VETS AGAINST LIVE EXPORT

Heat and cold stress in *Bos taurus* cattle from southern Australia during long-haul export by sea: draft report

Submission
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VETS AGAINST LIVE EXPORT
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Re: Bos taurus Review Draft Report

Vets Against Live Exports (VALE) was established in 2011, following the revelations of serious cruelty inflicted on Australian animals exported to Indonesia. VALE currently has over 250 members.

Since its establishment, VALE has analysed available data on the live export industry, particularly information pertaining to animal welfare during voyages.

VALE welcomes this opportunity to make a submission to the Review.

Yours sincerely

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(Spokesperson)

GENERAL COMMENTS

1. VALE acknowledges the large amount of work involved in performing this extensive analysis. The information provided and the depth of the analysis have added substantially to the live export information available. VALE does however have concerns that the specific TEG comments are not available. It is not clear in the draft report whether the recommendations made were those of DAWE or the TEG. VALE does have serious concerns about the weak recommendations made in the report in response to the findings of the review.

2. With 25-33% of voyages having **heat** affected cattle, questions have to be raised about the social licence for the live export of *Bos taurus* cattle, particularly those intended for slaughter (for which boxed meat is an alternative export option). Whilst the report expressed no concern regarding this percentage of voyages affected by heat stress/heat load, VALE do not find this acceptable and the Australian public and animal welfare advocacy groups are also unlikely to find this acceptable. As such, VALE urge both the TEG and DAWE to provide strong recommendations to reduce this incidence of heat load/stress eg **immediate increase in space allowance to recommended allometric "k" values** (as per Petherick and Phillips 2009) and a **cessation of voyages from May to September** as per sheep live export (at least for slaughter cattle). With the data from this review however, **the only acceptable long-term solution for *Bos taurus* slaughter cattle is a transition from live export to the boxed meat trade.**

3. This draft report found problems with bedding and its management under ASEL 2.3. Bedding provisions are essentially unchanged between ASEL 2.3 and ASEL 3.2 so concerns about bedding will be unchanged and ongoing. **Bedding provisions should be addressed immediately with significantly more bedding being prescribed.** This should not be delayed until the next ASEL revision. The DAWE could advise by an Export Advisory Notice. Animals should not have to suffer for some unspecified number of years before the next ASEL revision. It should be noted that 9 years elapsed between ASEL 2.3 and ASEL 3.0 and it is 12 years since the industry review in 2009 (Banney et al) that found **bedding was inadequate for good animal welfare.**

4. An essential element of the overall integrity of live export is the recording of data in reports produced by the various persons involved (independent observers (IOs), veterinarians, stockperson, ship's captain). The draft report highlighted the ongoing inadequacy of the reports with critical comments that reflect poorly on the records, the recorders and by extension, the live export industry. Given this was identified as a major issue, it is unacceptable that DAWE did not provide strong recommendations to resolve this issue, particularly as the draft report so consistently recommended "further research" based on shipboard data. VALE request that the DAWE recommend that **data recording should be consistent and comprehensive and include environmental logger information from all decks in addition to simultaneous CCTV footage.** This data should be sent to DAWE using block-chain technology (as per Australian Veterinary Association 2018). This would enable accurate analysis and "further research" to be performed in addition to identifying significant problems in real-time.

5. China was the end-destination of most analysed voyages. Veterinarians are not required on voyages to China despite these voyages crossing the Equator and being of similar voyage length to Middle East voyages. Given the high incidence of heat stress, and some voyages with cold stress, one recommendation should have been that a veterinarian was essential on all long-haul voyages. This is also critical if "further research" relying on shipboard data is to be performed. Stockpersons have a 4-day training course. Veterinarians are trained animal health professionals. VALE and the Australian Veterinary Association (AVA) have long requested that a veterinarian should be present on every live export ship. The findings of this review would be a strong indication that at the very least, **a veterinarian should be on every long-haul *Bos taurus* voyage.** VALE request a veterinarian on every long-haul voyage as a matter of urgency.

6. Given the findings about poor voyage reports, it was disappointing that there was not a comparison of IO report data with daily voyage reports. IO reports are not in the public domain and requests to retrieve them under *Freedom of Information* legislation are rejected by DAWE. Such a comparison would provide valuable information on the accuracy and integrity of reports generated by industry employees. As the draft report raised concerns about the inconsistency, inaccuracy and apparent discrepant data in some voyage reports, and as the Moss Review noted likely conflict of interests affecting reporting, this analysis should have been performed to either support or refute this possibility. It would appear that this may have been a missed opportunity for "further research".

7. The recommendations made in the report are weak. Despite the comprehensive data and evidence, there are almost no strong recommendations with most wording favouring phrases such as "should", "could" or "consideration should be given to..". Animal welfare is paramount and Australia's duty of care is to the animals and not to an industry. DAWE as the regulator, has been tasked with oversight of animal welfare in a trade with well-publicised animal welfare incidents and loss of public trust. As such, the precautionary principle should apply to safeguard the welfare of exported animals and a soft approach accommodating the exporters is not acceptable. VALE urge DAWE to **strengthen their recommendations in the final report**.

8. It was concerning that so many of the report recommendations were for "further research". Whilst "further research" may well be required, waiting for research to be performed and completed delays rectification of identified problems and implementation of measures to improve animal welfare. The first and foremost responsibility is the welfare of the animals involved and duty of care to those animals. Research, whilst helpful in assessing welfare concerns should be a secondary aim, not as it appears in this report, the main recommendation. The members of the TEG (Drs Fisher, Barnes and Millar) all have extensive livestock experience thus practical, logical recommendations should have been possible without "further research". It should be noted that Dr McCarthy had a similar paucity of research when performing the McCarthy Review (McCarthy 2018) yet the sensible recommendations made based on available research in combination with his practical observations and first-hand experience were applied to the live sheep export trade McCarthy's recommendation to increase space allowances based on allometric principles

and to cease sailing during the northern hemisphere winter with a halving of the acceptable mortality resulted in a substantial improvement in both animal welfare and voyage mortality rates; the latter had been unchanged for at least a decade. When research is not available, common-sense should prevail in recommendations. If McCarthy (and DAWE) had adopted the “further research required” – position for sheep, these substantial improvements in animal welfare and mortality would not have been made. Sometimes, **the best research is to actually institute logical changes and then compare the outcome(s) to previous data to prove (or discount) its benefit.**

9. This review highlights the fact that much scientific research data undermining the trade is 10-20 years old and that pertinent recommendations from that data have not been adopted in the actual operational protocols. **Resistance to adoption of industry-recommendations is strong evidence of an industry that has little interest in proactively improving animal welfare.**

10. Whilst such analysis is invaluable, more regular and timely reports of operational value are required in addition to historical data. VALE would recommend that building from this draft, such **reports should be published by DAWE on an annual basis** to enable concerns to be assessed and/or promptly rectified. Five years of repeated animal welfare issues until a report is generated is not acceptable from an animal welfare perspective. It also risks wasting time and resources if current conditions have changed from those in the preceding period (eg a change of ASEL). Annual regular reports could be compared with previous reports in order to demonstrate progress and or improvements. Implementing real-time changes is likely to be more cost effective and deliver improved welfare outcomes.

11. **It is essential that reported animal welfare conditions be assessed and investigated by DAWE as soon as possible and remedial actions and changes instituted during the voyage and / or for future similar voyages** eg ongoing and repetitive water provision issues. There is no evidence in the public domain that DAWE demand or request changes in response to reports of heat or cold stress or bedding mismanagement.

12. Australia is shipping ‘live animals’, not ‘voyages’, yet all percentages provided are of voyages and not the number of affected animals. Animals are sentient beings. Animal welfare is relevant to each individual animal on each ship. OIE r(2019) ecommendations and all Australian animal welfare codes relate to individual animal welfare. VALE appreciates that for some welfare assessments (eg how many animals were heat or cold stressed on any shipment), data is unlikely to be available given the poor standard of reports available. However, it is not acceptable that this draft report provides no information on the number of animals subject to specific environmental conditions eg the finding that 35% of voyages had wet bulb temperatures above 30°C level provides no information about the number of animals that were subjected to those temperatures, information that should be publicly available. It cannot be assumed that 35% of voyages represents 35% of animals exported as this depends on the numbers of animals on the affected shipments. In addition, few of the recommendations address suffering and welfare of individual animals on future voyages. For example, bovine respiratory disease (BRD) is a major cause of poor health

(and thus welfare) and mortality on every single voyage but the recommendation to vaccinate for BRD only covers the period of highest mortality, not all voyages. Likewise for the Heat Stress Risk Assessment recommendations. **Mortality is still the operative concern through this report and has heavily influenced the recommendations which is not acceptable.** There should be more detailed recommendations on how to immediately resolve or improve the relevant welfare issues for each animal on each ship with clear guidelines as to what can be done to avoid such welfare issue in future shipments regardless of whether the issue results in mortality.

13. A **detailed point-by-point assessment** of the draft report has been included.

Heat and cold stress in *Bos taurus* cattle from southern Australia during long-haul export by sea October 2021

Draft report with detailed VALE COMMENTS

Summary

Heat stress findings

The review determined that evidence of increased heat load occurred on at least 25% of long-haul *Bos taurus* voyages from southern Australia in all classes of cattle (breeder, feeder or slaughter): to all destinations, from all departure ports and departing during both the northern hemisphere winter and summer.

VALE COMMENT: The finding that one in three slaughter cattle voyages had evidence of increased heat load should have been highlighted in addition to the overall figure of "at least 25%." There was no concern expressed in the summary about the high frequency of voyages that would have resulted in poor animal welfare. Subjecting cattle to a 1/3 chance of heat stress whilst being shipped overseas purely for slaughter, that could be done in Australia, is unlikely to be acceptable to the Australian veterinary profession, Australian public or Australian farmers.

The review found that *Bos taurus* slaughter cattle voyages have a significantly greater risk of increased heat load compared to voyages of feeder cattle and breeder cattle. It was identified that *Bos taurus* slaughter cattle voyages have a significantly greater risk of heat stress-related mortality compared to voyages of other classes of cattle.

VALE COMMENT: One potential cause was not discussed, namely that slaughter cattle are worth less than breeder cattle so less attention is given to individual animals including space allowances, quantity/quality of bedding and/or provision of a veterinarian rather than a stockperson. VALE's analysis of the Independent Observer (IO) Summaries to all destinations suggested that space allowance and bedding appeared better in breeder voyages (See: https://www.vale.org.au/io-reports.html). VALE is unsure as to whether veterinarians are more likely to accompany voyages with breeder cattle than slaughter cattle. As DAWE would have access to voyage photographs (at least for voyages accompanied by IOs) and information on whether veterinarians accompanied the voyage, both should be assessed and included in the Final Report.

The review suggested that susceptibility to heat stress may be exacerbated by other health conditions

VALE COMMENT 1: This conclusion was reached without also considering the alternate and equally plausible conclusion that heat-stressed animals may have increased susceptibility to other health conditions (eg. heat stress may result in depressed immunity and predispose to infectious diseases such as Bovine Respiratory Disease (BRD)). As the suggestion is scientifically flawed, it must be rectified in the final report.

VALE COMMENT 2: There was no comment about the quality of the diagnoses and many voyages (eg. to China) are not accompanied by veterinarians – they are accompanied by stockpersons with no training in veterinary pathology (Hing et al 2021). It is disappointing that there was no comment about this in the Draft Report. With such a high rate of heat load/stress and repetitive recommendations for "further research", it is incomprehensible that a TEG comprised of veterinarians and commenting on this review would not recommend as a minimum that all long-haul voyages need to be accompanied by a veterinarian. VALE acknowledges that such a recommendation may have been made by the TEG with that recommendation omitted by DAWE.

The review concluded that important factors for the monitoring and management of the risk of heat stress during export voyages of *Bos taurus* cattle from southern Australian ports include:

- improved shipboard monitoring and collection of environmental data

VALE COMMENT 1: The industry has had nearly 20 years of reviews (including the recent Moss and Carter Reviews) and industry publications (including Meat and Livestock Australia (MLA)/Livecorp reports) recommending improved shipboard monitoring and environmental data yet it has never occurred. This should be a mandatory requirement if this industry is to continue and should not be left unaddressed until the next review to make the same comment.

VALE COMMENT 2: After the Awassi Express *exposé (2018) Kestrel loggers were instituted on numerous ships undergoing long-haul voyages. It is concerning that the data from these loggers seems to have been unavailable to the draft report authors. The fact that this review covered voyages that post-dated the* Awassi Express *exposé and that environmental monitoring is still not being adequately performed after constant assurances that this would occur, highlights that industry has no will or desire to record and provide this data. In their 2018 review, the Australian Veterinary Association (AVA Literature Review Live Sheep Export May 2018) requested that this data should be available and be collected by block-chain technology: "*Aggregated voyage data, including key animal welfare indicators, can and must be measured and collated using up-to-date technologies such as blockchain, with that data made available to scientists so future research topics are not only based on sheep mortalities, but also causes of morbidity during each voyage*." VALE supports the AVA recommendations and would urge DAWE to make similar recommendations.*

- the use of heat stress risk assessment (HSRA) modelling all year round to all destinations, particularly for *Bos taurus* slaughter cattle

VALE COMMENT: The necessity for extra care with cattle exported from southern ports (ie mostly Bos taurus) has been promoted since the Keniry Review (2004). HSRA modelling must be performed year-round for all Bos taurus cattle to all destinations as a matter of immediate priority.

- identifying hot spots in vessels along with appropriate husbandry and management of cattle

VALE COMMENT: It is not adequate to just identify hot spots. There should be no animals in those locations and the pens in that space should be removed from load-plans. Many of these ships have had well known hotspots for years to decades with no action taken, even after IOs identified them (See: https://www.vale.org.au/io-reports.html). Hotspots could be left free to accommodate animals experiencing cold-stress later in the voyage.

Cold stress findings

The review demonstrated the risk of cold conditions for cattle was greatest during the northern hemisphere winter particularly for exports departing from December to February. The final 5 days of the voyage were typically the coldest period with lowest recorded temperatures commonly coinciding with unloading at the destination port.

VALE COMMENT: Nearly 10% of voyages had recorded evidence of cold conditions with no comment regarding the seriousness of these conditions. It was concerning to note that on some voyages, water in troughs was frozen raising questions as to how ad libitum water was provided under such conditions. It is also concerning that until recently (Hing et al 2021), cold stress has never been mentioned as an animal welfare issue in the live export trade. VALE commends the review for analysing cold stress.

Potential impacts of extreme cold conditions on welfare during road transportation after disembarkation and beyond may be an area for further research.

*VALE COMMENT: It is concerning that this information was not collated in this review especially when shipboard veterinarians are sometimes required contractually to supervise stock for a number of weeks after arrival (eg some voyages to Russia). Shipboard veterinarians have advised VALE that they have advocated for shipboard veterinarians to not only accompany **all** voyages but to accompany and supervise the cattle for at least 1-2 weeks at the end destination. As animal welfare is reportedly an industry priority and the draft report has identified the need for "further research", it is disappointing that a recommendation for post-voyage veterinary care was not made. VALE requests that such a recommendation is made in the final draft.*

Impact of ASEL 3

Changes under ASEL 3 include:

- cattle more than 500kg must not be sourced for export or exported unless a heavy cattle management plan is approved in writing by the department

VALE COMMENT: It has been known for over 30 years that cattle >500kg do not travel well across the Equator (Hedlefs 1988). In addition to industry publications, one Australian stockman provided the following comment to Beef Central (See: https://www.beefcentral.com/beef-2018-review/ship-stockmen-share-their-livex-voyage-experiences-during-beef-2018/ Accessed 2 Dec 2021): "It was a real mess 20 years ago…We would get a load out of Portland or Adelaide, they would be 550kg big, fat Angus or Hereford steers, and they would already start to pant before we got to the equator….In those cases we were flat out doing what we could, flat out keeping the ship clean, keeping waters clean, decreasing their intake of pellets, increasing their chaff so they don't get that hot fermentation going on in their stomachs…." VALE does not believe that Bos taurus cattle more than 500kg should be exported by sea across the Equator under any circumstances. No management plan can change WBT at the Equator.

- a requirement that a sufficient quantity of bedding is carried, applied and monitored to ensure good animal welfare outcomes for livestock

VALE COMMENT: Whilst an extra non-specific clause was included in ASEL 3.0-3.2, the actual specified amount of bedding required was not changed from ASEL 2.3 (ASEL 3.0 "5.3.8 Cattle exported on voyages of 10 days or more must be provided with sawdust, rice hulls or similar bedding material to be used exclusively for bedding at a rate of at least 7 tonnes or 25m3 for every 1,000m2 of cattle pen space" which is approximately 2.5cm bedding thickness. This amount of bedding is trivial as identified in some photographs from IO Summaries (See: https://www.vale.org.au/io-reports.html). In addition, this requirement does not apply to cattle loaded from a port north of latitude 26° south and exported to South-East Asia". The industry report by Banney et al (2009) states that the bedding is insufficient and should be improved for animal welfare but ASEL 3.0/3.1/3.2 has essentially defined that level of bedding reviewed in 2009 as sufficient. DAWE has now also found bedding inadequate highlighting the inadequacy of ASEL 2.3 and thus 3.0/3.1/3/2 as previously identified by submissions into the ASEL Review including those from the AVA and VALE, two professional veterinary organisations. In addition, the current ASEL 3.0/3.1/3.2 is contradictory as there is no bedding required for South East Asian voyages despite the general comment about sufficient quantity of bedding required.

- the introduction of LIVEXCollect (a data collection and management system administered by Livecorp) to improve consistency in the way livestock observations and other measurements are recorded and reported.

VALE COMMENT 1: LIVEXCollect is not in the public domain so no comment can be made as to this proposal. It is inappropriate that a legal document (ASEL 3.0-3.2) should reference a data collection

system that is not available to the public. This has occurred with HotStuff and the argument is that Hotstuff cannot be made public due to commercial in-confidence ship information embedded in the model and commercial model ownership arrangements. There should be no such argument for data collection requirements. The reference to documents unavailable to the public in a legal document is not acceptable if this industry is to have social licence.

VALE COMMENT 2: Consistency is not the only concern with records. Frequency of observations is also critical eg. temperature data should be continuous with simultaneous CCTV footage available for independent assessment.

Findings and recommendations

1.1 Findings

Heat load and heat stress-related mortalities

1. Increased heat load during long-haul *Bos taurus* voyages from southern Australia can occur in all classes of cattle (breeder, feeder or slaughter), to all destinations, from all departure ports and departing during both the northern hemisphere winter and summer.

VALE COMMENT: This confirms that heat stress/load is essentially unavoidable in the Bos taurus cattle live export trade.

2. *Bos taurus* slaughter cattle on voyages departing from southern Australian ports are at a higher risk of increased heat load than other classes of cattle.

VALE COMMENT: As cattle can be slaughtered in Australia and sent as boxed beef, the logical conclusion on animal welfare grounds is that Bos taurus cattle should not be exported for slaughter.

3. *Bos taurus* slaughter cattle on voyages departing from southern Australian ports are at a higher risk of heat stress-related mortality than breeder cattle.

VALE COMMENT: See point 2.

4. Two-thirds of heat-stress related mortalities were identified as 'combined' with an underlying disease. This was most commonly respiratory disease.

5. Heat stress mitigation strategies employed during the voyages were reported.

VALE COMMENT: This finding is not helpful. There is no information as to whether these strategies were effective and how effectiveness was measured. The Draft Report merely describes some reported approaches with no assessment of their effect eg zig-zagging only helps air movement on open decks and is not of use in closed-deck ships. Increased deck washing may have helped with heat management but there is no information as the impact of this on available bedding for example. The number of washes and bedding changes required need to be taken into account when calculating bedding. As such, reporting of this finding does not contribute anything to the analysis.

Other heat stress factors

Hot spots:

6. Voyage reporting rarely provided any detail on hot spot monitoring and management.

VALE COMMENT: Hotspots were repeatedly identified by IOs indicating that these are well known on individual vessels and that nothing has been done to improve/alleviate the areas or remove them from calculations of available pen space. If hotspots are identified, animals should not be penned in those areas and this should be noted in the HSRA and load plan for each voyage on each particular vessel. VALE requests that this recommendation is made.

Bedding and pad management:

7. Welfare consequences of inappropriate pad management were noted on some voyages. The most common pad issue related to wet, sloppy pads in humid conditions.

VALE COMMENT: "Some voyages" would appear to be an underestimate with 76% of cattle voyages to China accompanied by IOs having wet sloppy bedding with bedding management

issues identified by Hing et al (2021). There should be significantly more bedding loaded as amount of bedding appeared to be the limiting factor in management in these particular voyages.

8. ASEL 3 has implemented additional requirements regarding bedding use, application and monitoring.

VALE COMMENT: This is not strictly correct. There is an additional statement about its adequacy with adequacy not defined. It should be noted that no bedding has always been deemed adequate by DAWE and industry for northern cattle voyages. The specified amount of bedding required (inconsistent with adequacy) is unchanged (see comments re ASEL 3.0-3.2 Bedding).

Reporting heat stress:

9. Daily deck temperature recordings may not accurately reflect actual conditions.

VALE COMMENT: This has been known and commented upon in every review, analysis etc for at least 20 years. Industry has done nothing to rectify this which suggests a reluctance to adopt best practice and a lack of transparency. The IO Summaries indicate that the temperatures recorded (See: https://www.vale.org.au/io-reports.html) are often not representative and this review has also found evidence of the non-representative nature. This must be rectified immediately as per the AVA recommendation regarding use of block-chain technology for environmental records, video footage and daily voyage reports (AVA 2018).

10. Evidence of increased heat load (elevated respiratory rates, altered respiratory character, increased panting score or heat stress score) was not consistently recorded or reported.

VALE COMMENT: Heat stress, heat crashes and evidence of increased heat load have been known by industry, veterinarians and animal welfare organisations for at least 30 years. It is thus concerning that nothing has ever been done to improve the records and the issue itself. VALE is aware of advice given to one shipboard veterinarian by a more senior company veterinarian to never record the words "heat stress" in reports (with detailed information relayed confidentially to the Independent Inspector General and confirmation available from the veterinarian). Lack of recording indicates a reluctance by this industry to record true conditions or to act upon the findings. The lack of transparency and the continued lack of improvement in this area should remove any remaining social licence for the live export trade.

Cold exposure and cold stress

11. Twenty of the 214 voyages were identified as having evidence of cold conditions based on either environmental signs such as temperatures of ≤5°C or evidence of relevant behavioural, physiological signs.

VALE COMMENT: This is nearly 10% of voyages.

12. There were no recorded primary mortalities due to cold stress.

VALE COMMENT: The draft report notes that personnel seem unaware of cold stress issues. If the issue isn't recognised, it is unlikely that primary mortalities due to cold stress would be reported. An extra comment should be added to highlight that although no mortalities were recorded, one cannot conclude that none occurred.

13. The cold tolerance of Australian cattle exported to cold climate destinations is not well established.

VALE COMMENT: Some shipboard veterinarians have been aware of this condition thus it should have been possible for the industry to assess this and attempt to ameliorate it eg. by not sailing during high-risk seasons and also carefully analysing and recording its impact on animal welfare.

14. Wet conditions are an important consideration on board a livestock vessel when animals are exposed to direct windchill (open decks) and high ventilation rates.

VALE COMMENT: Agree. However, acknowledging this is not a proactive recommendation as to how to address it or provide mitigation. Wet conditions are unavoidable except by voyage cessation when rain and/or rough seas predicted. It should have been acknowledged that this is an inherent and unavoidable risk on sea voyages.

15. Mitigation measures for managing cattle in cold conditions are not well established.

VALE COMMENT: One assumes that apart from not sailing into northern winters, there is actually little one can do once a voyage encounters cold conditions. There are no heaters onboard (apart from the known hotspot areas). Hotspot areas should be reserved for ill animals in cold conditions.

1.2 Recommendations

Heat load, heat stress-related mortalities and other heat load factors

1. A suitable HSRA should be employed all year round for *Bos taurus* slaughter cattle to all destinations.

*VALE COMMENT 1: A suitable HSRA should be employed all year round for **all** Bos taurus cattle to all destinations, not just slaughter cattle. Sheep sourced from the same areas are no longer exported to the Middle East in the northern hemisphere summer because, as shipboard veterinarian and heat stress researcher Dr Renee Willis said in a talk to the South African Veterinary Association (2021)," it is just too hot". Likewise, Bos taurus cattle, which have similar HSTs to southern-sourced sheep, should not be exported from Australia across the Equator between May and September/October.*

VALE COMMENT 2: As there has been no change to Hotstuff since 2012 the Bos taurus slaughter trade should be suspended until the suitable HSRA is available in order to ensure that it actually does happen and does not, as has happened since 2018, become a plan for some unspecified time in the future. Animals continue to suffer due to long delays between recommendations and implementation of those recommendations. This situation cannot be allowed to continue and the obvious proven solution to hasten industry improvement is trade suspension. It should be remembered that stunning of exported Australian cattle in Indonesian abattoirs was considered an 'aspirational goal' in 2010 (MLA/Livescorp 2010) before a trade suspension in 2011 that resulted in 80% stunned slaughter within 2 years.

2. Consideration should be given to providing *Bos taurus* slaughter cattle exported from southern Australian ports during the northern hemisphere summer additional pen space.

VALE COMMENT 1: With the evidence that at least 25% of voyages are affected by heat load (with IOs on China voyages specifically commenting on heat load/stress in 38% of the IO-accompanied voyages; Hing et al 2021) the conclusion should have been that Bos taurus cattle MUST be given additional pen space as per the TAC 2018-2019 Review recommendation. VALE request that the TEG provide information on specific minimum space allowances (k-value ≥ 0.033) and that DAWE adopts their recommendations.

VALE COMMENT 2: Space allowance for cattle loaded at southern Australian ports for long-haul export at any time of the year requires a minimum k-value ≥ 0.033 to reduce risk of adverse welfare outcomes (Petherick and Phillips 2009). It is unclear why ASEL 3.2 uses a k-value of

0.030 in its default settings as this space allocation does not necessarily allow cattle ability to rise and move freely to feed/water troughs.

3. Vaccination against bovine respiratory disease may be valuable in decreasing its incidence and should be considered for voyages of *Bos taurus* slaughter cattle departing Australia from southern ports between 1 May and 31 October.

*VALE COMMENT: Agree in principle but as BRD is the leading cause of cattle mortality on live export voyages (Moore et al 2015), VALE request that this recommendation is made mandatory and at **all** times of the year for Bos taurus voyages. The wording "should be considered" is unacceptable.*

4. Ongoing examination of *Bos taurus* slaughter cattle outcomes should occur to assess the benefit of this preventative measure.

VALE COMMENT: Given the industry reluctance to adopt meticulous, consistent and comprehensive voyage records,, this will not be possible. The Government must insist on CCTV footage and block-chain technology for all records as per AVA (2018).

5. Further investigation beyond the scope of this review is warranted to explain why slaughter cattle voyages departing in late autumn and early winter have substantially higher mortality rates than during other months of the year.

VALE COMMENT: Interesting finding but a strong recommendation should have been made that whilst such investigation is ongoing, slaughter cattle leaving at these times must have increased space allowance to a 'k' value of no less than 0.033. Animals cannot continue to suffer and die in order to determine why this is so.

6. Further investigation beyond the scope of this review is warranted to explain why voyages departing from Portland having greater odds of heat load compared to voyages departing from Fremantle.

VALE COMMENT: It is concerning that the authors of draft report did not at least suggest the some reasonable hypotheses eg that a) voyages from Portland carry more dairy cattle than voyages from Fremantle (not heat acclimatised and more susceptible to heat stress) b) that cattle leaving from the hotter state of Western Australia (WA) are likely to be better acclimatised (ie Zone 2 and 3 animals rather than Zone 1 and 2 animals – Maunsell Australia 2003) and/or c) cattle leaving from the relatively warmer and drier conditions of WA could have less BRD. Logical hypotheses should be included in the final report.

7. Further research should be undertaken into the effectiveness and appropriate employment of heat stress mitigation measures.

VALE COMMENT: Once certain ambient temperatures are reached, there is no possible mitigation of heat stress – as is evident from all the research done on heat stress by Barnes and co-workers and a comment in this report itself. Mitigation measures would help at the onset of these conditions and could help reduce the level of suffering (eg. easy access to water troughs). However, the most important mitigation measure in sheep to reduce morbidity and mortality on long-haul voyages was to stop sailing into the northern summer and to increase the space available. It is most disappointing that the TEG did not appear to advise DAWE of this evidence-base to make a similar suggestion pending any research that could occur however it is acknowledged that the TEG could have made this recommendation with DAWE not following their directive. Shipboard veterinarian Dr Mike McCarthy in the McCarthy Review (2018) and the AVA (Independent review of heat stress in sheep May 2018) were both able to make positive recommendations without "further research". The change in sailing dates and alterations of space

allowance using k values cut the industry's "acceptable" sheep mortality by half and high mortality voyages ceased. Mortality is a crude indicator of animal welfare. However, this is in-situ evidence of a decrease in the most extreme consequence of poor animal welfare. Thus, space and sailing times are the best mitigation factors identified in any species. Similar recommendations should have been made for Bos taurus cattle by the TEG and DAWE.

8. Hot spots on vessels should be identified and monitored using standardised and well-maintained data loggers to support the management of cattle in these areas.

VALE COMMENT: With at least 25% of voyages affected by heat (at least 38% of IO-accompanied China voyages; Hing et al 2021 consistent with the 33% of slaughter cattle voyages identified in the draft report), use of pens in these areas should be prohibited. The pens could be reserved to accommodate animals affected by cold stress in some northern voyages.

9. Exporters should implement proactive pad management during voyages. These should include specific contingencies for addressing sloppy pads in hot, humid conditions.

VALE COMMENT: Agree. This recommendation has been ongoing since the MLA report by Banney et al (2009). As such, there is evidence that this is strongly resisted by industry. As stated by Banney et al (2009):

> *"Based on current mortality rates and estimates of poor health attributable to bedding management, the cost of bedding is not likely to be recouped by a reduction in mortality rates alone. However, while the cost of bedding may not be justified purely in commercial terms through reductions in mortalities, lameness and possible live weight loss, addressing the welfare issues through bedding management will have a positive impact on the animal welfare image of the industry, assisting its long-term viability."*

10. The next ASEL review should investigate the adequacy of ASEL bedding requirements for long-haul voyages out of southern Australia.

VALE COMMENT: This is a totally unacceptable conclusion. The industry published a detailed review of bedding in 2009 (Banney et al 2009) with recommendations that have been ignored for 12 years. This current review has likewise found ongoing issues with bedding. It can be concluded that cattle have suffered for at least 12 years due to lack of implementation of industry's own recommendations and this current recommendation by DAWE ensures that they will continue to suffer until the next ASEL Review. Bedding provisions should be immediately rectified with an Export Advisory Notice. Animals should not have to suffer for some unspecified number of years before the next ASEL Revision (10 years between ASEL 2.3 and ASEL 3.2).

11. In addition to reporting on abortions and births, daily reports should also require reporting on premature lactation.

VALE COMMENT: Agree

12. On board data loggers should be used to improve the monitoring of deck temperatures.

VALE COMMENT: Agree but VALE believe CCTV footage is also required with block-chain technology for both as recommended by the AVA (2018). As loggers have been present on numerous ships since 2018, it is a sad indictment on the industry that a review should have to recommend this.

13. The use of and reporting of cattle panting scores should be consistent. A discussion between AAVs, stockpersons, exporters, heat stress technical experts, welfare groups and the department would promote this.

VALE COMMENT: *The MLA's Tips and Tools for Feedlot Cattle had a recognised panting score with the feedlot industry using this routinely since 2004. Dr Mike McCarthy, shipboard veterinarian and MLA researcher recommended its use in 2005 in Pilot Monitoring of Shipboard Environmental Conditions and Animal Performance (McCarthy 2005). The cattle industry, producers and researchers use this panting score. The live export industry has been well aware of this and had had a recommendation dating from 2005 which has not been adopted (McCarthy 2005). VALE does not believe that the industry will ever adopt this simple tool used elsewhere in the cattle industry. It does not need discussion – it has been discussed repeatedly. It just needs to be implemented and then modified if found to be unacceptable. There should be an immediate recommendation to follow the either the classic MLA Panting Score or the modified score (Jubb and Perkins 2019) on all voyages.*

Cold exposure and cold stress

14. Further research should be undertaken to determine appropriate critical temperatures that relate to compromised animal welfare for Australian cattle exported to cold climate destinations.

VALE COMMENT: This is only possible if consistent, detailed and high-quality records are provided to DAWE/researchers and if veterinarians accompany every voyage. Any recommendation for further research should be accompanied by an insistence that every long-haul voyage must be accompanied by a veterinarian.

15. Consideration should be given to timing and method of deck washing to allow time for cattle coats to dry before the vessel encounters cold conditions.

VALE COMMENT: Agree. However, it is left to individual discretion and veterinarians are not present on every ship. Clear guidelines should be provided by DAWE.

16. Industry should develop guidance for appropriate mitigation measures on board vessels for cattle in cold conditions.

VALE COMMENT: Industry have never publicly identified that cold stress is an issue so public trust in industry guidance is low. The changes must be mandated by law (by an updated version of ASEL or as an Export Advisory Notice) so that there is a legal requirement for this.

17. Measures to mitigate the risk of cold stress on board vessels should be incorporated into exporters' 'adverse weather contingency plan'.

VALE COMMENT: Agree in principle but details not provided.

18. The 'cold climate destination checklist' for cattle should be completed prior to the export of cattle to cold climate destinations.

VALE COMMENT: This should be mandatory ie "must" or "shall" not "should" ("should" is an optional term as per definitions of "shall" and "should" in all Standards Australia documents).

2 Introduction

The Australian live cattle export trade provides over $800 million in annual export revenue to the Australian economy and supports the livelihood of many people in regional and rural communities (DAWE 2021).

VALE COMMENT: The number of people supported has never been formally researched and DAWE has relied on industry estimates. Given the insistence on accurate peer-reviewed evidence, this statement should also have been qualified with appropriate references and a comment about the level of evidence, uncertainty and potential bias included.

Recognising this, the Australian Government is committed to supporting a sustainable livestock export trade whilst maintaining high standards of animal welfare…..

..In conducting the *Bos taurus* review, the department has assessed issues relating to heat and cold stress in *Bos taurus* cattle from southern Australia during long-haul export by sea on 214 long-haul voyages over five years from 2016 to 2020. We reviewed scientific literature, industry research, voyage reports (by stockpersons, shipmasters, AAVs and IOs), the ASEL sea review, data from the Bureau of Meteorology, targeted stakeholder feedback and other relevant information.

2.1 Purpose of the review

This review assesses the adequacy of current export arrangements in protecting the welfare of *Bos taurus* cattle from southern Australia, with regards to temperature stress during export by sea and provide evidence-based advice to the department on improvements to animal welfare during sourcing, preparation and export.

Several shipboard issues relating to *Bos taurus* cattle exports were identified by the TAC in the ASEL sea review. The TAC noted that *Bos taurus* cattle sourced from southern Australia are at greater risk of heat stress than *Bos indicus* cattle and that there will be some risk of heat stress (for any livestock) on any voyage that crosses the equator headed for northern hemisphere ports. Recommendations 1, 2 and 3 from the ASEL sea review addressed animal welfare concerns relating to export of *Bos taurus* cattle crossing the equator while Recommendation 27 addressed the need for updating the HSRA model:

- **Recommendation 1** stated that the revised ASEL should prevent *Bos taurus* cattle from an area of Australia south of latitude 26° south (southern ports) being sourced for export on voyages that will cross the equator between 1 May to 31 October (inclusive), unless an agreed livestock HSRA indicates the risk is manageable.

Currently only cattle exported to the Middle East are required to have a HSRA under ASEL 3. Until the HSRA model has been further developed to include all destinations across the equator, the provision should continue to apply to the Middle East. Once industry has updated the existing HSRA model to enable its application to voyages to any destination that requires equatorial crossing (not just the Middle East), ASEL will be revised to meet this recommendation.

VALE COMMENT: As per previous comments regarding delay in implementation of a revised HSRA, the slaughter animal trade should be suspended until that updated HSRA is available.

- **Recommendation 2** stated that the ASEL prevent pregnant *Bos taurus* cattle from southern ports being sourced for export on voyages that cross the equator from 1 May to 31 October (inclusive).

Prior to implementation it was determined that there was insufficient evidence to implement a complete prohibition, so a requirement was introduced to allow high performing exporters to export pregnant breeder cattle during this period under an approved management plan (ASEL 3, Standard 1.4.3).

- **Recommendation 3** stated that the ASEL prevent *Bos taurus* cattle with a body condition score of 4 or more out of 5, or 5.5 or more out of 6 for dairy cattle, being sourced for export from, or exported through, any area of Australia north of latitude 26° south from 1 October to 31 December (inclusive).

This recommendation was implemented in full (ASEL 3, Standard 1.4.4).

- **Recommendation 27** stated that the ASEL be revised over time to require the application of an agreed HSRA to all livestock voyages that cross the equator, at all times of the year, from all Australian ports.

This recommendation is yet to be implemented pending industry improvement of the existing HSRA to incorporate destinations other than the Middle East.

VALE COMMENT: As for Recommendation 1. This time delay is unacceptable.

In addition, animal welfare issues relating to temperature stress have been noted in a number of publicly available IO voyage reports and raised in correspondence from RSPCA Australia to the government.

VALE COMMENT: VALE has also publicly raised this issue with government and made both the information and the correspondence publicly available (www.vale.org.au). VALE should be referenced here also.

2.2 Scope of the review

This review considered voyages transporting animals described as *Bos taurus* breeds or cross-bred *Bos taurus* cattle with phenotypical *Bos taurus* characteristics, sourced and exported from southern regions of Australia (ports south of latitude 26° south) from 1 January 2016 to 31 December 2020. Long-haul voyages are those to 'far' markets that take over 10 days. Except for 2 months (November and December 2020), all voyages analysed for this review were governed by standards in ASEL 2.3. ASEL 3, which introduced the term 'far' markets, was introduced on 1 November 2020.

Under ASEL 2.3, day 1 of the voyage referred to the first day at sea after leaving the first port of loading. Whilst ASEL 3 introduced a new definition of voyage length, this did not impact our voyage analysis as all the voyages within the scope of this review were defined as long-haul.

The review covers *Bos taurus* cattle exports from 5 ports of departure, to 4 destination regions, 9 destination countries and 34 destination ports. The ports of departure reviewed are Fremantle, Portland, Geelong, Geraldton, and Port Adelaide. The destination countries reviewed are China, Israel, Jordan, Kuwait, UAE, Oman, Qatar, Pakistan, and the Russian Federation. Japan is excluded as a destination from the review because no consignments were exported from the southern Australian focus ports.

2.3 Consultation

2.3.1 Key stakeholders

Our process identified the key groups for consultation. These stakeholders will be engaged with at varying stages during the review process to ensure all have had an opportunity to provide feedback. Stakeholders include:

- animal welfare organisations
- Australian Maritime Safety Authority
- livestock exporters
- general public
- peak industry and industry-related bodies
- research organisations and academics
- state and territory governments
- veterinarians, including accredited veterinarians.

2.3.2 Targeted consultation

We undertook targeted consultation with a range of stakeholder groups to inform the review, including:

- a round of teleconferences with targeted stakeholder groups to inform the scope of the review and its process. Stakeholder groups included animal welfare groups, industry groups, researchers, AAVs and state and territory representatives.
- a written submission process for targeted stakeholder groups to inform the draft report. We received 7 written submissions during this targeted consultation process.

VALE COMMENT: VALE considers that as a professional veterinary group, dedicated to assessment of live export, recognised for its role in live export voyage analysis and having authored peer-reviewed scientific literature on live export, it should be considered as a stakeholder. Whilst VALE appreciated the opportunity to provide a submission on invitation, VALE was not included in any of the stakeholder teleconferences or even notified that the draft report was available for comment. VALE considers that the Department of Agriculture's consistent refusal to recognise VALE as a stakeholder, is unacceptable and needs to be rectified. VALE also requests that, as a matter of transparency, the stakeholders and submitters should be named in this document. VALE gives permission for its formerly confidential submission to the review to be made public.

2.3.2 Independent technical expert group

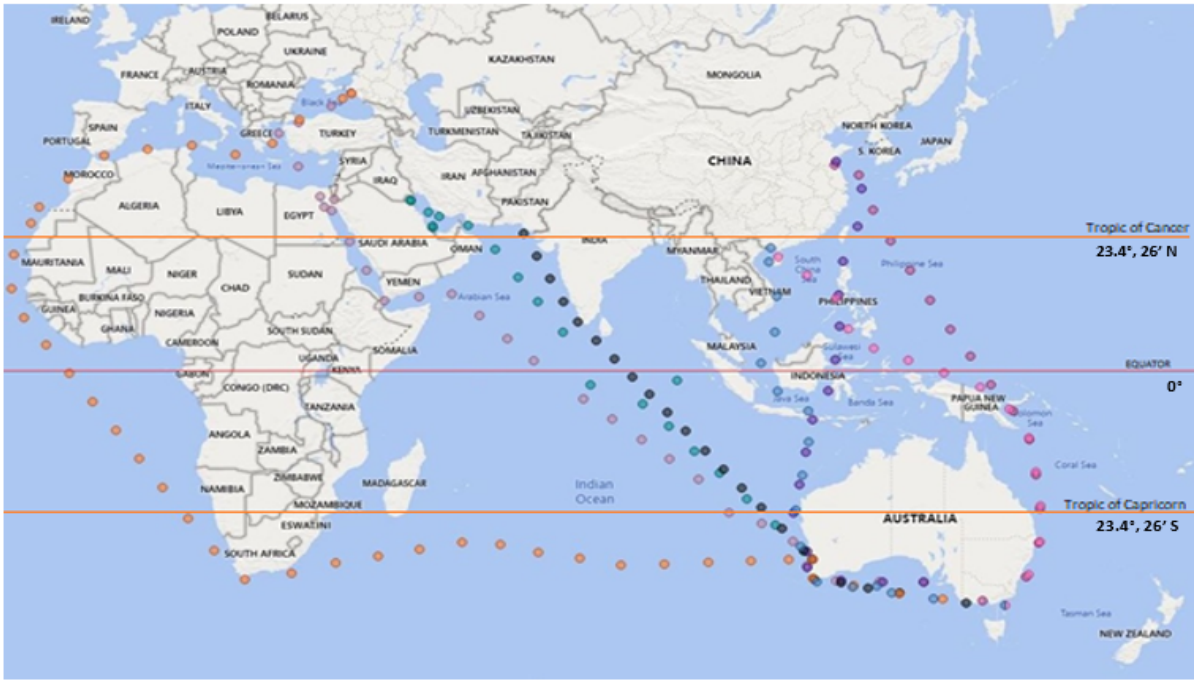
An independent technical expert group (TEG) was contracted to provide advice and feedback to the department about the content of the review before release of the draft for comment and its finalisation.

VALE COMMENT: The TEG was expert but not truly independent. Two of the members have received industry funding for research of heat stress-related issues. The experience and knowledge contributed by both is acknowledged but a potential for conflict of interest does exist. It would appear that only one member of the panel is potentially independent of the live export trade. The descriptor "independent" should be removed.

…..The TEG provided comments on a preliminary draft of this report. The TEG's comments, and the department's response, can be viewed at Appendix D: Feedback from the technical expert group.

3 Overview of voyages

Map 1 Typical voyage routes from southern Australian ports to destination countries



Destination countries were grouped by region to reflect similar voyage routes and environmental conditions likely to be experienced by cattle during voyages by sea (Table 1). As Pakistan-bound export vessels take a similar voyage route as those to Persian Gulf countries, Pakistan has been included in this region. One voyage in 2016 exported animals to both Israel and the Russian Federation and has been included in the Russian region due to the voyage length and route.

VALE COMMENT: It is of potential concern that Ashdod and Haifa have been grouped with Eilat and Aqaba. Voyages to Ashdod and Haifa require transit through the Suez Canal and should have been analysed separately if similar routes were being analysed. It would be surprising if voyages from Australia had Ashdod or Haifa as destinations as it adds 2 days and considerable expense to the voyage. These ports are usually only employed in live export voyages from Europe.

Table 1 Destination regions, countries and ports

Region	Country	Port
China	China	Beihai, Caofeidian, Dafeng, Dalian, Dongying, Fuzhou, Huanghua, Jingtang, Lianyungang, Macun Port, Ningbo, Qingdao, Qinhuangdao, Qinzhou, Rizhao, Shidao, Tangshan, Tianjin, Weifang, Xiamen, Yantai
Red Sea	Israel, Jordan	Ashdod, Eilat, Haifa, Aqaba
Persian Gulf	Kuwait, Oman, Pakistan, Qatar, UAE	Kuwait, Shuwaikh, Muscat, Sohar, Sultan Qaboos, Karachi, Doha, Jebel Ali
Russian Federation	Russian Federation	Novorossiysk

From 2016 to 2020, 31 vessels were used to export *Bos taurus* cattle from southern Australian ports to the specified regions. Frequency of use was variable, with one vessel undertaking just one voyage whilst another vessel undertook 20 voyages. On average, each vessel sailed 7 times.

3.1 Overview by class of cattle

Live export cattle are categorised according to end use. Feeder cattle are generally lighter as they will be fattened in the importing country prior to slaughter. In comparison, slaughter cattle are generally heavier with higher body condition scores, as they are slaughtered a short period after arrival at destination country. Breeder cattle include cows, heifers and bulls intended to be used for breeding. Voyage data indicates the average weights for breeder and slaughter cattle are around 300kg and 550kg respectively. While exact figures are not available it is estimated that over 80% of breeder exports are dairy breeders.

VALE COMMENT: The industry/Government should have accurate information on breeder exports and if this is not available, a recommendation should be made, in the interests of "further research", that this information be accurately recorded and made publicly available.

Feeder and slaughter cattle are exported under the same ASEL conditions. There are additional conditions and pregnancy testing requirements for pregnant cattle outlined in Appendix A.

The majority of voyages (60.7%) …..

4 Science of heat stress

4.1 Physiology of heat stress

High thermal heat load occurs when animals are subject to hot environmental conditions, especially when accompanied by high humidity, and cannot remove heat generated by metabolic processes in the body (Collins, Hampton & Barnes 2018). A possible outcome of excess heat load is heat stress, for which various definitions are available in scientific papers. According to De Rensis et al. (2015) heat stress occurs when an animal's normal biological responses to hot conditions can no longer maintain body temperature at its resting level. The Meat and Livestock Australia Veterinary Handbook describes heat stress as a state where animals are responding to excessive heat load (Jubb & Perkins 2019). A definition is also provided by Barnes et al. (2004):

> Heat stress is a term used to denote a state where an animal is responding to adverse hot conditions. Under such conditions an animal can respond to the heat by making physiological changes and adjustments within the body, so that it can survive in that environment. These changes will act to keep critical systems and mechanisms within the body functioning. However, if the heat load experienced by the animal becomes excessive, the critical functions may no longer be maintained, and clinical disease, collapse and even death can result. Such a situation may be described as severe or clinical heat stress.

VALE COMMENT: This definition is somewhat confusing. The same paper (Barnes et al 2004) defined the ***heat stress*** *threshold (HST) as "*the WBT at which cattle are no longer able to maintain their normal body temperature". If heat stress denotes inability to maintain normal body temperature (as also used in *Stockman et al (2011), Caulfield et al (2014)), then heat stress would appear to have been well defined. VALE recommends removal of this particular definition/paragraph to avoid confusion and to continue with the definition of heat stress as exceeding the HST, a logical, previously published definition.*

An animal's behavioural and physiological response…..

Behavioural and physiological changes associated with heat stress in cattle vary according to the severity of the heat stress (Table 2).

Table 2 Behavioural and physiological responses to heat stress in cattle

Mild to moderate heat stress	Severe heat stress
Agitation/distress	Frothy discharge from mouth or nose (pulmonary oedema)
Depression	Ataxia
Tendency to seek shade	Refusal to move
Refusal to lie down or lying in any wet areas	Collapse
Crowding around water troughs	Convulsions
Increased water intake	Coma
Reduced feed intake	Death
Increased respiratory rate	
Open mouth panting	
Increased heat rate	
Elevated rectal temperature	
Excessive salivation	

Source: Jubb & Perkins (2019); Parkinson et al. (2019)

The department notes that there are differing views on what constitutes whether an animal is 'heat stressed'. Despite much scientific research over many years on the subject of heat stress in livestock, there is yet to be any scientific consensus that clearly identifies the point when an animal changes from responding to increased heat (being heat affected) to being 'heat stressed'. Heat stress at the extremes appears to be clearly identified, however, the transition point and the impact of duration remain undefined.

VALE COMMENT: Heat-affected implies an impact on animal welfare as does heat stress. As such, the differences in definitions are semantic. It is disappointing that the TEG did not advise DAWE of a contemporary definition (or that if that advice was provided, it was not followed), especially given the wealth of research experience in this field of one of its members. Alternatively, there should have been a statement that any heat affected animal has an adverse animal welfare state under the Five Domains, especially if heat affected for any significant period of time (with significance defined by the reviewers). This section of the draft report has a strong emphasis on physiology rather than animal welfare with the exception of the following paragraph.

In the recently completed Animal Welfare Indicators Pilot for the Livestock Export Industry Supply Chain (Collins et al. 2021), industry proposed a range of indicators to assess the ability of livestock to cope with periods of heat and humidity and to better understand the welfare impact of heat. Indicators included panting scores, feeding behaviour score, posture, resting, drinking and ruminating. This pilot proposed twice daily recording of panting scores and other measures during voyages, as this would

improve the ‘understanding of the welfare impacts of thermal loading in a live export context, as well as the degree and duration of heat that types of livestock can cope with and respond to’.

4.2 Assessing heat load

4.2.1 Measuring heat load in the environment

Thermal load can be measured through WBT, temperature humidity index, heat load index, and equivalent temperature index. As noted by Collins, Hampton, Barnes (2018), numerous studies have used WBT as the measurement to assess heat load in live animal exports as WBT incorporates both air temperature and humidity. This is relevant because an animal’s ability to dissipate heat via evaporative means is highly dependent on the level of moisture in the air.

The Temperature Humidity Index (THI) …

The Australian feedlot industry uses a web-based service providing weather and heat load forecasts to feedlot operators, called The Cattle Heat Load Toolbox. The model integrates weather station data to predict the Accumulated Heat Load Units (AHLU). The AHLU give an indication of the amount of heat that is accumulated by an animal when it is exposed to hot environmental conditions. AHLU incorporate factors such as intensity and duration of heat, the opportunity to dissipate heat, animal factors and mitigation measures (Burchill et al. 2021). This model is not currently used to assess heat load on live export vessels.

VALE COMMENT: The report provides no insight as to why the AHLU is not used.

The Equivalent Temperature Index (ETI) is ….

4.2.2 Duration of increased heat load

Duration is important in defining heat stress but is currently not well defined. Heat stress can result from short periods of extreme heat or extended periods of hot conditions (Collins, Hampton & Barnes 2018) Diurnal and day-to-day variation in deck WBT means that periods of heat stress might be interspersed by respite periods, such as overnight, during which an animal’s physiology can recover. The welfare impacts for cattle experiencing periods of increased WBT are likely to be more severe if there is no respite. However Collins, Hampton & Barnes (2018) and the HSRA Technical Reference Panel (2019) noted that no studies have been conducted on the necessary duration of respite periods needed to protect livestock from heat stress.

The department was unable to assess the effect of duration of increased heat load in this review because daily voyage reports only require a single daily temperature measure. The full range of temperatures experienced in any 24 hours is not available for analysis. It is possible that cattle experienced periods of respite from hot conditions between daily temperature measurements.

VALE COMMENT: Given that the Equator is one of the main regions of concern and that there is limited diurnal variation in the Equator, respite is unlikely during heat load/heat stress events. It is accurate to comment that “it is possible”. However, it is not likely, evident or assessable from the industry’s own reports, thus should be presumed to be uncommon (in the interests of animal welfare and if industry is incapable of providing the data). In addition, whilst there has been no such work in cattle, there is evidence in sheep for cumulative effects of heat stress (Stockman et al 2011 as analysed in Caulfield et al 2014). When evidence is lacking in one species, it is acceptable in “evidence-based medicine” to use evidence from another appropriate species with similar issues in a similar simulated environment.

4.2.3 Measuring increased heat load in animals

The assessment of increased heat load ….is best determined from the effects of heat on the animal's behavioural and physiological responses. An obvious method is the measure of core body temperature, but this is impractical for shipped animals. Panting score is a frequently used practical measure, although panting is both a response to increased thermal exposure and an indication that the animal continues to require heat loss to maintain homeostasis (HSRA Technical Reference Panel 2019).

With increasing heat load, Jubb & Perkins (2019) explain that cattle will sweat, drink more water and increase their respiratory rate. On board export vessels, animals may move towards ventilation fans and away from ship structures that radiate heat near pen areas. Feed intake and rumination is often decreased which may assist in lower metabolic heat output. These physiological and behavioural signs can be useful in assessing livestock response to heat.

Panting scores are a non-invasive, non-intrusive visual tool that may be used in conjunction with respiratory rate and effort as an index of heat stress (HSRA Technical Reference Panel 2019). Gaughan et al. (2008) outlined a panting score table for cattle. A slightly modified version is provided in the MLA veterinary handbook and was recommended for continued use by the TAC (Table 3). According to the MLA Veterinary Handbook (Jubb & Perkins 2019) in assessing cattle, if more than 10% of animals have a panting score of 3.5 or higher, then there is a potential for serious losses if steps are not taken quickly to allow animals to dissipate heat'.

Table 3 Panting score used in the assessment of heat stress in cattle

Breathing pattern	Panting Score	Respiratory Rate (breaths per minute)
Normal – no panting, difficult to see chest movement.	0	<40
Slight panting, mouth closed, no drool or foam. Easy to see chest movement.	1	40–70
Fast panting, drool or foam present. No open mouth panting.	2	70–120
As for 2, but occasional open mouth panting. Tongue not protruding.	2.5	70–120
Open mouth + some drooling. Neck extended and head usually up.	3	120–160
As for 3 but with tongue out slightly and occasionally fully extended for short periods. Excessive drooling.	3.5	120–160
Open mouth with tongue fully extended for prolonged periods + excessive drooling. Neck extended and head up.	4	>160
As for 4 but head held down. Cattle "breathe" from the flank. Drooling may cease.	4.5	Variable – RR may decrease

Source: MLA Veterinary Handbook (Jubb & Perkins 2019) adapted from Gaughan et al. (2008)

4.3 Managing increased heat load

4.3.1 Stocking density and pen space allocation

Stocking density considerations relevant to Australian livestock exports were discussed extensively by the TAC in section 3 of the 2018 ASEL sea review:

> It is universally accepted that the amount of space provided to animals during periods of confinement is critically important for their health and welfare. Stocking density governs important elements of body posture and behaviour, including social interaction. It also affects access to fodder and water, influences susceptibility to disease and has a strong influence on heat load experienced by confined animals. (ASEL Review Technical Advisory Committee 2018)

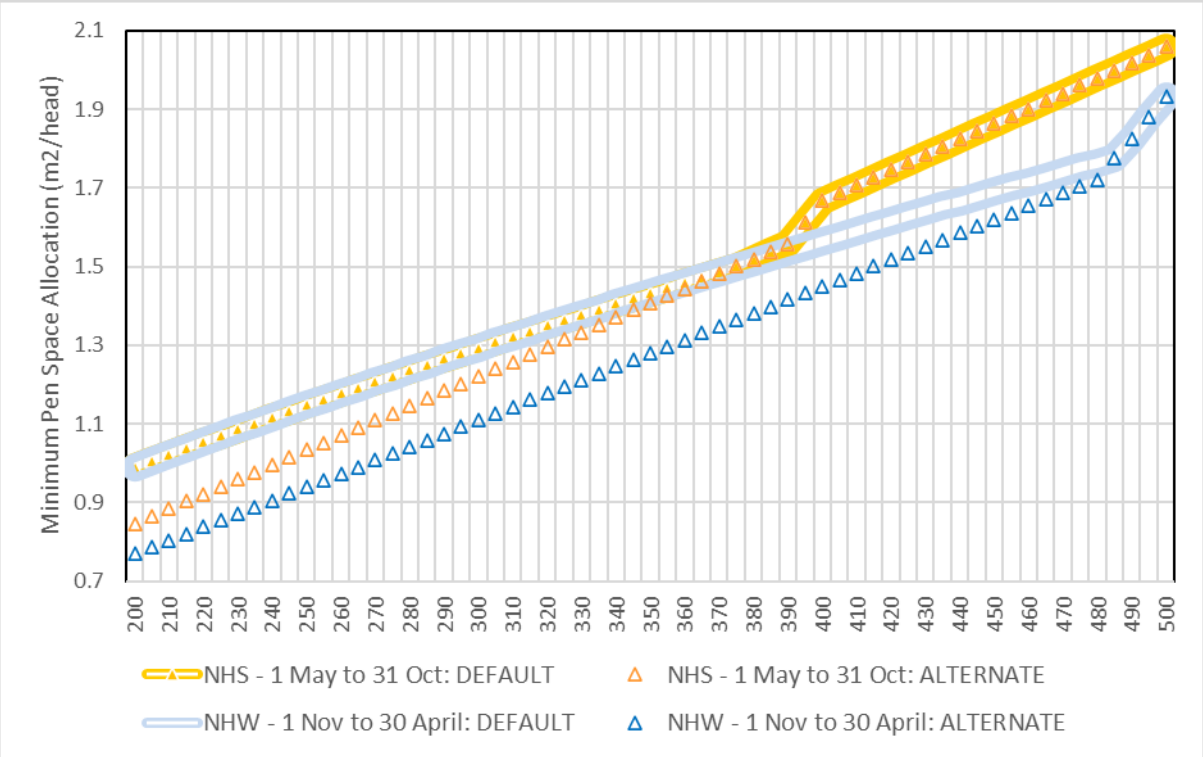
Allometry is the study of the relationship between body size to animal shape and behaviour. The TAC recommended that allometric principles were incorporated into ASEL 3 for calculating pen space allocations, with the proviso that no animal will receive less space than under ASEL 2.3.

For cattle, the TAC determined that animal welfare outcomes on most export voyages could be improved if animals are provided with more space. The TAC recommended that the default pen space allocation for cattle voyages be based on a “k” value of 0.030.

> *VALE COMMENT: Given the improvement in welfare and mortality after this change was implemented on live sheep export voyages, it should have been adopted, as a minimum, for cattle voyages in ASEL 3.2 (2021). The fact that it was not adopted, indicates that neither industry nor Government are committed to improving animal welfare. It should be noted that space allowance for cattle requires a minimum k-value of 0.033 to reduce risk of adverse welfare outcomes (Petherick and Phillips 2009). It is unclear why ASEL 3.2 (2021) uses a k-value of 0.030 in its default settings as this space allocation may not allow cattle to rise and access feed and water troughs. That an alternative arrangement for all months of the year with lower k-values was added to ASEL 3.2 (2021) despite the TAC recommendation indicates that both the industry and DAWE favour economic considerations over cattle welfare.*

Other considerations also impacting pen space allocations for cattle exported from Australia …..

Figure 1 ASEL 3 pen space allocations for voyages departing from south of latitude 26 deg south - northern hemisphere summer vs northern hemisphere winter with alternative pen space options included



Alternative pen space allowances are available to exporters who meet the criteria set out in department's Alternative Minimum Pen Space Allocation Policy. For cattle sailing from 26° south, the alternative pen space allowance tables under ASEL 3 have been sourced, unchanged from ASEL2.3. This means:

- During the NHS, the **alternative** pen space allowances for cattle under ASEL 3 are the same as the **standard** pen space allowances for cattle during the NHS under ASEL 2.3
- During the NHW the **alternative** pen space allowances for cattle under ASEL 3 are the same as the **standard** pen space allowances for cattle during the NHW under ASEL 2.3.

VALE COMMENT: As per previous comment ie TAC made a recommendation that was not adopted.

For exports departing in the NHS, the default and alternative pen space allowances are the same for cattle over 370kg.

VALE COMMENT: That is, not using k=0.030/0.033 as advised and no change to space allocation from ASEL 2.3.

For exports departing in the NHW, the default and alternative pen space allowances are the same for cattle over 485kg. This is a result of the minimum pen space allowances under ASEL 2.3 for heavier cattle being greater than the pen space allowance calculated using the allometric formula with a constant of k=0.030. The department applies the principle of using whichever pen space allowance that gives the most room for the individual animal.

Default and seasonal space allowances also make some provision for a normal range of climatic conditions, but not for exposure to periods of high heat and humidity. Efforts to manage this welfare risk factor have been made through the application of a HSRA model. MLA developed a proprietary

HSRA model called 'HotStuff' which manipulates stocking densities depending on a variety of inputs. It relies on climatology from the specific export routes and destinations. The most recent version in use, 'HotStuff' Version 4 released in 2012, has been applied to sheep and cattle exports to the Middle East. 'HotStuff' Version 4 does not include climatology for non-Middle East countries so is not applicable to many of the destinations considered in this draft report. The TAC recommended 'HotStuff' be upgraded to cover all destinations for Australian livestock exported by sea. The recommendation was accepted by the Australian Government, however, at the time of writing an updated version of 'HotStuff' has not been released.

VALE COMMENT: The TAC report was in 2018 and in 2021, no new version of HotStuff is available. Three years is an unacceptable time frame especially considering that the recommendation was prompted by a heat stress event exposed in 2018. In addition, given the extent of research and reviews since 2012, it is unacceptable that this industry should be allowed to operate using a 9 yo model that has proved ineffective (ie did not prevent the events highlighted by the 2018 Awassi Express *footage) when measures implemented for sheep after the* Awassi Express *exposé (without requiring "further research") proved successful. This would imply that significant changes only occur after media exposés and that that the rate-limiting step for improvement is the lack of a media exposé of a heat-affected cattle voyage.*

Impacts of stocking density on heat stress

There are direct and indirect impacts of stocking density on heat stress. The more cattle that are in a pen or on the deck of a ship:…..

Control over both the provision of water and feed are potentially important in managing heat stress risk. One early submission to the *Bos taurus* review claimed cattle can drink up to 20% of their body weight as water a day when hot, stressing the need for *ad libitum* water during voyages. Voyage reports have noted crew regularly assessing the number and placement of water troughs during hot periods. Savage et al. (2008) stated that offering chilled water to animals may be a useful method to decrease body temperature during times of high heat load but noted that cattle will drink greater volumes of warm water. The department would welcome feedback on the efficacy and practicality of chilled water as a heat mitigation measure on board live export vessels.

VALE COMMENT 1: This statement indicates a serious disconnect between DAWE and the reality of live export voyages. It is not possible to provide chilled water when critical WBTs are reached as the air and all structures and substrates will equilibrate to the ambient WBT unless air-conditioning (not available) is also provided. In addition, any such comment would imply that cattle can sip away at this chilled water ad lib, which is not the case for animals that don't have easy access to water troughs (space allocation less than k = 0.033). In heat stress events, with water trough space at a premium, the most important criteria is volume of water – chilled water would be difficult/impossible to drink in the quantities required and animals would likely die of dehydration.

VALE COMMENT 2: In addition, one scientific study in dairy cows (Stermer et al 1986) found that "chilled water was only about 32% effective in reducing body temperature, and it is doubtful if the effect was prolonged enough (about 2 h) to keep the body temperature of cows from rising above the critical temperature of thermoneutrality."

..Voyage reports often mention minimising unnecessary handling and disturbance of animals to avoid unnecessary physical exertion. This management practice, particularly if used in combination with other practices outlined above, could reduce the impact of hot conditions.

VALE COMMENT: This is inaccurate. Reduced handling does not reduce the impact of hot conditions. It just prevents exacerbation of problems in those conditions.

Determining the effectiveness and appropriate use of mitigating measures is outside the scope of this review. Further analysis to determine the most effective mitigation strategies to manage heat stress risk is encouraged.

4.4 Animal factors influencing heat tolerance

The review of the literature and information from early submissions to this review have highlighted the animal factors that may influence an animal's ability to tolerate heat……

4.4.5 Concurrent illness

Sick and recovering cattle are more susceptible to heat stress (Gaughan et al. 2008). Lees et al. (2019) noted that 'The health status of an animal can significantly influence the ability to cope with heat load conditions.' A study by Brown-Brandl et al. (2006) reported that animals with a previous treatment history for pneumonia, anytime from birth to slaughter, had respiration rates that were on average 10.5% higher compared to those never diagnosed or treated. The net effect of fever related to illness, and concurrent exposure to heat load increases the risk of adverse outcomes including death.

The most common cause of mortality during live export was reported as bovine respiratory disease (BRD) (Moore et al. 2015). BRD negatively impacts an animal's ability to utilise evaporative cooling via the respiratory tract which may increase their susceptibility to heat stress.

VALE COMMENT: It is concerning that the draft report did not note that stress of any cause and especially cumulative stress can increase susceptibility to infectious diseases. Heat stress may predispose to BRD just as BRD can predispose to heat stress. Voyage reports can highlight BRD to deflect from the issue of heat stress (as per specific details provided to Mr Ross Carter, Independent Inspector General).

4.6 Heat stress thresholds

Maunsell Australia Pty Ltd (2003) described the HST as 'the maximum ambient WBT at which heat balance of the deep body temperature can be controlled using available mechanisms of heat loss.' This would suggest that the HST itself is not a measure of poor welfare but rather the maximum temperature at which an animal maintains homeostasis. Barnes et al. (2004) state the HST is the WBT at which cattle are no longer able to maintain their normal body temperature.

For this review, we did not seek to determine temperatures for HSTs for exported live *Bos taurus* cattle. ……

An industry paper describing the development of the heat stress risk assessment model 'HotStuff', provides a table of HSTs for various breeds of cattle (

Table 4) (Maunsell Australia Pty Ltd 2003). According to this research, a 300kg *Bos taurus* beef breed, with body condition score of 3, mid-season coat, spring/summer acclimatised for southern Australia has a HST of 30°C WBT. A *Bos taurus* dairy breed with the same characteristics has a HST of 28.2°C WBT. *Bos indicus* and *Bos indicus* crosses by comparison have higher HSTs.

Table 4 also lists mortality limits (MLs) which are described as the WBT at which an animal will die. It is important to note that the difference between the base HST and the base ML ranges from 3.2°C to 4.7°C WBT.

Table 4 Base heat stress threshold and mortality limit values

Base Parameter	*Bos taurus*		*Bos indicus*		
	Beef	**Dairy**	**Beef**	**25% indicus**	**50% indicus**
Weight (kg)	300	300	300	300	300
Core temperature (°C)	40	40	40	40	40
Body condition score	3	3	3	3	3
Coat	Mid	Mid	n/a	n/a	n/a
Acclimatisation (WBT)	15	15	15	15	16
Base HST (WBT)	30	28.2	32.5	31.25	31.875
Base ML (WBT)	33.2	32.9	36.0	34.6	35.3

Source: Maunsell Australia Pty Ltd (2003)
*n/a Not applicable.

The MLA Veterinary Handbook (Jubb & Perkins 2019) provides guidance on WBTs with regards to heat stress (Table 5). It notes that *Bos taurus* cattle are comfortable below 26°C WBT but that over 30°C WBT is considered a 'danger' zone.

VALE COMMENT: As Dr Jubb is an experienced live export veterinarian and both Drs Jubb and Perkins have strong academic credentials, then it would appear prudent to accept the WBT recommendations of Jubb and Perkins (2019) published by industry and based on shipboard experience rather than pontificating about heat-affected vs heat load vs heat stress from a variety of academic physiology studies.

Table 5 WBT risk criteria for heat stress on export vessels

	Safe	**Caution**	**Danger**
Bos indicus cattle	< 28°C	28–31°C (non-acclimatised) 30–33°C (acclimatised)	>31°C (non-acclimatised) >33°C (acclimatised)
Bos taurus cattle	<26°C	26–30°C	>30°C

Source: Jubb & Perkins (2019)

5.0 Heat load voyage analysis

Industry submissions, the literature review and the data available from end-of-voyage, daily and IO reports identified 4 possible risk factors that may be associated with increased heat load and heat stress-related mortalities. These were:

- cattle class (breeder, feeder, slaughter)

- season of departure (ASEL season either NHW or NHS or April, May, June season (AMJ season))
- destination region (China, Persian Gulf, Red Sea, the Russian Federation)
- departure port (Portland, Geelong, Port Adelaide, Fremantle and Geraldton)…..
- ……We found that determining the occurrence of heat stress as distinct from a normal physiological response to heat was challenging:
- ……Science has not yet determined the explicit moment or threshold that cattle become heat stressed, and existing views among interested stakeholders in the live export trade vary significantly. This moment or threshold varies between a species of cattle for reasons discussed in section 3.4

VALE COMMENT: As per previous, the industry handbook by Jubb and Perkins (2019) should have been the guide to best assessment/practice for generalisations. There will always be differences in individual animals and situations so the industry's own guide by these authors should be regarded as an appropriate guide.

- Under ASEL 2.3, reporting requirements for daily voyage reports were limited. A single measure per voyage per day of respiratory character (normal, panting or gasping) was the minimum heat stress-related requirement. In some cases this may have been presented as a single measure per deck. Around 2018/2019 some exporters voluntarily included daily deck heat stress measures and/or panting scores in voyage reports. Rankings were not necessarily consistent and it is unclear what panting score system was used (possibly that described in the MLA Veterinary Handbook)
- A single measure of respiratory character or panting score per voyage or per deck per day means the reporter provided an 'averaged' reading even if it applied across species. This measure does not provide any information about the range of behaviours across the vessel. It also does not provide visibility about what happened in between daily reports
- Voyage reporting also only provided a single deck temperature per day. This means we have limited knowledge of the effect of duration of high temperatures and limited ability to determine if the cattle were experiencing periods of respite.

VALE COMMENT: It is evident from IO Summaries that the deck temperature reports were often an inaccurate representation and frequently, for Middle Eastern voyages, performed in the morning before maximum WBT reached (See: https://www.vale.org.au/io-reports.html).

5.1 Evidence of hot conditions

Voyage reports under ASEL 2.3 provide a single daily deck temperature as well as ambient temperatures and bridge temperatures. The time that temperatures are recorded is assumed to be at the same time each day but this was not reported. The department was therefore unable to assess daily temperature ranges.

VALE COMMENT: It is inexplicable after analysis of the IO reports and summaries and the IO comments, why DAWE has not insisted on multiple temperature recordings at standard times. Collecting the data from voyages is of no value if DAWE continues to accept sub-standard data and to make no changes to the required data collection.

The department collated maximum WBTs reported for each voyage. The average maximum daily WBT across all voyages was 29.2°C WBT with a range of 25°C WBT to 34°C WBT. The highest maximum of 34°C WBT was recorded on one voyage in April (Table 6). Out of 214 voyages, 213

(99.5%) voyages recorded at least one day of 26°C WBT or greater while 75 voyages (35%) recorded a maximum of 30°C WBT or greater (Table 6).

VALE COMMENT: Jubb and Perkins (2019) indicate that Bos taurus cattle are comfortable when the WBT is 26° or less implying that that some cattle on nearly all (99.5%) voyages experienced heat that was uncomfortable. In addition, 35% voyages were in the "danger" zone of >30° WBT. As such, the conclusion that only 25% of voyages were reported by industry to be affected is likely to be a significant under-estimate and this should be noted in the report.

Table 6 Maximum voyage wet bulb temperature from 214 voyages (2016 to 2020)

Maximum temperature on voyage (°C WBT)	Voyages with at least 1 day at or above maximum temperature
26	213 (99.5%)
28	189 (88.3%)
30	75 (35.0%)
32	16 (7.5%)
34	1 (0.5%)

……

5.1.3 Voyages recording heat stress-related mortality

We collated data on voyages which reported at least one mortality related to heat stress. Our case definition for heat stress-related mortality was any mortality where the cause of death was reported by the AAV or stockperson to be due to heat stress or associated with heat stress. Each heat stress-related mortality was classified as either primary, 'combined' or other. A primary heat stress mortality was recorded where the reporting clearly identified heat stress as the cause of death. A 'combined' heat stress mortality was recorded where the cause of death was not attributed to heat stress alone but often listed as a differential diagnosis with other diseases. The 'other' heat stress mortality category included deaths associated to heat stress in the reports that were unable to be classified as primary or combined. Due to limited detail provided in the voyage reports, the analysis could not question the accuracy of the reported causes of death.

VALE COMMENT: There have been recommendations from numerous reviews and submissions since 2018 to improve record-keeping so the ongoing status quo of limited detail is evidence of industry and/or Department recalcitrance to be proactive and implement acceptable records.

……

5.2 Analysis of risk factors for increased heat load and heat stress related mortality

5.2.3 Summary of cattle class analysis

- Over 1 in 3 slaughter class voyages (33.4%) experienced heat load and over 1 in 4 slaughter class voyages (27.3%) reported at least 1 heat stress-related mortality

VALE COMMENT: That one third of slaughter animal voyages have heat as a significant animal welfare issue with at least some mortality on nearly all those voyages (27.3% vs 33.4%) is

unacceptable from an animal welfare perspective. The report should contain recommendations to be instituted immediately to mitigate this animal welfare issue.

- A significant association was identified between cattle class and the occurrence of a heat load voyage
- Slaughter cattle voyages have 4.0 times the odds (95% CI 1.42 – 12.05) of experiencing increased heat load than breeder cattle voyages (P = 0.010) and
- Slaughter cattle voyages have 4.33 times the odds (95%CI 1.34 – 15.95) of experiencing increased heat load than feeder cattle voyages (P = 0.018).
- Slaughter cattle voyages are significantly more at risk of heat stress-related mortality compared to voyages carrying breeder cattle, independent of the effect of increased heat load.
- Slaughter cattle voyages have 38.8 times the odds (95%CI 4.80 – 561.10) of heat stress-related mortality compared with breeder cattle voyages.

VALE COMMENT: As beef can be provided as chilled/frozen meat, a reasonable suggestion would be to stop exporting cattle for slaughter and confine Bos taurus export to the feeder/breeder trade. An alternative would be to cease export of slaughter cattle from at least April/May until September/October (the highest risk months) with chilled/frozen meat providing an alternative during this period.

5.2.5 Summary [Season of voyage departure]

- A greater proportion of voyages with evidence of increased heat load occurred during the NHS (28.6%; n=26) compared to NHW (22.0%; n=27)
- Approximately 1 in 10 voyages departing in the NHS resulted in at least 1 heat stress-related mortality. A lower proportion of departures in the NHW resulted in heat stress-related mortality (1 in 30)
- Voyages that departed in April, May or June had 2.43 times (95%CI 1.22 – 5.63) the odds of heat load or mortality than those departing during other months of the year
- There was no independent effect of voyages departing in April, May or June on mortality, but the significant effect of heat load on mortality includes an effect of AMJ season
- Further investigations into the substantially higher mortality rates for slaughter cattle on voyages departing in late autumn and early winter would be useful to explain the trend.

VALE COMMENT: "Further investigations" are not required. The evidence should prompt immediate action to restrict/cease export of slaughter cattle in late autumn/early winter. This review was prompted by welfare concerns which need to be addressed in the short term, not as a tool to identify potential areas of future research by industry-funded scientists and academics.

5.2.6 Voyage destination region

The proportion of voyages with evidence of increased heat load by destination region ranged ……..

However, some of these vessels only conducted a small number of voyages during the review period so significance is unclear. **Error! Reference source not found.** shows vessels that experienced a heat stress-related mortality. Vessel 'F' reported 1 voyage with heat-stress related mortalities from a total of 2 voyages (50%). In contrast, vessel 'G' reported 4 voyages from a total of 15 voyages with heat stress-related mortalities (27%). There are factors relating to vessels, such as ventilation rates and the impact of changes to air flow requirements which had to be implemented by 1 January 2020

under Marine Order 43 (2018), that may influence voyage outcome. Further analysis of the influence of vessel on heat stress outcomes is necessary to determine significance.

VALE COMMENT: Vessel factors should be considered as a matter of urgency rather than waiting for review at another unspecified time. The DAWE have data and it is clear from responses to IO Summaries, that the DAWE/AMSA do not act to improve conditions on ships despite repetitive issues being noted (Correspondence from VALE to Tina Hutchinson on 4 March 2020 - See: https://www.vale.org.au/gov-correspondence.html).

…

5.3 Summary of key findings

Heat load:

- Approximately 1 in 4 long-haul *Bos taurus* voyages from southern Australia reported signs of increased heat load in 1 or more animals.
- These voyages covered all classes of cattle, to all destinations and from all departure ports in the review and departed during both the NHW and NHS.

Heat stress-related mortality:

- 6.5% of voyages recorded at least one heat stress-related mortality
- Approximately 2 in 3 heat stress-related mortalities were in combination with another issue. This issue was most commonly respiratory disease.

VALE COMMENT: This should be rewritten as "were reportedly in combination" as the accuracy of records and final diagnoses has been noted as problematic in the draft report.

….

5.4 Discussion and recommendations

5.4.1 Challenges faced

One of the challenges encountered during this review was that the analysis was highly dependent on voyage reports and therefore limited by the quality and quantity of available data in these reports. Determining the reliability of the reported data for accuracy and completeness was also challenging. There were some inconsistencies in voyage reporting which could not be explained. For example, some voyages recorded high deck temperatures, where historical studies suggest the cattle should have been showing evidence of increased heat load, but no evidence was reported. It is not known if this was a true occurrence or inaccurate reporting. Indeed, two voyages included reports of at least one mortality documented as heat stress, but with no reports that other cattle were showing signs of responding to increased heat. This seems illogical and raises questions about the accuracy and completeness of the dataset. This is further discussed in section 5.5.

VALE COMMENT: It is unacceptable that the quantity, quality and accuracy of the records is so limiting to this external review. The industry has had adequate time to improve record keeping in line with recent review recommendations but no changes have occurred. Independent oversight of a representative number of records is required on an ongoing basis with exporters penalised for inadequate/inaccurate/inconsistent records. Of concern is that the DAWE have not noted these discrepancies and demanded changes. VALE has consistently noted problems with daily voyage reports and End of Voyage reports since 2012 and has repeatedly raised these concerns with the

DAWE (https://www.vale.org.au/gov-correspondence.html). VALE has also raised the same concerns with proof/documentation with Mr Moss and Mr Carter.

Under ASEL 2.3, reporting requirements for daily voyage reports were limited. For example, a single measure per voyage per day of respiratory character or panting score was the minimum heat stress related requirement. This means the reporter provided an 'averaged' reading which does not provide any information about the range of cattle behaviours observed across the vessel. It also does not provide visibility about what happened in between daily reports. Voyage reporting also only provided a single deck temperature per day, meaning we have limited knowledge of the effect of duration of high temperatures and limited ability to determine if cattle were experiencing periods of respite. Where exporters voluntarily included daily deck heat stress measures and/or panting score, it is unclear whether the rankings within these were consistent and it is unclear what panting score system was used (possibly that described in the MLA Veterinary Handbook).

The timing and nature of changes introduced on 1 November 2020 under ASEL 3 made it challenging to determine how many pertinent factors may change or improve through ASEL 3 alone. The department notes that changes introduced under ASEL 3 may address some of the welfare issues raised in this export supply chain. We have tried to acknowledge these improvements when discussing findings and recommendations throughout our report.

VALE COMMENT: VALE is concerned that the industry may deny the issues identified in this report under the guise that all is fixed in ASEL 3.2. VALE recommends that the 2021 data is analysed similarly in a timely fashion so that any improvement or lack of improvement can be objectively assessed with appropriate action taken. Whilst this draft report is important, it can be dismissed by industry as "historical data" unless annual reviews are now performed to allow accurate and ongoing assessment.

…We acknowledge it may not be possible to fully 'correct' for some of these confounding factors.

5.4.2 Discussion

The department's analysis shows that increased heat load can occur in across all classes of cattle, exported to any destination, from any departure port and in any season. For this reason it is recommended that heat stress risk management measures should be employed all year round for all classes of cattle to all destinations.

VALE COMMENT: The word "should" implies optional. VALE request the wording be changed to "must".

This concurs with the TAC recommendation that heat stress risk assessment should apply to all *Bos taurus* cattle exports from southern Australian ports on voyages that will cross the equator with the additional recommendation that measures should be conducted all year, not just between 1 May to 31 October (inclusive).

There was a significant association of heat stress-related mortality with timing of departure. Voyages that departed in April, May or June had 2.6 times (95%CI 1.22 – 5.63) the odds of heat load or mortality than those departing during other months of the year. This finding contrasts with one submission that suggested there was little evidence of seasonal difference in mortality rates. This may be due to the assessment of cause of death in this review, which focused on heat stress-related mortalities, as opposed to all cattle mortalities.

In addition to the season of departure, there was a significant association of heat stress-related mortality with class of cattle with slaughter cattle voyages having significantly higher odds of heat

stress-related mortality. One submission analysed mortality data from Reports to Parliament. This submission highlighted that voyages carrying slaughter cattle, departing southern ports in Australia during May to July appeared to have higher overall voyage mortality rates when compared with other months. This observation is supported by the findings of this review.

The increased risk of heat load in slaughter class cattle may be explained by a number of factors. The smaller surface area-to-mass ratio of these animals make it more challenging to dissipate heat. Slaughter cattle are usually heavier and fatter that other classes of livestock. Additional risk management measures for heat stress should be considered for long-haul slaughter cattle exports. Providing cattle additional space during the voyage, particularly during the AMJ season, may allow slaughter cattle to reduce heat load by evaporative losses. This could be achieved by providing cattle with more space in line with the HSRA model or a suitable allometric calculation.

VALE COMMENT: As a very minimum measure, all slaughter cattle should be afforded space allocated a "k" value of 0.033 as per Petherick and Phillips (2009).

Another potential risk factor for slaughter cattle is their diet, often grain or high in grain, which may increase metabolic heat production. As acknowledged in section 3.4 cattle fed a highly fermentable diet to increase growth rates are at greater risk of heat stress. One early submission to this review stated that slaughter cattle are often on high levels of nutrition for the purpose of maximising growth and to ensure they retain optimal bodyweight for slaughter. Another submission stated concern that 'grain-assisted' feeding practices prior to export may lead to subclinical or clinical gastrointestinal problems during the voyage that are exacerbated by heat stress.

The department does not have oversight on the feeding strategy of cattle prior to their entry into a registered establishment. Once there, we understand that all cattle are adjusted to the shipboard ration. A common mitigation measure on live export ships during times of high heat is to 'temporarily reduce or cease feeding of concentrate and consider a higher roughage proportion in ration' (Jubb & Perkins 2019). One submission to the review did suggest that further research could be undertaken to enhance the understanding of the role of diet in heat stress. It noted that 'research, to better define metabolic heat outputs directly relevant to diets and feed intakes typically encountered on livestock vessels, and their impact on individual animals and on deck temperatures … may improve management of … heat stress on livestock vessels.'

VALE COMMENT: The industry have had 40 years to do this research and have not done it. Animals should not continue to suffer whilst the Department and researchers recommend "further research".

Two thirds of heat stress-related mortalities were identified as occurring in combination with other diseases, primarily respiratory disease. This suggests that concurrent illness may exacerbate susceptibility to heat stress. The high prevalence of respiratory disease in conjunction with reported heat stress-related mortality in our analysis is consistent with findings documented in literature (Lees et al. 2019) Cattle that are transported are at risk of BRD. A vaccination is available that provides protection from the most common aetiological agents of BRD. Vaccination of cattle, particularly slaughter cattle, may therefore reduce heat stress mortalities by reducing the occurrence of underlying disease.

VALE COMMENT: Whilst concurrent illness undoubtedly exacerbates susceptibility to heat stress, heat stress also exacerbates susceptibility to other illnesses. Failure to make this conclusion is either poor science or industry bias.

We documented heat stress mitigation strategies employed during voyages, discussed in detail in section 3.3.2. These include washing decks and wetting animals, altering navigation strategies such

as zig-zagging vessels, managing hot spots and the manure pad, and feeding an increased proportion of chaff. In addition, 1 submission highlighted other possible mitigation strategies that were beyond the scope of this review, including genomic selection of cattle. It is not clear how these strategies are used as a planned approach to mitigate heat stress. It is also not clear how effective these strategies are. We suggest that further research into heat stress mitigation strategies by industry is warranted.

VALE COMMENT: "Further research" is not going to change WBT on ships. Animals should not continue to suffer whilst "further research", benefiting both the industry (delaying any changes until the definitive article appears) and academics (recipients of large research grants) occurs. The focus here should be on animal welfare with immediate reduction of known risk factors identified in this and other reports eg class of animal, sailing times and space allowances.

Heat load and heat stress-related mortalities

Findings

1. There was evidence of increased heat load during long-haul Bos taurus voyages from southern Australia can occur in all classes of cattle (breeder, feeder or slaughter), to all destinations, from all departure ports and departing during both the northern hemisphere winter and summer.

2. *Bos taurus* slaughter cattle on voyages departing from southern Australian ports are at a higher risk of increased heat load than other classes of cattle.

3. *Bos taurus* slaughter cattle on voyages departing from southern Australian ports are at a higher risk of heat stress-related mortality than breeder cattle,

4. Two thirds of heat-stress-related mortalities were identified in combination with an underlying disease, primarily respiratory disease.

5. Heat stress mitigation strategies employed during the voyages were reported. While mitigation strategies are applied it is not clear if these are a planned or reactive approach.

Recommendations

1. A suitable HSRA should be employed all year round for *Bos taurus* slaughter cattle to all destinations.

VALE COMMENT: The word "should" must be replaced by "must" as per previous. In addition, export of Bos taurus cattle (at least for slaughter) should be prohibited between April/May and September/October (see previous).

2. Consideration should be given to providing *Bos taurus* slaughter cattle exported from southern Australian ports during the NHS additional pen space.

VALE COMMENT: It is incomprehensible that this only warrants consideration rather than immediate implementation. This should be a mandatory change: slaughter cattle exported from southern Australian ports must be given a space allocation of k=0.033 or greater to be implemented immediately.

3. Vaccination against bovine respiratory disease may be valuable in decreasing its incidence and should be considered for voyages of *Bos taurus* slaughter cattle departing Australia from southern ports between 1 May and 31 October.

VALE COMMENT: Given that BRD has previously been identified as the leading cause of mortality of export cattle (Moore et al 2015), failure to routinely vaccinate indicates that exporters have not been proactive in improving animal health and welfare. Vaccination of southern Bos taurus cattle of all classes at all times of the year should be mandatory.

4. Ongoing examination of *Bos taurus* slaughter cattle outcomes should occur to assess the benefit of this preventative measure.

VALE COMMENT: The outcomes must be assessed in real-time and annually, not just at 5-year reviews.

5. Further investigation beyond the scope of this review is warranted to explain why slaughter cattle voyages departing in late autumn and early winter have substantially higher mortality rates than in all other months of the year.

6. Further investigation beyond the scope of this review is warranted to explain why voyages departing from Portland having greater odds of heat load compared to voyages departing from Fremantle.

VALE COMMENT: As per previous, one obvious reason is that cattle departing from Fremantle are from Zones 2 and 3 not 1 and 2 (Maunsell 2003).

7. Further research should be undertaken into the effectiveness and appropriate employment of heat stress mitigation measures.

VALE COMMENT: "Further research" is not possible without improved reporting across all aspects of the voyage eg CCTV of representative pens on all decks combined with environmental records and stockperson/veterinary records all by block-chain technology thus not subject to, and restricted by, the subjective and/or selective observations by industry-employed shipboard representatives. It should be noted that the inappropriate/inaccurate/incomplete records have been noted at every review: Moss Review, Carter Review, this particular review. This should be rectified as a matter of urgency. In addition, reduction of the incidence of heat stress should not depend on "further research" when there are practical steps that could be taken immediately to alleviate animal suffering (as per previous).

6. Other heat stress factors

6.1 Ventilation and hot spots on decks

The OIE Terrestrial Animal Health Code Chapter 7.2 Transport of Animals by Sea (OIE 2016) includes a generic requirement that the ventilation system must be adequate to meet the thermo-regulatory needs of the animals being transported. Details regarding how to achieve this are not explained and minimum requirements for air change rates, air flow rates over livestock pens or air quality parameters are not stipulated.

Australian ventilation requirements, efficacy and auditing are the responsibility of the Australian Maritime Safety Authority (AMSA). Standards applicable to ventilation of live export vessels are detailed in Marine Order 43 and

. ASEL 3 also requires daily and end of voyage reports to include any issues relating to ventilation.

MAMIC (2001) noted that the major source of deck heat is livestock-derived, from metabolic heat output.

VALE COMMENT: This is incorrect. The most important source of deck heat is ambient WBT. This is further increased by metabolic heat output from animals.

Adequate ventilation is necessary to maintain ambient conditions on decks to support welfare and physiological needs of livestock. It is also necessary to remove deck-side pollutants such as carbon dioxide and ammonia.

Additional heat sources on decks are from inefficient air intake systems (motor and fan inefficiencies) blowing frictional heat into the decks and radiated heat from walls (near engine rooms and fuel tanks), and ceilings (especially uppermost deck). Inefficient intake systems can add as much as 15% of the heat produced by livestock. Radiated heat can be significant in specific locations, also adding an amount of heat equivalent to 15% of the heat produced by cattle (MAMIC 2001).

6.1.1 Voyage analysis of ventilation and hotspots

We analysed daily and end of voyage reports for comments relating to ventilation and hot spots. Voyage reporting on ventilation was varied. Reports for:

- 5/214 (30.4%) voyages included no comment about the ventilation

VALE COMMENT: As per previous comments, this is unacceptable record keeping.

- 104/214 (48.6%) voyages included subjective comments such as 'good', 'excellent' and 'adequate' regarding the effectiveness of the ventilation
- 45/214 (21%) voyages included objective comments on functionality of the ventilation system, such as whether it worked throughout the voyage without issues or disruptions.

Reporting for 2 voyages provided actual airflow measurements. It was not clear in either case whether these were real time measurements or reporting of the vessel's known capability. The department understands that real-time airflow and air quality measurements during the voyage are possible.

*VALE COMMENT: Checking of real-time ventilation on loaded vessels (rather than empty vessels) has been requested repeatedly of AMSA by Dr Lynn Simpson, former shipboard veterinarian, in her advisory role to that body (L Simpson pers comm). It is inexplicable that this has not been instituted post-*Awassi Express *footage, where inaccurate ventilation (pen air turnover) information has been identified.*

Comments regarding issues with ventilation were generally rare. This may be because the ventilation generally worked well or may be due to under-reporting. Twenty-one out of the 214 voyages (9.8%) reported hot spots particularly near the engine room and on closed decks (Table 7).

It was not uncommon for the same vessel to receive both good comments on ventilation for 1 voyage and poor comments for another voyage. Reasons for this may be factors such as different ambient conditions, class of stock, stocking levels and competency/experience of the reporter.

The AAV on 1 voyage suspected that temperature readings on some decks were not representative of the whole deck because thermometers were placed near ventilation outlets or located centrally. Two IO reports noted that the wet bulb thermometers were not working accurately.

In a number of reports, it was noted that hot spots were destocked or lightly stocked if conditions became too warm. Rarely further detail was provided however in 1 report, the AAV made the following recommendation about stowage near a hot spot:

> It is strongly recommended that at this time of the year, the most heat tolerant cattle (ex-pastoral or *Bos Indicus* infused) be stowed in Hold 3 (on this vessel) particularly in the areas adjacent to the exhaust vents.

Only 1 voyage report provided a description of the temperature of the hot spot compared to surrounding pens. It noted that radiation heat from the engine room increased temperatures next to the engine room walls by 2°C compared to surrounding pens. The actual temperature was not noted.

Table 7 Hot spots identified in voyage reports

Vessel*	Location	Comment from reports
A	'aft section near engines'	'High temperatures'
B	Aft Deck 4 hold 2	'some known hot spots stocked lightly' 'Inadequate airflow to most pens in this location'
C		'additional fans for slow extraction areas'
D	Deck 5 hold 3	This location was noted to be hotter than other decks
E		'some known hot spots lightly stocked'
F	Deck 4 Deck 5–7	'pens under exhaust fans destocked' 'ventilation intake tower near engine room caused nearby pens to be up to 2°C warmer'
G		'areas of higher humidity had lower stocking density'
H		'one intake tower close to engine room doors can result in hot air intake'
I		'Some deficiency in airflow to small areas relative to outside conditions'
J		'Few hot spots, nearby pens lightly stocked'
K	Deck 4 hold 3	Hottest deck due to proximity to engine room
L	Deck 4 hold 3	AAV noted hot spots near engine room
M	Decks 4 & 5, hold 3	Highest heat loads observed in these areas
N	Hold 3	Hottest area
O	Deck 2 and Deck 4	'Hottest areas were deck 2 near the engine room and the whole of deck 4'
P	Decks 1–3	Increased heat load noted on these decks

*vessel labels in Table 21 do not match other lists of vessels

6.1.2 Summary of ventilation and hotspots

- Issues with vessel ventilation systems were rarely noted
- Sixteen vessels reported hot spots with 9.8% of voyages reporting hot spots
- Voyage reporting rarely provided any detail on hot spot monitoring and management unless conditions were warm enough to warrant movement of animals
- It is not clear from voyage reports how closely hot spot conditions are monitored, the extent of hot spot temperature differences with surrounding pens and whether there is any pre-determined approach or guidelines to managing hot spot areas.

6.2 Bedding and pad

ASEL 3 sets out the minimum requirements with regards to bedding on voyages. The standards require that bedding provisions be:

a) applied in a sufficient quantity that allows pens to be maintained in a manner that ensures the health and welfare of the livestock and minimises slipping, injuries, abrasions, lameness, pugging and faecal coating; and

b) applied prior to and during loading and unloading to minimise slipping during loading and unloading; and

c) be monitored routinely (at least daily) to ensure consistency and depth is appropriate to mitigate risks to the health or welfare of the livestock (Standard 5.1.10).

Bedding provides comfort and traction for livestock, improves air quality, absorbs moisture on decks and reduces humidity. The manure pad develops over pen flooring and is made up of bedding material, faeces, urine and environmental moisture. In most environmental conditions the ship's ventilation system draws moisture out of the pad allowing a firm to tacky layer to develop (Jubb & Perkins 2019).

With regards to heat stress, the main welfare risks relate to wet, sloppy pads and the amount of faeces. High ambient temperatures on a deck will cause an increase in the amount of water consumed by the livestock and when water consumption increases, urine output will also increase. The manure pad will deteriorate when animals are producing more liquid waste than the bedding can absorb and the ventilation system can evaporate. The evaporation of moisture from the manure pad will also make conditions more humid on decks (McCarthy & Banhazi 2016).

Wet pads can result in poor welfare conditions (Banney, Henderson & Caston 2009; McCarthy & Banhazi 2016) including:

- coat contamination which particularly affects medium to heavy-coated animals; when marked, this can impact the animal's ability to dissipate body heat
- limited mobility and access to all areas of a pen
- lameness and abrasions due to soft feet
- poor air quality due to ammonia
- unhygienic conditions which support the spread of disease
- reluctance to lie down, drink and feed.

Feedback during industry consultation has described differences in the way the manure pad is managed at different times of the year. In the NHW, it may be possible to undertake a final wash 3–4 days prior to arrival, with the pad remaining dry and in good condition. In the NHS, undertaking a deck wash as closely as possible to arrival is ideal, as the pad is likely to deteriorate very quickly at this time of year.

VALE COMMENT: This feedback would suggest that the main role of the final wash and improved bedding is to ensure that the ship and its animal welfare appear exemplary on arrival at the destination country. This aim was also observed in IO Summaries for voyages to China (Hing et al 2021). All deck washes and bedding changes should be dictated by the state of the bedding and the animal's welfare, not the desire to impress an importing country.

The importance of pad management has been noted in industry publications (Banney, Henderson & Caston 2009; McCarthy & Banhazi 2016). These relay the importance of pre-determined deck washing plans and use of an appropriate substrate in sufficient amounts to assist pad development and moisture absorption.

Banney, Henderson & Caston (2009) noted that:

> Based on current mortality rates and estimates of poor health attributable to bedding management, the cost of bedding is not likely to be recouped by a reduction in mortality rates alone. However, while the cost of bedding may not be justified purely in commercial terms through reductions in mortalities, lameness and possible live weight loss, addressing the welfare issues through bedding management will have a positive impact on the animal welfare image of the industry, assisting its long-term viability.

VALE COMMENT: This sums up the situation effectively. The positive welfare aspects of good bedding are not commercially justifiable so improvements to bedding have not occurred. The industry has influenced the decision in ASEL 3.0/3.1/3.2 to retain status quo despite their own publications and numerous IO Summaries/Reports recommending improvements.

6.2.1 Voyage analysis of bedding and pad

Deck washing was regularly noted in voyage reports. This was often implemented as the vessel neared humid conditions around the equator as well as at other times. The frequency of deck washes varied from not at all (n=2) to as often as every second day. Most voyage reports noted that deck washing, and substrate (sawdust or wood shavings) application was readily and appropriately used to support pad management.

VALE COMMENT: This may be reported by industry personnel but independent assessment has been discrepant. A number of IOs have been critical of bedding quantity and management and there are a number of representative photographs in the IO Summaries showing absence of bedding or inadequate bedding (Hing et al 2021).

It was rarely clear whether the approach to deck washing was pre-determined or ad hoc. Issues with deck washing included inadequate water pressure, poor drainage resulting in flooding of pens or wet pads, and inadequate frequency.

The most common pad issue related to wet, sloppy pads (n=44). This was related to humid conditions or issues with flooding or leaking pipes and troughs. A small number of voyages noted that the pad was poorly managed. This was observed or noted to be because deck washing was not frequent enough (n=6), there was insufficient substrate or substrate was sparingly used (n=8). Reported welfare consequences of inadequate pad management included coat contamination (n=1), lameness (n=4), and ammonia build up in the environment (n=2).

VALE COMMENT: The reviewers appear not to have visualised the IO Reports/Summaries in which photographs show coat contamination on numerous voyages (not n=1): see Hing et al (2021) and IO Summaries (https://www.vale.org.au/io-reports.html). The numbers provided are thus inaccurate and need to be corrected in the final report.

6.2.2 Summary of bedding and pad

- Sloppy pads were noted on 44 of 214 voyages (20.6%)

VALE COMMENT: If the China voyages were representative, it would appear that IOs must have reported sloppy pads more than industry representatives as 76% of IO Summaries for China voyages described wet sloppy pad conditions (Hing et al 2021, IO Summaries). If there is indeed a discrepancy of >50% between all voyages and IO-accompanied voyages, then this should have been noted by DAWE with serious under-reporting identified. The actual documents used in the analysis are not provided in adequate detail to assess whether IO Reports and Summaries were analysed in addition to industry's shipboard reports.

- Pad management was usually reported to be adequate with appropriate use of substrate and deck washing
- Fourteen of 214 voyages (6.5%) reported inadequate pad management

VALE COMMENT: At least 3 of the IO-accompanied China voyages (ie 8.1%), which presumably are included in the 14/214 voyages identified noted inadequate pad management. It is possible that as a higher percentage was noted in voyages accompanied by IOs, under-reporting is occurring.

- Welfare consequences of inappropriate pad management included coat contamination, lameness and ammonia build up.

VALE COMMENT: This review, industry publications and numerous submissions have identified the role of heat stress in inducing wet pads but also the role that wet pads have in increasing humidity, WBT and heat stress. Heat stress should have been included as a potential sequel to wet pads.

6.3 Water provision

Clinical observations of animals subject to high environmental heat and humidity include an increase in evaporative heat loss and an increase in water consumption (Barnes et al. 2008; Beatty 2005; Stockman 2009). It is imperative that cattle have an adequate source of clean drinking water during periods of high environmental temperatures.

6.3.1 Voyage analysis of water provision

The analysis identified voyages that recorded minor and major water provision issues and the corresponding actions taken during these voyages. Many of these issues were found to be minor and short-term and were addressed during the voyage. Examples are given below.

Displaced water troughs

There were accounts of poorly secured water troughs being knocked off railings on 3 voyages.

VALE COMMENT: It is surprising that this was identified in only 3 voyages. VALE identified 3 voyages out of 37 China voyages accompanied by IOs (Hing et al 2021). Was this only an issue on the 3/37 IO-accompanied China voyages?

In these instances, IOs reported that the issues were addressed by the crew through regular monitoring and reinstalling displaced troughs. On all 3 voyages IOs onboard reported that sufficient water was available throughout the voyage.

Water supply system issues and empty water troughs

Issues with water supply were noted on 15 (7% of) voyages. Minor and temporary issues included broken floats or valves (n=3), troughs knocked off railings (n=3), cessation to water supply for cleaning (n=4) or unknown (n=2). These issues were rectified without any reported impact to health and welfare of cattle.

More significant issues with water supply were noted on 3 (1.4% of) voyages:

- The IO report for one voyage noted issues with empty water troughs. There were several non-systemic causes. Two pens did not have water for a period when water valves were not turned on after cleaning. Empty troughs were also caused by float valves being incorrectly set. Two decks were out of water for 45 minutes when higher demand for water could not supply upper decks. These issues were addressed by the crew at the time they were noted
- On one voyage the IO report noted that drinking water to the upper decks was not supplied *ad libitum* on days 5, 7, 10, 11, 12, 13, 15, 17 and 18 as evidenced by the presence of empty water

troughs. Remedial action by the crew was undertaken on each occasion to resolve the issue and supply water. After longer outages, the cattle were queuing to drink. The department referred the water supply issue to the exporter and AMSA

- Another voyage reported issues with *ad libitum* water supply. Water and feed troughs were not properly secured to the rails and were regularly pushed off the rails by cattle. Several issues were identified relating to hose connections, broken isolating switches and a lack of spare parts. These issues meant it was not possible to leave the deck water on without supervision. Many troughs were disconnected each day when staff were not on the deck. This issue was referred to AMSA which applied conditions to the vessel's Australian Certificate for the Carriage of Livestock (ACCL), preventing it from undertaking long-haul voyages (i.e. >10 days) until actions were taken to address the drainage and trough issues. Subsequent reporting by IOs on this vessel noted only minor issues which were readily fixed.

Water quality

Issues with water quality were identified on 9 voyages. Most of these were readily addressed by the crew. Issues with rust or rusty discolouration were noted on 2 voyages. On 1 of these voyages the IO reported water lines were flushed to clear the contamination. The other voyage did not carry an IO, but the voyage report noted that the water supply needed regular attention due to rust, although no disruption to water supply was reported.

Difficulty in operating nose bowls

On 2 voyages it was noted that animals were experiencing initial difficulties in operating nose bowls. On 1 voyage the cattle took 1 to 2 days to become accustomed to using the nose bowls. A number of voyages noted that the use of nose bowls was monitored closely.

VALE COMMENT: The draft report has not recorded the mechanical breakdown of the ship's reverse osmosis (RO) unit on the Shorthorn Express (IO 55): "From day 5 of the (22 day) voyage there were periods when the cattle did not have access to ad lib water because the vessels' water generation capability was insufficient to meet demand." This is a concerning omission by the reviewers as breakdown of a RO unit is potentially a catastrophic issue. Either this was an omission by DAWE or it was not mentioned in the daily voyage reports by the industry representatives and only reported by the IO. This must be included in the final report.

6.3.2 Summary of water provision

- Issues with the provision of water were reported on 7% of voyages, while 1.4% of voyages reported more significant water supply issues

VALE COMMENT: Possibly inaccurate figure as one voyage appears to have been excluded (IO 55 as per previous).

- Water issues were generally non-systemic in nature, and usually rectified at the time
- More significant issues raised by IOs were addressed with the exporter or AMSA.

6.4 Pregnant cattle

Scientific literature describes that increased heat load impairs numerous functions associated with fertility and establishing and maintaining pregnancy (Lees et al. 2019). Heat stress may be detrimental to early-stage pregnancy and the period prior to full establishment of the placenta (De Rensis, Garcia-Ispierto & Lopez-Gatius 2015). Heat stress is also of concern in late gestation when its influence can affect milk yield after calving and have long term negative impacts on calves (Hansen 2019).

Appropriate heat stress thresholds for pregnant cattle have not been clearly defined. A study of 6 pregnant dairy heifers at 3–5 months gestation (average weight 420 ± 19kg) found the heat stress threshold to be 27°C to 28°C WBT (Barnes et al. 2008). This was based on an increase in mean daily body temperature up to 1°C and clinical signs of heat stress such as open mouth panting. Further literature on the influence of breed, weight, class, acclimatisation, duration of hot conditions and influence of live export conditions specific to pregnant cattle was not found.

Some submissions raised concerns about the export of pregnant cattle. The risks associated with heat stress in pregnant cattle mainly referred to the risk of abortion and, to a lesser extent, premature lactation in pregnant and non-pregnant dairy heifers. Gaps in evidentiary knowledge on heat stress were also highlighted, as outlined in Collins, Hampton & Barnes (2018) such as 'experimental manipulation of variables that influence heat load, further assessment of the HSRA and development of a suite of animal welfare indicators to identify at risk animals before severe heat stress occurs'. These gaps pose challenges to policy development.

VALE COMMENT: If there are such significant gaps in knowledge, pregnant cattle should not be carried.

….

6.4.2 Voyage analysis of pregnant cattle

….

Noting reporting limitations, a summary of the 41 voyages is provided below……..

- Twenty-one of 41 (51%) voyages departed during the NHS
- Destination countries included China (35), Oman/Pakistan (1), Oman/UAE (1) and Pakistan (4)
- The mortality rates for these voyages ranged from 0.00% to 0.46% with a mean voyage mortality rate of 0.16%
- Forty of 41 voyages recorded a maximum WBT of 26°C or more for at least 1 day. The highest WBT, 32°C, was recorded on 2 voyages. The mean maximum WBT was 29.0°C
- Nineteen of 41 (46%) voyages recorded evidence of cattle responding to hot conditions

VALE COMMENT: This would appear to indicate under-reporting given the mean maximum WBT.

- These nineteen voyages noted increased water consumption (n=14) and/or a decrease in feed consumption (n=7)
- Twelve of 19 voyages noted alterations to respiratory character (11) and/or increased panting score/heat stress score (n=5)

VALE COMMENT: This would also appear to indicate under-reporting as pant scores should increase in line with increased water consumption and decreased feed consumption.

- Eleven of the 19 voyages departed during the NHS while 8 departed during the NHW
- There were no reports of mortalities of pregnant adult cattle attributed to heat stress
- Ten of 41 (24%) voyages recorded abortions.

VALE COMMENT: This would indicate that live export had a significant animal welfare impact on pregnant cattle, likely due to heat stress as per next finding.

……Of the 10 voyages that recorded abortions, 1 voyage recorded 3 abortions with the main differential diagnosis noted as heat stress. Two voyages recorded 2 abortions and 7 voyages recorded 1 abortion. No reasons were provided for the abortions reported on the latter 9 voyages. Of these 9 voyages, 5 also reported physiological responses to increased heat load (increased respiratory character or panting score). The remaining 4 voyages did not include reports of any cattle response to heat load. This information is tabulated below (**Error! Reference source not found.**).

The frequency of voyages reporting premature lactation is small which makes it difficult to determine its significance. One submission recommended that 'documentation of the occurrence of premature lactation during voyages, accompanied by detailed information regarding livestock factors, environmental conditions and resource management could improve our understanding of this issue'. We agree that further information is required to better understand the disease and its welfare significance and encourages further industry driven research on the matter.

VALE COMMENT: Yet another call for "further research". As per previous recommendations for such research, high quality record keeping by veterinarians will be required to ensure any research can even be undertaken.

6.4.3 Summary of pregnant cattle

- Ten of 41 voyages carrying pregnant cattle reported abortions
- One voyage recorded abortions related to heat stress
- There was no clear seasonal trend to the occurrence of heat stress risk in pregnant cattle
- Under ASEL 3, pregnant cattle are receiving additional space
- Improved reporting on pregnancy, abortions and premature lactation could assist future analyses.

VALE COMMENT: This is not debatable ie "could". Wording needs to be changed to "would" (not "could") given that any improved reporting would be expected to improve the analysis.

6.5 Reporting of heat stress

The assessment of 214 voyages for evidence of heat load noted some reporting anomalies. Four of the 14 voyages with reports of heat stress-related mortalities did not report any other evidence of hot conditions, such as increased respiratory rate or heat stress score in any other cattle on board the vessel. It would be reasonable to deduce that if a voyage reported a heat stress-related mortality, other cattle on the voyage would likely have demonstrated elevated respiration rates or other signs of heat stress. Inconsistences in the reporting of respiratory character were also raised in a submission.

VALE COMMENT: VALE have repeatedly raised this issue after analysis of high mortality voyage reports obtained under Freedom of Information Act (1982). VALE has detailed these concerns to DAFF, Dept of Agriculture, DAWR and DAWE in addition to providing evidence of inaccurate heat stress records to Dr Schipp, Mr Moss and Mr Carter. VALE has raised these issues for the last 9 years to no avail – neither the Australian Government or industry has responded proactively to the criticism and as a consequence, in 2021, we have an official review noting the same discrepancies and inaccuracies that VALE has documented for the last 9 years.

Voyages with WBTs that would be considered hot (based on literature of HSTs) did not always report evidence of heat stress. In total, 15.4% (n=33) of voyages reported maximum deck WBTs of 30°C or greater with no reported evidence of heat stress. One voyage carrying feeder and slaughter cattle reported a mortality rate of 1.8% for lines of cattle housed on 1 particular deck (overall voyage

mortality rate was 0.8%). This voyage recorded 9 consecutive days with maximum deck WBTs at ≥28°C. This period included 3 consecutive days of maximum deck WBTs at 30°C. Mortalities were mostly attributed to pneumonia or 'unknown' causes, with no mention of hot conditions contributing to mortalities. In addition, every daily report recorded the same respiratory rate and a respiratory character rating of '1' ('normal'). Examples such as this raise the possibility that reporting could be limited or inaccurate.

VALE COMMENT: This is not unusual in VALE's experience. Analysis of high mortality voyage reports historically demonstrates similar mis-reporting (eg HMV 39 where cattle panted consecutively for 17 days with no mention of heat stress; see https://www.vale.org.au/high-mortality-voyages.html). The Department itself removes the words "heat stress" from IO Summaries (See: https://www.vale.org.au/io-reports.html). Other voyages document rising WBTs well above the HST for animal class with accompanying deteriorating pad conditions (indicative of heat stress if no other case such as water leaks identified) but no record of panting or heat stress. Notwithstanding the possible conclusions of the reviewers (see next comment) there is little doubt that this industry and their representatives actively under-report heat stress. This was noted in some IO Summaries also highlighting the importance of an IO or independent veterinarian.

Some inconsistencies may be attributed to the fact that reporting requirements under ASEL 2.3 were limited. Historical reporting only allowed for a single entry per deck per day for relevant physiological and behavioural signs. This means daily reports recorded a single rank of respiratory character or heat stress score per deck, with no ability to capture the number of animals displaying these signs. This would result in the reporter 'averaging out' symptoms for each deck. Additionally, records were often abbreviated or with vague statements, meaning it was not always possible to determine their accuracy and completeness.

VALE COMMENT: It should also be noted that not all voyages are accompanied by veterinarians and that stockpersons are not trained in veterinary physiology thus may not correctly diagnose heat stress and/or animal health and welfare issues. The Final Report must include reference to lack of veterinarians on many of these long-haul ships with concern expressed about the diagnostic abilities of the accompanying personnel. The Final Report must document the percentage of voyages that did not have an accompanying veterinarian as this information is pertinent but not in the public domain. A recommendation for veterinarians on all Bos taurus voyages should be made.

This issue may be alleviated by the introduction of LIVEXCollect on 1 November 2020. LIVEXCollect is a data collection and management system administered by LiveCorp for use on livestock export vessels to improve consistency in the way livestock observations and other measurements are recorded and reported. The LIVEXCollect forms standardise data entry and reporting in accordance with ASEL, allowing for improved data aggregation and analysis. Daily and end of voyage reporting is then provided to the department in a consistent form. This aligns with findings in the Inspector-General of Live Animal Exports report on monitoring and reporting during livestock export voyages (March 2020). The Inspector-General recommended improvements to the quality, standards and analysis of reported data.

The Moss review noted that inconsistencies may be attributed to an unwillingness to raise concerns by the person reporting. Moss noted that 'AAVs appear have an inherently conflicted role. While they are required to report to the department on animal welfare issues, they are either employed, or engaged by exporters or contracted on a consignment by consignment basis'.

VALE COMMENT: VALE share this concern and have first-hand evidence from one (male) former shipboard veterinarian that indicates veterinarians have been actively discouraged from using the term

"heat stress" or similar. This example was reported to Mr Moss and Mr Carter with the shipboard veterinarian prepared to corroborate the statement. VALE have long promoted having an independent veterinarian on every ship.

Another issue relates to the fact that daily deck temperature recordings may not accurately reflect actual conditions. Data loggers on live export voyages to the Middle East regularly record variations in WBT of 6°C within a 24-hour period, especially near the start and end of voyages when the distance from the equator is greatest. Closer to the equator, daily WBT fluctuations are more typically 1–3°C in a 24-hour period. Several voyage reports note that some of the wet bulb thermometers were not reading accurately. A number of voyages might record 1 temperature in the daily report but note temperatures exceeding these in reporting commentary. This indicates that having a set time each day to note temperatures in daily reports does not capture the actual range experienced for that day. Having an appreciation for diurnal temperature variations and the extent of respite periods during hot conditions can provide important information to AAVs and stockpersons monitoring a voyage where cattle are at risk of heat stress (HSRA Technical Reference Panel 2019).

VALE COMMENT: As per previous, continuous environmental logging is possible and has been employed on at least some vessels since 2018. The technology is available and single-time, non-representative data should have long since been rectified.

6.5.1 Summary of reporting of heat stress

- Evidence of heat stress (elevated respiratory rates, altered respiratory character, increased panting score or heat stress score) was not consistently recorded or reported
- The maximum temperature recording may be inaccurate in some voyage reports.

VALE COMMENT: The report should thus make a clear and separate point that any estimates of heat stress and heat mortality are thus minimums and that the true incidence/prevalence could be higher.

6.6 Discussion on other heat stress factors

Voyage reporting indicates that many vessels have hot spots. It is possible that stockpersons and crew are monitoring these areas more closely, but this is not clear from voyage reports. Only 1 voyage reported a temperature difference between a hot spot and surrounding areas, but otherwise actual conditions in these areas are not reported. It is difficult to assess specifically how hot spots should be monitored and managed without an understanding of temperatures experienced. Improved accuracy and recording of diurnal ranges of deck temperatures could be assisted by the use of data loggers on all long-haul cattle voyages. Placement and maintenance of these data loggers is also of critical importance.

VALE COMMENT: There should be clear instructions as to what logger records are required, when and how frequently they record and how and to whom the data is transmitted in order that poor records do not continue. As per AVA (2018), VALE believe that this data should be collected both automatically and in manual records with both transmitted via block-chain technology.

Reducing stocking rates in affected pens assists airflow around animals to support evaporative cooling and provides cattle with easier access to water troughs. However, if conditions are hot enough, a single animal in a hot pen will still be at risk of heat stress. This highlights the value of using data loggers to continually record temperatures in affected areas. This will assist decision making around the use of pens in hot spots and appropriate mitigation measures.

VALE COMMENT: VALE commend the reviewers for highlighting that heat stress cannot be avoided by reducing space allowance if WBT is above their HST. With this understanding, it should be evident from the WBT data that mitigation of heat stress/heat load is simply not possible on these voyages.

In this analysis, 20.6% of voyages reported sloppy and wet pads. We encourage exporters to include pad management plans in their approved arrangements. This should include instructional material for stockpersons and AAVs. The pad management plan should include an intention to discuss pad management during the daily meeting, the provision of highly absorbent bedding substrate and clear instructions for the use of substrate on board vessels.

VALE COMMENT: ASEL 3.0 should have improved bedding in line with minimum bedding amounts and industry recommendations (Banney et al 2009). It did not and the statements in ASEL 3.0/3.1/3.2 are now incompatible with each other as noted previously.

We acknowledge that under ASEL 3 there are additional requirements regarding bedding application and monitoring. This may influence pad management outcomes in the future. Accurate reporting on pad issues will assist when making assessments regarding adequacy of bedding requirements. The next ASEL review should investigate the adequacy of bedding required under ASEL 3 for long-haul voyages from southern Australian ports. The appraisal of 41 voyages of pregnant (and non-pregnant) *Bos taurus* breeder cattle from southern Australian ports noted the occurrence of abortions on 10 voyages. Six of these voyages also reported evidence of heat stress, while 4 voyages reported no evidence of heat stress. Voyages reporting abortions were split evenly between NHS departures (n=5) and NHW departures (n=5). Of the 6 voyages with abortions and evidence of heat stress, 4 departed in the NHS and 2 departed in the NHW. Although case numbers are small, these findings do not show a strong association between the risk of abortion and any particular northern hemisphere season.

ASEL 3 Standards applicable to pregnant cattle provides additional pen space for pregnant cattle which may mitigate the risk of heat stress and associated abortion. As there does not appear to be as seasonal trend in heat stress risk in pregnant cattle, we the department recommends pregnant cattle management plans for *Bos taurus* cattle departing from southern ports and crossing the equator, should be employed for all months of the year.

The inconsistent reporting of heat stress signs warrants attention. Clarifying the use of and appropriateness of cattle panting scores through discussion with users could unearth issues with existing reporting methodologies. Such a discussion should include AAVs, stockpersons, exporters, heat stress technical experts, welfare groups and the department. A review of cattle panting scores has been incorporated in the department's forward plan.

VALE COMMENT: It is incomprehensible that 16 years from McCarthy's MLA study (McCarthy 2005) and 3.5 years on from the Awassi,Express *exposure there is a need to recommend appropriate cattle panting scores (see previous detailed comment).*

Issues with water quality and supply during voyages were not systemic. In general, minor issues were associated with mechanical problems and corrective measures were taken immediately. Issues concerning water delivery interruptions and water quality were vessel specific. Reports indicate that where significant issues were identified the necessary corrective measures were taken by the crew. Exporters were notified of any major repairs or improvements that were needed before future voyages.

VALE COMMENT: Water provision issues were repetitive on some ships (Hing et al 2021) and were either not communicated to exporters or not rectified by exporters. VALE raised this with DAWR (See: https://www.vale.org.au/gov-correspondence.html).

Significant water provision issues were not noted as a systemic failure on long-haul *Bos taurus* voyages from southern Australian ports.

VALE COMMENT: Minor or major water provision issues were noted in 43% of the IO Summaries for voyages to China (Hing et al 2021). Unlike the findings in this report, Hing et al (2021) also considered the impact some of these had on pad quality in addition to thirst. If the IO Summaries for the China voyages were representative, then 43% indicates a systemic failure.

Some aspects of thermal stress that were raised in early submissions are beyond the scope of this review, including vessel design and infrastructure, training and experience of veterinarians and stock people. We encourage ongoing research and discussion into the issue of heat stress in cattle. **.....**

7 Cold stress

7.1 Physiology of cold stress

Cold stress has been described in a number of ways in scientific literature. According to Abbas et al. 2020, temperatures below the thermoneutral zone (TNZ) threshold can result in cold stress. Wagner (1988) states that as the temperature declines below the lower critical temperature (LCT), cold stress on an animal increases…..

…Wet conditions are an important consideration on board a livestock vessel when animals are exposed to direct windchill (open decks) and high ventilation rates. To ensure coats are not wet as a vessel nears cold conditions, consideration should be given to timing and method of deck washing to avoid wetting of livestock and allow time for coats to dry.

VALE COMMENT: Dry coats may not be possible on open decks if there have been rough seas or rain (conditions noted to affect animals and/or pads in IO Summaries on a number of voyages).

The publication ….

One submission noted that cold stress in cattle may only become evident upon arrival at the importing country when, under cold conditions there may be inadequate feed available to meet the increased metabolic demands of the thermoregulatory system. Conditions on arrival are outside the scope of this review.

VALE COMMENT: Similar information has been relayed to VALE by shipboard veterinarians concerned about quality and quantity of food at end-destination. There is anecdotal information (that VALE has no ability to confirm or refute) about the use of straw as a food source in quarantine facilities in China for example. Some shipboard veterinarians have advocated for extended veterinary care by Australian veterinarians after arrival and this would appear to occur in some instances. It should be mandatory that Australian veterinarians accompany the cattle at the end destination for a minimum of 2 weeks for winter northern hemisphere destinations. At the very least this would assist with "further research".

Studies of feedlot cattle in winter have shown that cattle benefit from diets that are higher in energy when wind chill index increases (Mader & Griffin 2015; Wagner 1988)…..

7.5 Cold stress voyage analysis

7.5.1 Description of voyages

Twenty of the 214 voyages (9.3%) were identified as reporting ambient temperatures of ≤5°C DBT or included evidence of cold conditions based on behavioural, physiological, or environmental signs. The average minimum temperature for these 20 voyages was 3.2°C DBT, while the lowest minimum was −7°C DBT (**Error! Reference source not found.**).

VALE COMMENT: this would appear to be inaccurate as IO Summary 59 (Yangtze Fortune to China Dec 2018/Jan 2019 reported -10°C DBT on arrival (Hing et al 2021; IO Summaries).

7.5.2 Observations of cold conditions

Thirteen of these 20 voyages did not report evidence of cold stress, despite 11 voyages reporting minimum DBT between 2°C and 5°C and 2 voyages reporting DBT of −0.3°C and −3°C……

Three of the 7 voyages reported behavioural or physiological signs of cold conditions including:

- shivering when the minimum deck DBT was −1°C
- decreased water consumption when DBT was 10°C
- cattle reported to be 'cold, wet and windblown' with temperatures of 13.6°C WBT/17.2°C DBT after rough seas and high winds flooded the lowest open deck in the Great Australian Bight. Excluding this voyage, the average minimum was 2.5°C DBT.

Another 3 of the 7 voyages, on 3 different vessels, documented environmental issues with frozen water troughs or pipes with minimum deck DBT of 0°C, −1°C and −7°C. In these instances water was provided manually by the crew.

One of the 7 voyages reported cattle were euthanased as their BCS was too low to support the environment they were entering.

VALE COMMENT: VALE is unsure as to whether the IO comments for IO 40 for a NHW voyage to China are captured by these observations. The deck temperature on that voyage was "around zero" (Hing et al 2021) so it would appear to have been omitted from the data set of 7/20 voyages where lowest minimum was 5°C. The IO on that voyage noted cattle affected by cold conditions. If this voyage has not been included in this review, VALE strongly recommends that the data be corrected.

7.6 Summary of key findings

Cold stress:

- Twenty of the 214 voyages were identified as having evidence of cold conditions based on either reported temperature of ≤5°C or environmental signs such as frozen water in pipes, or behavioural and physiological signs.
- Of the 20 voyages:
    - 13 recorded cold temperatures between 5°C and −3°C DBT but reported no evidence of cold stress
    - 3 reported behavioural or physiological signs of cold conditions (1.4% of voyages in this review)

- Average minimum temperature was 3.2°C DBT and the average difference between minimum and maximum WBTs was 17.6°C

VALE COMMENT: It should have been noted that some voyages had differences of up to 42°C (Hing et al 2021).

- During the final 5 days there was an average decrease of 9.1°C DBT over a 24-hour period
- All voyages recording DBT ≤5°C departed Australia between the months of October and April (inclusive)
- There were no recorded primary mortalities due to cold stress.

VALE COMMENT: The draft report notes that some cattle were euthanased to prevent their death from cold stress. As such, these deaths should have been included as primary cold-stress mortalities.

7.7 Discussion and recommendations

The analysis demonstrated that the risk of cold conditions in all classes of cattle is greatest during the NHW particularly for exports departing from December to February. The coldest part of the journey appears to be during unloading in northern ports.

The scope of this review ends at unloading. There is very little reporting of environmental conditions and the management of cattle beyond this point including the suitability of transportation and feedlot infrastructure to protect cattle from cold stress. These aspects may also be important in terms of welfare outcomes.

One submission raised concerns about the welfare impact of temperature variations. We have not identified scientific research discussing the significance of wide temperature variation on cattle welfare (or other species).

VALE COMMENT: This was likely VALE's submission. VALE likewise noted that there is no research but given that animals only acclimatise slowly to heat or cold (as acknowledged in this report), it would be prudent to assume that wide temperature variation could impact animal welfare. In addition, there was at least evidence from one voyage that an IO made such an assessment unprompted and first-hand (IO 40): "the heat/humidity and subsequent cold temperatures appeared to adversely affect the health of some of the cattle, particularly those in poorer condition."

Another submission noted that conditions can be so cold as to impact normal watering operations on vessels, for example the freezing and fracturing of water lines. No feeding issues due to cold conditions were reported in the voyage reports analysed by the department in this review. However, the reports noted that crew undertook manual watering if water pipes were frozen.

Extremely cold drinking water could be a welfare concern, particularly if cattle reduce or cease drinking. While reduced drinking was reported on 1 voyage (at deck DBT of 10°C), the impact on welfare was not recorded. Further research into the impact of drinking water temperatures on cattle behaviour might help to improve animal welfare.

VALE COMMENT: More "further research" required whilst animals continue to potentially have adverse animal welfare impacts is an unethical recommendation that would almost certainly be unacceptable to an Animal Ethics Committee. Immediate changes based on available scientific evidence and relevant veterinarian experience should be implemented as a matter of priority.

Increased availability of dietary energy when cattle experience cold conditions could present a simple mitigation measure. Other measures such as the adjustment to the temperature of the water, timing and method of deck washing if a vessel is approaching cold conditions should also be considered. Further examination of mitigation measures employed on vessels is encouraged.

VALE COMMENT: More "further research". See above.

At one port the AAV euthanased 10 "skinny/depressed" cattle prior to discharge on welfare grounds. The AAV determined that the cattle were not in sufficient body condition to survive transportation to the feedlot. This highlights the importance of a cattle body score condition and susceptibility to cold stress.

More reporting and data collection regarding cold stress should take account of the LCTs described in the LiveCorp cold climate checklist noted in section 6.3.5. Lack of awareness of how to recognise and mitigate the impacts of cold conditions could be a factor. Establishing the bounds of the TNZ for Australian cattle across different seasons could be an area for future research. We note that the MLA Veterinary Handbook and the LiveCorp Stockies Guide (Jubb & Perkins 2019) released in November 2020 contain limited information about cold stress.

ASEL requires that written contingency plans be prepared to address a number of animal welfare challenges including adverse weather conditions. It is not clear to what extent appropriate management of cattle in cold conditions is incorporated into the contingency plans.

Cold exposure and cold stress

Findings

13. Twenty of the 214 voyages were identified as having evidence of cold conditions based on either environmental signs such as temperatures of ≤5°C or evidence of relevant behavioural, physiological signs.

14. There were no recorded primary mortalities due to cold stress.

15. The cold tolerance of Australian cattle exported to cold climate destinations is not well established.

16. Wet conditions are an important consideration on board a livestock vessel when animals are exposed to direct windchill (open decks) and high ventilation rates.

17. Mitigation measures for managing cattle in cold conditions are not well established.

Recommendations

14. Further research should be undertaken to determine appropriate critical temperatures that relate to compromised animal welfare for Australian cattle exported to cold climate destinations.

VALE COMMENT: If "further research" is required, voyages to these destinations should cease until that research has been completed unless the voyages are actively recruited for research analysis with comprehensive record-keeping, video footage available and a veterinarian on-board.

15. Consideration should be given to timing and method of deck washing to allow time for cattle coats to dry before the vessel encounters cold conditions.

16. Industry should develop guidance for appropriate mitigation measures on board vessels for cattle in cold conditions.

17. Measures to mitigate the risk of cold stress on board vessels should be incorporated into exporters' 'adverse weather contingency plan.'

18. The ‘cold climate destination checklist’ for cattle should be completed prior to the export of cattle to cold climate destinations.

References for VALE COMMENTS

Australian Veterinary Association (AVA). AVA Submission: A short review of space allocation on live export ships and body temperature regulation in sheep. 2018

Barnes, A, Beatty, D, Taylor, E, Stockman, C, Malone, S & McCarthy, M (2004) Physiology of heat stress in cattle and sheep, Meat & Livestock Australia Limited, Sydney, accessed 19 October 2021.

Caulfield MP, Cambridge H, Foster SF, McGreevy P. Heat stress: A major contributor to poor animal welfare associated with long haul live export voyages. *The Veterinary Journal* 2014;199:223-228

Hedlefs R. Factors influencing mortality and wastage of slaughter cattle transported from Queensland to Japan by sea. Department of Primary Industries, Queensland. 1988

Hing, S., Foster, S. and Evans, D. Animal welfare risks in live cattle export from Australia to China by sea. *Animals* 11 (10), 2862

Maunsell-Australia. Development of a heat stress risk management model. Live Export Project LIVE.116, Meat & Livestock Australia. 2003

McCarthy M. Independent review of conditions for the export of sheep to the Middle East during the northern hemisphere summer. 2018. See: https://www.awe.gov.au/.../biosecurity/export/live-animals/mccarthy-report.pdf (accessed 23 Nov 2021)

McCarthy M. Pilot Monitoring of shipboard environmental conditions and animal performance. LIVE.223. Meat and Livestock Australia Limited, Sydney, NSW Australia 2005

MLA/Livecorp. Live Trade Animal Welfare Partnership 2009/10 Final report – Public Release Indonesian point of slaughter improvements. MLA, Sydney Australia. 2010

Moore SJ, Madin B, Norman G, Perkins NR. Risk factors for mortality in cattle during live export from Australia by sea, *Australian Veterinary Journal,* 2015: 93;10:339-48

Office International des Épizooties (OIE). Section 7 Animal Welfare. In Terrestrial Animal Health Code; 2019. Available online: https://www.oie.int/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access/ (accessed 29 Nov 2021).

Petherick JC, Phillips CJC. Space allowances for confined livestock and their determination from allometric principles. *Applied Animal Behaviour Science* 2009;117:1-12

Stermer RA, Brasington CF, Coppock CE, Lanham JK, Milam KZ. Effect of drinking water temperature on heat stress of dairy cows. *Journal of Dairy Sci ence* 1986;69:546-551

Stockman CA, Barnes AL, Maloney SK et al. Effect of prolonged exposure to continuous heat and humidity similar to long haul live export voyages in Merino wethers. *Animal Production Science* 2011;51:135-143