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DPIRD Submission to the Review of the Australian Standards for the Export of Livestock 19 October 2018

Heat Stress Risk Assessment Issues Paper

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1. Our response

This paper is the submission of the Department of Primary Industries and Regional Development (DPIRD) in response to the Heat stress Risk Assessment Issues paper published by the Department of Agriculture and Water Resources (DAWR), in September 2018.

The nature of our response is twofold.

Firstly, we address the points identified on page 6 in the section titled "1.2 Make a submission". In this section, we aim to highlight that detail available about the methods used to implement the recommendations of the McCarthy report are lacking. Such methods could be as important as the recommendations themselves for their successful implementation.

Secondly, we answer the specific questions in sections 3 to 5 of the Issues Paper. Much of these questions are of a very technical nature and this makes them difficult to answer. The Hotstuff model being confidential and the lack of any description about implementation systems exacerbate this difficulty.

2. Key issues

2.1 Evidence and factual data on HSRA

The McCarthy review identified the better use of data to improve HSRA as a major opportunity. However, the approach to data collection appears piecemeal and has the potential to frustrate both implementation and reporting.

2.1.1 Data reporting responsibilities

DPIRD reports voyage data and in particular animal mortality rates, on behalf of MLA, by collating data provided voluntarily by shipping companies. The DPIRD function has no statutory requirement, with Australian Marine Safety Authority (AMSA) being the nominated authority in the Australian Standards for Export of Livestock (ASEL). Whoever is responsible for collation and reporting of data, it is essential that there is an increase in the accuracy and timeliness of this information being provided.

2.1.2 The AMSA focus is to oversee Heat Stress Risk Assessment (HSEA) modelling and loading plans and this relies on animal weight data. Effectively, two authorities, one state and one national, administer animal data independently of one another. The accuracy & precision of data required for a range of purposes

Data collected with a task in mind can be inconclusive if used in a broader context. How animal age records are currently collected is one example of this. Evidence from the farming community suggests that the majority of sheep exported are around 18 months of age, yet the age record of many of these animals may simply be "adult wether". There is no way of verifying such a record with the current system, which differs to that for domestic slaughter. The age of an adult wether could in reality range from 12 to 96 months of age. Similarly, sorting animals according to weight is an important consideration for ship stability done at the truck consignment rather than the individual animal level.

Conceivably the precision of such data might therefore limit the precision of the outputs from the HSRA. So is the precision of the data currently available sufficient to provide accurate and precise risk assessment? If the data currently being provided does not adequately describe the stock being transported, including age and number, then it will be more difficult to ensure good animal welfare because compliance is an unrealistic expectation.

The value of demographic data for reasons other than HSRA justifies the effort required for collection. Neither farmers nor exporters can make astute comparisons between marketing options if the supply chain does not provide accurate and precise information about the animals they trade. The integrity of the supply chain would likely improve if the data collected were more precise and automated.

The development of innovative electronic monitoring systems for livestock is gaining momentum and allowing for greater stock traceability and management along the supply chain, including live exports. DPIRD is aware of several companies that have developed monitoring devices that can collect individual animal data that could be used to determine heat stress in sentinel animals with data being provided in real time. This opportunity should be encouraged as part of this review process, and DPIRD is well positioned to seek funds from industry to provide the necessary rigour and independent assessment of this technology. Comment on this approach from the review panel would be welcome.

2.1.3 Data rules

A valuable step toward capturing precise sheep parameters would be uniformity in nomenclature, for animals but also for ship and other facilities. There are numerous and increasing systems of data-capture at various points in the lifetime and handling of sheep, many of which are “isolated” by their prescribed parameters. Uniformity of nomenclature would allow more meaningful data-sharing and aggregation of data for reporting of the various sheep industry components, for investigation into health and welfare issues and for research toward improving the sheep industry.

Uniform nomenclature would also facilitate increasing automation of the various data-capture points. Automation has the potential to minimize data errors through menu-driven recording, boost efficiency of data handling and reporting, provide monitors and researchers with faster, “big-picture” reviewing of current conditions and allow accurate prediction of future conditions via Internet linkage to other databases and “live” information.

An example of working through the issues of nomenclature and automation is the concurrent rollout of the mortality recording project upgrade, and the on-board development/trialling stage of the Animal Welfare Indicators project, both of which DPIRD has a role in.

2.2 Possible impacts of implementing the McCarthy review recommendations related to HSRA.

2.2.1 Reporting role of DPIRD

DPIRD currently provides 80% of a full time equivalent (FTE) staff member to collate and report livestock mortality data collected on board ship. MLA funds this resource provided on a cost recovery basis. Following implementation of the McCarthy review recommendations, is there an opportunity to expand this role to include more of an auditing function that includes other components besides mortality rate.

2.2.2 Potential to share information & improve accountability along the supply chain

Automation of sensing equipment was a recommendation of the McCarthy review and this is a worthy suggestion. If this were the case, then real time monitoring along the supply chain would be possible from data available via a cloud application. This could facilitate a block chain system that would make available information from the farm as well as the ship. All members of the supply chain could then view the data from each part of the supply chain to make each sector of the supply chain more accountable to others in the supply chain. As indicated in 2.1.2, the use and/or testing of new technology to monitor animal physiology and behaviour in real time has merit and should be encouraged.

2.2.3 Implementation of the allometric equation for space requirements

The concept of setting the minimum space requirement according to allometric principles, so that animals can stand, feed and lie down all at the same time is sound.

However, it is unclear how the recommended level for the k value relates to heat stress. Has the k value of 0.033 been set according to the optimum space requirements for behavioural reasons alone or to the amount of heat produced by the animals and the subsequent susceptibility to heat stress? DPIRD does not have access to the HotStuff v 4.0 model which makes it difficult to comment on how this is implemented.

There is no parameter for heat stress in the allometric equation. Therefore, the way in which this equation combines with the HSRA is unclear. Is the intention to use the allometric equation to calculate the maximum stocking rate? Then if the HSRA deems the risk of heat stress to be high, a downward adjustment calculated from the HSRA dictates the actual rate at loading time. This would mean the actual rate is equal to or less than the allometric rate. Currently the description might suggest that the stocking rate will always be equal to the allometric rate. If that were true, there would be no need for a HSRA, hence the need for further clarity.

Furthermore, there is no standard weight parameter specified for the equation. It could be the weight of an individual animal, the average for a pen or the average for a deck.

Another consideration is the usability of the function to describe space requirements. Is the equation describing space as a function of weight a power function because space is a multidimensional attribute? A plot of the equation appears to follow closely to that of a straight line over the weight range for sheep. So if that is the case, then is there really a need to describe this with a power function that is difficult to conceptualise?

The setting of the intercept at weight of 0kg as described by a linear function might be an alternative to a k value and possibly easier to relate to than a k value.

2.2.4 Mortality benchmarks

Inanition/salmonella likely accounts for more deaths in time than heat stress that kills large numbers of animals in events that occur more sporadically (Norris, Richards, & Dunlop, 2008). The epidemiology of the two diseases is therefore quite different. The incidence of inanition/salmonella compared to heat stress is unclear in the new benchmark value for mortality of 1%. If welfare signs signify heat stress rather than mortality, the basis for the mortality benchmark becomes unclear. Should there not be a benchmark of mortality for each disease rather than a single rate for all diseases?

2.2.5 Tactical versus strategic use of HSRA

When catastrophic heat stress events have occurred in the past, they seem to have been a function of an unfolding set of circumstances not predicted at the time of loading in port. Therefore, a tactical response appears to be missing. Used as a tactical tool during a voyage to avoid changes in circumstances that were not part of the strategic inputs known at the time of loading, could HSRA avoid such incidences?

Given that neither the Federal regulator nor the State animal welfare inspector has any means of checking the accuracy of inputs to the HSRA (animal numbers and weight), nor is the relevant software (HotStuff) open to any type of independent verification, it is thus difficult to suggest an improvements to either the way HSRA is implemented and/or audited.

3. Further information

3.1 Successful livestock health and welfare initiatives relevant to HSRA for sheep

No suggestions

3.2 Scientific papers describing relevant research findings

DPIRD supported a review of the literature, published recently by the authors in the scientific journal Animal (Collins, Hampton, & Barnes, 2018). We are unaware of any extra literature outside of this review. DPIRD is also aware of research that has been conducted at the University of Melbourne that has investigated the use of natural feed additives (e.g. Betaine) to minimise the impact of heat stress in sheep. References can be provided if required. There appears to have been little attention given to the general issue of diet formulation.

3.3 Details of perceived barriers and challenges to achieving effective HSRA during the export of sheep by ship.

3.3.1 Practicality of measuring heat stress

The nature of mortality data is such that a complete population data set can be collected and appropriate statistics calculated, such as mortality rates. Heat stress is likely to be a time dependent event and more difficult to collect across a full shipping consignment, compared to mortality data.

Have sampling protocols been designed that are both practical to implement and meaningful in terms of representing the population on board a ship? Factors such as the proportion of animals to sample and the frequency of sampling periods are considerations that come to mind.

Table 2 on page 14 of the Issues Paper specifies how to assess respiration rate and heat stress in an individual but not a ships population of sheep. Does this standard apply to a sheep as an individual or to the population? If the latter, then how is this done and should there be a time component stated in the monitoring protocol?

3.3.2 Plain English language and communication strategy

The language used to describe HSRA currently tends to be jargonistic and sometimes conflicting. For example, without prior knowledge the difference between the Hotstuff and HSRA models is unclear. They could be the same thing with a different name, or two different things. This clearly hampers communication for people who work in the industry as well as those who do not. Improvements to the clarity of the language around heat stress and live export in general to a plain English version would be a huge improvement both for people working in the industry and the public.

3.3.3 Operational procedures

There does not appear to be any transparency about the description of any operating procedures for the HSRA. Therefore, it is difficult to know how implementation of the "HSRA model" occurs, hence to comment without this. The nature of these could have a large influence on their use. Are these HACCP based?

3.3.4 Financial implications to shipping agents

The profitability of shipping will likely determine the response of shippers to any proposed change. Mostly, they appear to be negative, such as decreased stocking rates and decreased voyage frequency. However, there would also be some positive aspects such as decreased death rates, increased feed intake, and better performance after shipping. Is there any scope to investigate profitability on behalf of the shipping companies that consider this?

4. Specific questions raised (as listed in blue boxes in Issues Paper)

4.1. Questions about mortality limit and heat stress threshold (page 15)

4.1.1 How should the effects of heat on animals be defined?

Combination of welfare and physiological parameters as described in table 2 of the HSRA document.

4.1.2 How would you detect heat load in the animal? (How is the animal acting?)

The term heat load requires better definition and is an example of the jargon used in the regulations. Without an adequate definition of "heat load", this question is ambiguous. Terms like heat stress, heat load and heat tolerance seem to be used interchangeably.

4.1.3 What level of heat load is tolerable/acceptable? (Considerations might be: What can a sheep's body temperature be before the animal starts to suffer heat stress? / What are the signs the sheep is too hot?)

We accept the explanation in the literature except that the heat stress definition should be in a population sense and not just described for an individual animal. In addition, the time of heat stress should be part of the definition and assessment.

We would also like to draw attention to the HSRA model not appearing to take into account exposure to heat by radiation from hot metal surfaces (Caulfield, Cambridge, Foster, & McGreevy, 2014). Some areas on vessels can be much hotter than others (e.g. the bulkhead). Wall and ceiling temperatures up to 50C have been reported in pens and this could increase the heat load on animals by up to 15% (MAMIC, 2001).

4.1.4 Are the model standard Merino estimates for heat stress threshold (30.6°C WBT) and mortality limit (35.5°C WBT) appropriate/accurate or are there other estimates, supported by the available science that should be considered?

McCarthy proposes that rather than using mortality as an indicator of heat stress, that a heat tolerance limit corresponding to a heat stress score based on animal welfare indicators is used. This heat stress score would be set at Level 3. Panting scores are well correlated to core body temperature, but some authors differ in their opinion about the temperature at which some observations are made. Hales and Webster (1967) found first phase panting with rapid shallow respiration occurs when core body temperature was on average 0.5 C above normal, and second phase or open mouthed panting occurs when core temperature was on average 1 C above normal. Stockman (2006) report that summer acclimatised sheep start showing open-mouthed panting at

0.5 C above normal core temperature, while winter acclimatised sheep did not start open mouthed panting until they were 1 C above normal. Silanikove (2000) concluded, however, from a controlled elevation of temperature and water vapour pressure study that moderate heat stress exists at lower respiration rates than that suggested by McCarthy.

For the purposes of the HSRA model, the Heat Stress Threshold (HST) is the wet bulb temperature (WBT) when the core body temperature is 0.5 C above what it otherwise would have been (Collins et al., 2018). The HSRA Issues Paper uses Table 1 (pg 14) to describe the Base Heat Stress Threshold Mortality Limit values for the 'Standard Animals' (Temperatures in Wet Bulb C):

30.6 C is the HST for a 40kg, shorn adult wether, body condition score 3. However, the WBT at which there is a rise in core body temperature has been the subject of various studies, and with regard to an adult wether, the HST may range from 26C to 30C (Stockman et al., 2011). Use of the higher HST leads to underestimation of the heat load on sheep on voyages to the Middle East, and can result in elevated mortality (AVA, 2018; Collins et al., 2018). Phillips (2016) suggests that the definition of HST and its use in the HSRA may not sufficiently account for the effects of environmental conditions, acclimatisation, and thermoregulatory responses of animals.

While we support McCarthy Recommendation 3 in principle, we recommend further review of the threshold WBT indicators of heat stress, and animal based heat tolerance indicators, as suggested by some researchers cited above. The Heat Stress Score of Level 2 should be considered instead of Level 3 as the heat tolerance limit. If the animal reaches Level 3, then this indicates the animal is already suffering heat stress, and corrective actions may be too late. Level 2 provides an indication that animals are heat affected, but not yet compromised, and actions can be taken to prevent progression to a state where the animal is suffering heat stress i.e. Level 3.

4.1.5 Are there other physiological indicators linked to the effects of excessive heat on sheep that could be measured and considered for inclusion in the HSRA model?

Automation of water and feed intake monitoring might enable water and feed intake to be included in the model. These are likely to change in response to environmental temperature and humidity.

4.1.6 What animal welfare indicators could be considered in assessing the effects of heat on animals?

We have no further information to assist here.

4.2 Questions about HSRA settings (page 17)

The current HSRA model has been used by the live export industry since 2004 to predict heat stress events during voyages to the Middle East. It uses a software program, HotStuff v 4.0, that is commercial-in-confidence. DPIRD does not have any information on the software used, so it is difficult for us to estimate its efficacy and the possible need for improvements. However, we note that the HSRA model has failed to predict heat stress events on several occasions, judging by the number of episodes of significant mortality that have occurred. This could reflect flaws in the model or failure to input accurate data on number and weight of sheep. These data are not checked by the regulator, so cannot be verified.

4.2.1 How should the probability settings used in the HSRA model be determined?

There is evidence that even outside the period May-October, live export consignments may be exposed to significant heat stress events (Caulfield et al., 2014). Therefore, we consider that changes to the HSRA, and the use of allometric principles to calculate stocking density, should be applied to all live export shipments, i.e. to include shipments outside the May-October period.

4.2.2 How might the change from mortality to heat load be incorporated in the mathematical model?

As stated previously the unavailability of Hotstuff makes it difficult to comment on how to change the model to incorporate the changes proposed. Presumably, the simple way would be to substitute the parameters for mortality with heat stress. That is, that 2% of the animals would suffer heat stress on 5% of voyages. However given that non-fatal heat stress is a less severe event than mortality, this might overestimate the risk.

4.2.3 What other probability settings might be considered for inclusion in the HSRA model and on what basis?

The welfare of animals shipped in live export vessels depends to a large extent on the correct application of the HSRA model. We recommend that the regulator take steps to ensure independent verification of data entered into the HSRA. This could be done on a random sampling basis for all shipments and in all cases where significant mortality events occur, as a retrospective examination of the causes of the event.

4.3 Questions about allometric stocking densities (page 19)

4.3.1 How can allometric stocking densities most effectively be used?

Stocking densities should be calculated using allometric principles. ASEL space allowances are two dimensional, and linked to an animal's weight, whereas the k-value in the allometric space allocation equation compares space allocation for different postures such as moving between lying down and standing up, and is not dependent on body weight.

4.3.2 What k-value (constant) should be used in the allometric equation, and what is the scientific basis for this choice?

The HSRA Issues Paper states that in May - October, ASEL provides 0.29m2 for a 40kg sheep and that DAWR has implemented Recommendation 2 of the McCarthy review: that allometric principles and a k-value of 0.033 be used to determine stocking densities during this period. This means that a 40kg sheep will have 0.377m2 of space.

When using a k-value of 0.033, the allometric method provides space at a "threshold below which there are adverse effects on welfare outcomes in intensive housing." (Petherick & Phillips, 2009). When the k-value is set at 0.047, more space is provided and this "enables animals to move between standing and lying, and readily access feed and water (equivalent to lying laterally with legs extended away from the body", AVA Submission, 2018).

The allometric calculation of space allowance takes into account the space that animals need to express normal posture, including lying down to rest. Ferguson and Lea (2013) observed that when there is more space, animals spent more time lying down, particularly during the initial stages of the voyage. Increased space also allows animals to change posture, to increase surface area for heat loss, and provides better welfare outcomes generally (Collins et al, 2018, AVA Review, 2018). In contrast, the space allowances provided by ASEL (based on body weight) are insufficient for animals to lie down or readily access feed and water.

Consistent with our submission to the ASEL Stage 2 Issues Paper Review; consideration should be given basing calculations on a k-value of 0.047 because the journey by sea is one of confinement, not just transport. Animals must have space to perform normal behaviours, as well as eat, drink, lay down to rest and maximise their ability (posture) to dissipate heat.

However, we acknowledge that the k value chosen clearly has a large effect on the stocking density (Figure 1). A change to 0.047 could effectively halve the numbers of animals loaded and would likely have a large negative effect on the cost of transport. We therefore would like to see modelling done to determine how the HSRA might change between k values of .033 and 0.047.

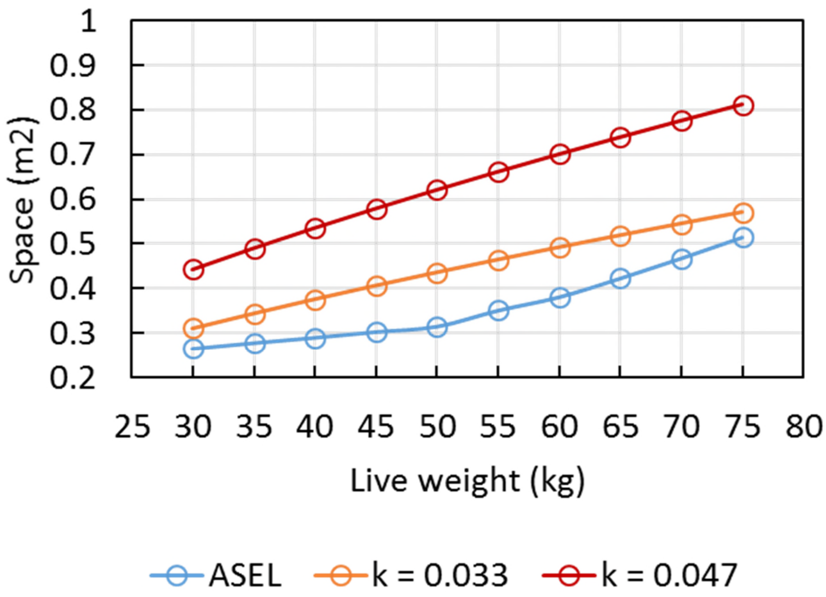

Figure 1 Space requirements for ASEL & allometric predictions

4.4 Questions about heat load exposure and destination ports (page 22)

The HSRA model does not take into account the cumulative effects of heat load on core body temperature that occurs with prolonged exposure (Caulfield et al, 2014, McCarthy, 2018, Phillips, 2016). This is especially relevant on voyages during the northern summer, when there is little diurnal variation and therefore no respite for animals in the form of night time cooling (Maunsell Pty Ltd, 2003).

4.4.1 How might potential duration and repeated exposure to high heat loads be incorporated into the HSRA model?

This presumably implies some understanding of the time and conditions before the systems that buffer high temperature become depleted exists. This would allow a set of rules or a physiological sub model would inform the HSRA model. Perhaps this is a matter of quantifying "heat load" in a physiological sense.

4.4.2 How might minimum daily temperatures be factored into the HSRA model?

The same comment as for 3.4.1 applies to this question.

The HSRA model does not appear to take into account exposure to heat by radiation from hot metal surfaces (Caulfield et al, 2014). Some areas on vessels can be much hotter than others (e.g. the bulkhead). Wall and ceiling temperatures up to 50C have been reported in pens and this could increase the heat load on animals by up to 15% (MAMIC, 2001).

4.4.3 How might multiple discharge ports be taken into account when assessing heat stress risk?

If new ports and journeys are to be considered in the HSRA Model, consideration must be given to the conditions in areas that vessels transit, not just destination ports. For example, vessels that transit the Red Sea and the Suez Canal must negotiate the Gulf of Aden, where conditions can be very hot and humid.

4.5 Questions about ventilation (page 24)

The ability to prevent animals experiencing harmful heat load during shipment to the Middle East may be limited by the ventilation capacity of the vessels (Collins et al 2018).

4.5.1 What elements or factors contribute to good ventilation performance on a vessel?

We have no further information to assist here.

4.5.2 How might ventilation performance be incorporated into the HSRA model?

We have no further information to assist here.

4.5.3 How might we ensure ventilation design delivers efficiency/performance/output requirements?

We have no further information to assist here.

4.6 Questions about open decks

4.6.1 How should open decks be treated for the purpose of assessment in the model?

We have no information to assist here.

4.6.2 What other things need to be considered in the assessing heat stress risk on open decks?

We have no further information to assist here.

5. References

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