors that may have greater impact on interactions in the group.

7 Conclusions and recommendations

Video footage and real-time observations found that mixing horned and polled sheep or cattle, within specification, did not result in more aggressive interactions, mortality, disease, or difference in feed intake than when segregated in horned and polled groups. The findings thus support the original interpretation of the standards, such that polled animals and those with horns within specification may travel in mixed groups. Comments from shipboard personnel support this, with stated concerns regarding the additional drafting required to separate animals, and problems with groups of all horned animals accessing the feeders together.

Since the segregation options are finite in terms of pens available for different groups it is important that there is optimisation of such separation. The highest priority segregation options need to be defined, therefore allowing a hierarchy of options rather than a yes/ no approach. Further study is needed to provide rationale behind live export guidelines, particularly in the area of segregation of animals for live export. It is also important to recognise that regardless of segregation options chosen, previous studies have shown that social behaviour will change with limited feed availability and increased stocking rate, resulting in increased aggressive encounters. Therefore, feed availability and stocking rate will also prove to be important in the management of the welfare of animals during live export.

While these studies have been necessarily limited due to the availability of suitable shipments, and the time it takes for the extensive viewing of the video post shipment, there are no indications from the videos, or from the shipments recorded on the proforma, that there is a problem that requires further investigation.

Therefore we conclude that, within specification and with regard to other social and animal factors that also influence hierarchy formation and aggressive interactions (such as size, age, sex, breed, previous social grouping, feed availability and stocking rate), separation according to whether an animal possesses horns within specification or not is not necessary for improved animal welfare.

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9 Appendices

9.1 Appendix 1 Proforma for use by shipboard personnel

RESEARCH AND DEVELOPMENT PROJECT

Assessment of the welfare and feeding behaviour of horned and polled sheep and cattle during live export

Background:
The aim of this project is to examine the Australian Standards for the Export of Livestock (ASEL) focused on the penning of cattle or sheep with horns separately from those with no horns (Standard S4.11). The project will examine the welfare and feeding behaviour of penning animals with mixed horn length together or penning polled animals separately from horned animals.

Description:
The project is funded by LiveCorp and project outcomes will be considered by the Live Export Standards Committee (LESAC) in finalising the guidelines of management of sheep and cattle relating to horn length.

In this study, horned animals will be defined as cattle with a horn length less than 12cm or sheep with a horn length less than one full curl and a shape that will not cause eye damage or restrict feeding. Polled animals will be those lacking horns. Two management techniques of horned and polled sheep and cattle will be considered and are as follows;

1. The mixing of horned and polled sheep or cattle in pens during live shipment and therefore the loading of sheep or cattle of mixed horn length together.
2. The segregation of horned and polled sheep or cattle in pens during live shipment and therefore drafting of sheep or cattle according to horn length before shipment.

In each shipboard trial there will be six experimental pens. Two of these pens will include a mix of both horned (horn length up to 12 cm in cattle or up to 1 full curl in sheep) and polled animals, two pens will include only polled animals and two pens will include only horned animals (horn length up to 12 cm in cattle or up to 1 full curl in sheep). Within these constraints all management procedures will follow ASEL guidelines.

The documentation of results in this study is important to ensure an accurate outcome. Any additional information on the behaviour and welfare of these animals is welcome.

Contacts:
If you need more information, please contact Peter Stinson (Technical Services Manager, LiveCorp) ph. 02 99296755.

CONTENTS OF PROFORMA

SECTION 1: TRIAL INSTRUCTIONS

SECTION 1A: INSTRUCTIONS ON PENNING ON SHIP

- Experimental pens

On each shipment, only one species will be examined in the experimental pens (either sheep or cattle). There will be six experimental pens included in each voyage; 2 pens of mixed animals (both poll and horn length up to 12 cm in cattle or up to 1 full curl in sheep), 2 pens of animals that are only polled, and 2 pens of animals that are only horned (horn length up to 12 cm in cattle or up to 1 full curl in sheep).

For purposes of recording results, pens need to be numbered as follows:
Pens 1 and 2: Mixed animals
Pens 3 and 4: Horned animals only
Pens 5 and 6: Polled animals only

To allow effective comparison between experimental pens, factors other than horn length will need to be similar between pens. Therefore, experimental pens will need to be,

- Located on the same deck, preferably in close proximity to each other and in a location that allows all experimental pens to have a similar climate in terms of ventilation and temperature/ humidity.
- Pens need to be of similar size with similar stocking density
- Animal factors will need to be similar between pens with all experimental pens having animals that are similar in,
    - age,
    - condition score,
    - sex,
    - breed and
    - sourced from a similar region.

Experimental pens will need to have automatic feeders turned off and feed will need to be added manually while still maintaining an *ad libitum* supply.

To allow penning of animals with mixed horn length LESAC approves the preparation, loading and transport of polled animals together with horned animals (horn length up to 12 cm in cattle or 1 full curl in sheep). However in pens that are segregated according to horn length (Horned only: pens 3 and 4; Polled only: pens 5 and 6), horned and polled animals will need to be handled and managed separately.
Existing requirements for animals sex, weight range and type (rams v wethers; bulls v steers) will continue to apply.

- Remaining shipboard pens

The remaining pens on the ship are to be composed of animals with mixed horn length (horn length up to 12 cm in cattle or 1 full curl in sheep). Existing requirements for animals sex, weight range and type (rams v wethers; bulls v steers) will continue to apply.

SECTION 1: TRIAL INSTRUCTIONS

SECTION 1B: INSTRUCTIONS ON RECORDING EXPERIMENTAL RESULTS

Measurements can be recorded on an excel spreadsheet or a hard copy that will be supplied before the voyage. Stockmen and vets will be contacted before departure to give an opportunity to ask any questions regarding the trial. If there are any further questions or need for clarification please contact:
Catherine Stockman (Murdoch University): 0438004071
Dr Anne Barnes (Murdoch University): 08 9360 2643

Measurements required as part of this trial include;

- Section 2A: Information on voyage and animals
- Section 2B: Daily measurement of animals in experimental pens and climatic conditions
- Section 2C: Behavioral observations of animals in experimental pens (Day 1 to 4, 7 and 14)

For purposes of recording results, experimental pens need to be numbered as follows:
Pens 1 and 2: Mixed horn length animals
Pens 3 and 4: Horned animals only
Pens 5 and 6: Polled animals only
Feed will need to be given manually in each of these pens to enable calculation of daily feed intake.

Recording measurements for SECTION 2A:
Voyage details (Recording sheet: page 7):

1. Details are required about the voyage and additional comments are welcome about voyage details that may have affected the results of the trial.
2. Contact details are required to allow for clarification of results following the voyage by research staff. The contact person should be someone who would be able to answer any queries regarding the documented results.

Background on experimental animals and pens (Recording sheets: page 8 to 9):

3. Information required for animals in each experimental pen is as follows;

- Location of farm of origin: This can be described as a particular region (e.g. South west W.A., North west W.A. ect.).
- Sex
- Approximate age
- Breed
- Conditions score (approximate average per pen)
- Number of animals per pen
- Stocking rate (m^2/ head)
- Type of ventilation in pens: This can be described and forced or natural
- Type of deck: Enclosed or open deck
- Total feed intake for entire voyage: Need to calculate total feed given per pen (kg) for the entire voyage and total feed left once animals are unloaded (kg).

Information on **all** shipboard pens (Recording sheet: page 10)
4. The following measurements need to be recorded as totals for all shipboard pens on voyage;

- Total number of animals on board
- Total mortality for the entire voyage (sum of mortality as a total for **all** shipboard pens).
- Total morbidity for the entire voyage (sum of morbidity as a total for **all** shipboard pens).

- Feed intake for the entire voyage as a total for **all** shipboard pens: This is calculated by determining the total feed given for the entire voyage to all shipboard pens and then calculating the total feed left in feed troughs following unloading of animals at destination. These measurements will be given in kgs.

Recording measurements for SECTION 2B:

Recording of daily climate details and mortality rate (Recording sheet: page 11):

1. Weather data will need to be recorded daily at the same time each day as a wet bulb temperature or alternatively as dry bulb temperature (˚C) and humidity (%). Ventilation performance would be best recorded as windspeed in pens; however, can also be described as the relative effectiveness of ventilation in the pens (satisfactory or unsatisfactory).
Total mortality rate per day for the entire ship needs to be recorded as a total number per day.

Daily measurements of animals:

2. Animal measurements are required for each experimental pen (pen 1 to 6) and can be recorded in Section 2B of this document:
Pens 1 and 2 (mixed): recording sheets pg 12 to 17
Pens 2 and 3 (horned): recording sheets pg 18 to 20
Pens 4 and 5 (polled): recording sheets pg 21 to 23
Alternatively results can be recorded on the excel spreadsheet (Section 2B).
Measurements include:

- **Mortality rate (mortality/ day):** In mixed pens (pens 1 to 2) total number of mortalities/ day need to be recorded for both horned and polled animals. In segregated pens (horned: pens 3 and 4, polled: pens 5 and 6) total number of mortalities/ day need to be given as totals per pen.
- **Number of animals that are diseased:** This measurement needs to specify the disease and the number of animals infected. In mixed pens (pens 1 to 2) total diseased animals/ day need to be given for both horned and polled animals. In segregated pens (horned: pens 3 and 4, polled: pens 5 and 6) total diseased animals/ day need to be given as totals per pen.
- **Number of animals with injuries (not resulting in lameness):** This measurement needs to specify the injury (e.g. laceration) and the number of animals with each injury. In mixed pens (pens 1 to 2) total animals displaying injuries/ day need to be given for both horned and polled animals. In segregated pens (horned: pens 3 and 4, polled: pens 5 and 6) total animals displaying injuries/ day need to be given as totals per pen.
- **Number of animals with injuries (resulting in lameness):** This measurement needs to specify the injury (e.g. laceration) and the number of animals with each injury. In mixed pens (pens 1 to 2) total animals displaying injuries/ day need to be given for both horned and polled animals. In segregated pens (horned: pens 3 and 4, polled: pens 5 and 6) total animals displaying injuries/ day need to be given as totals per pen.
- **Feed intake (kg/day):** Feed intake is calculated for each pen by determining total feed given per day and the total residue left at the end of the day. Daily feed intakes will be determined per day (4pm to 4pm the following day) by recording amount of feed added in the evening (4 to 5 pm) (day a) till the evening (4 to 5 pm) the following day (day b). The amount of feed left over at 4 to 5pm on day b needs to be recorded. Intakes need to be recorded as kg/ pen.

Measurements required for SECTION 2C:

Observations can be recorded in Section 2C of this document:
Pens 1 and 2 (mixed): recording sheets pg 24 to 26
Pens 2 and 3 (horned): recording sheets pg 27 to 29
Pens 4 and 5 (polled): recording sheets pg 30 to 32
Alternatively, results can be recorded in the excel spreadsheet (Section 2C).
Behavioural observations are required from each experimental pen on days 1 to 4 and day 7 and 14. It is important than behavioural observations are made on these specific days to enable the best assessment of behaviour over time. On each of these days behaviour is to be recorded for 5 minutes in the morning (8am), 5 minutes at midday (12pm) and 5 minutes in the evening immediately following addition of new feed (4 to 5pm). Vet or stockman must position themselves in such a position as to not affect normal feeding behaviour. Behavioural observations include:

- Number of animals displaying aggressive physical contact:
Physical contact is isolated to that which is aggressive, including bunting, horn strikes or pushing. Within the 5 minute interval the number of animals that display this type of physical contact is to be recorded.

- Number of animals displaying non physical threats:
Threats include all aggressive threats that do not result in physical contact. The number of animals that display these non physical threats needs to be recorded.

- Number of feeding events:
The number of animals that put their head into a feed trough to feed needs to be recorded. In mixed pens (pens 1 to 2), the number of feeding events is recorded for both horned and not horned animals.

- Difficulty in accessing feeder due to horns:
In the horned pens (pens 3 and 4) and mixed pens (pens 1 to 2), the number of animals that had difficulty in accessing feeder due to horn length is to be recorded.

SECTION 2: RECORDING SHEETS

SECTION 2A

1. Voyage details (See page 4 for explanation)

Ship Name	
Species being included in experimental pens 1 to 6 (cattle or sheep)	
Departure port/s	
Date of departure	
Destination port/s (if more than one destination then detail which experimental pens were received at each port)	

Date of arrival at destination/s (if more than one destination then detail when each of the experimental pens were received at each port)	
Additional comments about voyage that may have influenced results	

2. Contact details for person responsible for recording trial results

Contact person			
Address			
State			
Telephone		Mobile	
Fax		Email	

3. Animal details (animals in experimental pens only) See page 4 for explanation

3a. Mixed Horned and Polled pens (pens 1 and 2)

	Mixed Pens only			
	Pen 1		**Pen2**	
	Horned	**Polled**	**Horned**	**Polled**
Location of farm of origin				
Sex				
Age				
Breed				
Weight				
Condition score (1 to 5)				
Number of animals in pen				
Pen area (m^2)				
Type of ventilation in pen (forced/ natural)				
Type of deck (open/ enclosed)				
Total feed given for entire voyage (kg)				
Total feed left over in troughs at end of voyage (kg)				

3b. Segregated pens (horned or polled) See page 4 for explanation

	Horned pens only		Polled pens only	
	Pen 3	**Pen 4**	**Pen 5**	**Pen 6**
Location of farm of origin				
Sex				
Age				
Breed				
Weight				
Condition score (1 to 5)				
Number of animals in pen				
Pen area (m^2)				
Type of ventilation in pen (forced/ natural)				
Type of deck (open/ enclosed)				
Total feed intake for voyage entirety (kg)				
Total feed left over in troughs at end of voyage (kg)				

4. Measurements on all shipboard pens See page 5 for explanation

	Cattle	Sheep
Total number of animals on board		
Total number of mortalities		
Total number of morbidity		
Total feed given (kg)		
Total feed left over (kg)		

SECTION 2B Daily animal and climate measurements

1. Daily climate details and total daily shipboard mortalities (See page 5 for explanation

Day of voyage	Dry bulb (˚C)	Humidity (%)	Wet bulb (˚C)	Windspeed or adequacy of ventilation (satisfactory/ unsatisfactory)	Total shipboard mortality/ day
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					

SECTION 2B (2a) Daily animal measurements: **MIXED PENS (PENS 1 AND 2)** See page 5 and 6 for explanation

Day	Pen Number	Animal Group	Total mortality	Total diseased (detail type of disease)	Total injuries not resulting in lameness	Total injuries resulting in lameness	Amount of feed added (kg)	Amount of feed left over(kg)
1 Date:	1	Horned						
		Polled						
	2	Horned						
		Polled						
2 Date:	1	Horned						
		Polled						
	2	Horned						
		Polled						
3 Date:	1	Horned						
		Polled						
	2	Horned						
		Polled						
4 Date:	1	Horned						
		Polled						
	2	Horned						
		Polled						

SECTION 2B (2b): Daily animal measurements: **HORNED PENS ONLY (PENS 3 AND 4)** See page 5 and 6 for explanation

Day	Pen Number	Animal Group	Total mortality	Total diseased	Total injuries not resulting in lameness	Total injuries resulting in lameness	Amount of feed added (kg)	Amount of feed left over(kg)
1 Date:	3	Horned						
	4	Horned						
2 Date:	3	Horned						
	4	Horned						
3 Date:	3	Horned						
	4	Horned						
4 Date:	3	Horned						
	4	Horned						
5 Date:	3	Horned						
	4	Horned						
6 Date:	3	Horned						
	4	Horned						
7 Date:	3	Horned						
	4	Horned						
8 Date:	3	Horned						
	4	Horned						

SECTION 2B (2c): Daily animal measurements: **POLLED PENS ONLY (PENS 5 AND 6)** See page 5 and 6 for explanation

Day	Pen Number	Animal Group	Total mortality	Total diseased	Total injuries not resulting in lameness	Total injuries resulting in lameness	Amount of feed added (kg)	Amount of feed left over(kg)
1 Date:	5	Polled						
	6	Polled						
2 Date:	5	Polled						
	6	Polled						
3 Date:	5	Polled						
	6	Polled						
4 Date:	5	Polled						
	6	Polled						
5 Date:	5	Polled						
	6	Polled						
6 Date:	5	Polled						
	6	Polled						
7 Date:	5	Polled						
	6	Polled						
8 Date:	5	Polled						
	6	Polled						

SECTION 2C: Behavioural observations **MIXED PENS (PENS 1 TO 2)** See page 6 for explanation

Day	Pen Number	Number of aggressive physical interactions	Number of threatening non physical interactions	Number of feeding events of horned animals	Number of feeding events of polled animals	Difficulty in accessing feeder due to horn length
1 Date:	1					
Time:	2					
1 Date:	1					
Time:	2					
1 Date:	1					
Time:	2					
2 Date:	1					
Time:	2					
2 Date:	1					
Time:	2					
2 Date:	1					
Time:	2					

SECTION 2C: Behavioural observations **MIXED PENS (PENS 1 TO 2)** See page 6 for explanation

Day	Pen Number	Number of aggressive physical interactions	Number of threatening non physical interactions	Number of feeding events of horned animals	Number of feeding events of polled animals	Difficulty in accessing feeder due to horn length
3 Date: Time:	1					
	2					
3 Date: Time:	1					
	2					
3 Date: Time:	1					
	2					
4 Date: Time:	1					
	2					
4 Date: Time:	1					
	2					
4 Date: Time:	1					
	2					

SECTION 2C: Behavioural observations **MIXED PENS (PENS 1 TO 2)** See page 6 for explanation

Day	Pen Number	Number of aggressive physical interactions	Number of threatening non physical interactions	Number of feeding events of horned animals	Number of feeding events of polled animals	Difficulty in accessing feeder due to horn length
7 Date: Time:	1					
	2					
7 Date: Time:	1					
	2					
7 Date: Time:	1					
	2					
14 Date: Time:	1					
	2					
14 Date: Time:	1					
	2					
14 Date: Time:	1					
	2					

SECTION 2C: Behavioural observations **HORNED PENS ONLY (PENS 3 AND 4)** See page 6 for explanation

Day	Pen Number	Number of aggressive physical interactions	Number of threatening non physical interactions	Number of feeding events	Difficulty in accessing feeder due to horn length
1 Date:	3				
Time:	4				
1 Date:	3				
Time:	4				
1 Date:	3				
Time:	4				
2 Date:	3				
Time:	4				
2 Date:	3				
Time:	4				
2 Date:	3				
Time:	4				

SECTION 2C: Behavioural observations **HORNED PENS ONLY (PENS 3 AND 4)** See page 6 for explanation

Day	Pen Number	Number of aggressive physical interactions	Number of threatening non physical interactions	Number of feeding events	Difficulty in accessing feeder due to horn length
3 Date: Time:	3				
	4				
3 Date: Time:	3				
	4				
3 Date: Time:	3				
	4				
4 Date: Time:	3				
	4				
4 Date: Time:	3				
	4				
4 Date: Time:	3				
	4				

SECTION 2C: Behavioural observations **HORNED PENS ONLY (PENS 3 AND 4)** See page 6 for explanation

Day	Pen Number	Number of aggressive physical interactions	Number of threatening non physical interactions	Number of feeding events	Difficulty in accessing feeder due to horn length
7 Date: Time:	3				
	4				
7 Date: Time:	3				
	4				
7 Date: Time:	3				
	4				
14 Date: Time:	3				
	4				
14 Date: Time:	3				
	4				
14 Date: Time:	3				
	4				

SECTION 2C: Behavioural observations **POLLED PENS ONLY (PENS 5 AND 6)** See page 6 for explanation

Day	Pen Number	Number of aggressive physical interactions	Number of threatening non physical interactions	Number of feeding events
1 Date:	5			
Time:	6			
1 Date:	5			
Time:	6			
1 Date:	5			
Time:	6			
2 Date:	5			
Time:	6			
2 Date:	5			
Time:	6			
2 Date:	5			
Time:	6			

SECTION 2C: Behavioural observations **POLLED PENS ONLY (PENS 5 AND 6)** See page 6 for explanation

Day	Pen Number	Number of aggressive physical interactions	Number of threatening non physical interactions	Number of feeding events
3 Date: Time:	5			
	6			
3 Date: Time:	5			
	6			
3 Date: Time:	5			
	6			
4 Date: Time:	5			
	6			
4 Date: Time:	5			
	6			
4 Date: Time:	5			
	6			

SECTION 2C: Behavioural observations **POLLED PENS ONLY (PENS 5 AND 6)** See page 6 for explanation

Day	Pen Number	Number of aggressive physical interactions	Number of threatening non physical interactions	Number of feeding events
7 Date: Time:	5			
	6			
7 Date: Time:	5			
	6			
7 Date: Time:	5			
	6			
14 Date: Time:	5			
	6			
14 Date: Time:	5			
	6			
14 Date: Time:	5			
	6			

4. ADDITIONAL COMMENTS

Comments on improvement of proforma:

Comments on other measures that may be useful for inclusion in this study

Other comments