

LiveCorp Submission

Review of Australian Standards for the Export of Livestock (ASEL) – Stage 2

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Table of Contents

Introduction	3
LiveCorp and its activities	3
LiveCorp / MLA Research, Development and Extension (RD&E) Program.....	3
Australian Standards for the Export of Livestock (ASEL)	4
This submission and links with other submissions	5
ALEC submission	5
Previous LiveCorp submission	6
Moss Review submission	6
Key topics raised.....	6
Voyage mortality and reporting requirements	6
Mortality and other animal welfare measures	7
Automation of data recording	8
Heat stress on-board	9
Heat Stress Risk Assessment Model (HotStuff).....	9
Open Innovation – on-board heat stress mitigation for sheep exported to the Middle East	10
Bos taurus cattle to the Middle East.....	10
Shearing sheep and hair sheep	11
Maximum cattle weight	12
Minimum time in RP – sheep.....	12
Management of shy feeders and inanition in sheep	13
Strategies to reduce inanition.....	14
Development of a Salmonella vaccine	14
Pregnancy test requirements and limits.....	16
On-board stocking densities	16
Management of bedding and ammonia levels	17
Fodder and chaff requirements on vessels	17
On-Board Personnel and the monitoring and management of animals.....	18
Accredited Stockpersons.....	18
Australian Accredited Veterinarians (AAVs)	18
Additional key research projects	19
Animal welfare indicators	19
National Livestock Export Industry Sheep, Cattle and Goat Transport Performance Report	20
Other resources / useful links	21
• 2018 LEP Research and Development Updates	21
• LEP R&D reports	21
• 360° and conventional footage of livestock preparation and loading.....	21
Appendix 1. Comments on proposed ESAL	22
Appendix 2. Relevant LiveCorp / MLA research and development project reports (1999 –)	24

Introduction

LiveCorp and its activities

The Australian Livestock Export Corporation Limited (LiveCorp) is a not-for-profit industry body funded through statutory levies collected on the live export of sheep, goats and beef cattle, and a voluntary levy collected on live dairy cattle exports. LiveCorp is one of the 15 Australian rural Research and Development Corporations (RDCs).

LiveCorp is the only RDC focused solely on the livestock export industry and it works hard to achieve the right kind of change for industry by supporting exporters with their compliance and animal welfare requirements. LiveCorp delivers this by investing in research, development and extension (RD&E) and provides technical and marketing services and support to enhance the productivity, sustainability and competitiveness of the livestock export industry. LiveCorp works across several program areas, often in close consultation with other industry stakeholders including the Australian Government, to continuously improve animal welfare, regulation, market access and supply chain efficiency. LiveCorp does not engage in agri-political activity.

LiveCorp works in partnership with other RDCs, industry bodies and research providers to achieve strategic outcomes for the industry and leverage higher returns for investments that demonstrate value for money for livestock exporters. In recognition of the benefit of livestock exports to businesses throughout the entire supply chain, including producers, much of LiveCorp's investment occurs in partnership with Meat and Livestock Australia (MLA), through the joint Livestock Export Program (LEP). The partnership with MLA to deliver the LEP is widely recognised as the most efficient mechanism for delivering RD&E and in-market technical support.

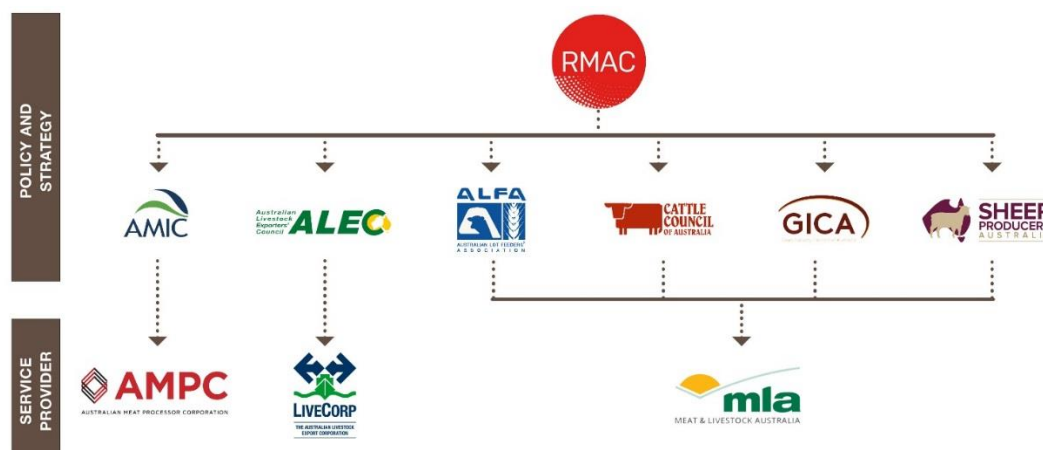


Figure 1. Red meat industry structure

LiveCorp / MLA Research, Development and Extension (RD&E) Program

The LEP Research, Development and Extension (RD&E) Program is the primary mechanism for undertaking RD&E activities for the livestock export industry. The RD&E Program is focused on three key strategies:

1. Improve animal health and welfare outcomes across the supply chain;
2. Improve supply chain efficiency and regulatory performance; and
3. Enhance market access conditions for existing and new markets.

The most significant area of investment for the RD&E Program is the delivery of animal health and welfare improvements, which receives 71% of the annual RD&E Program budget. Supply chain efficiency and regulatory performance receives 17% and market access receives 12% (Figures 4 and 5). This allocation across program areas does not fluctuate significantly year to year.

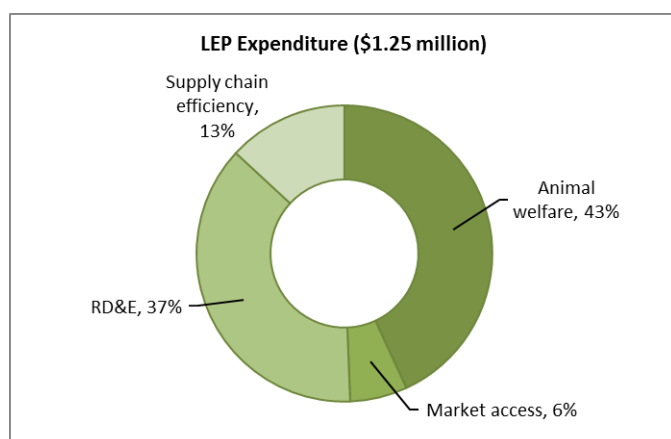


Figure 2. LEP expenditure 2017-18

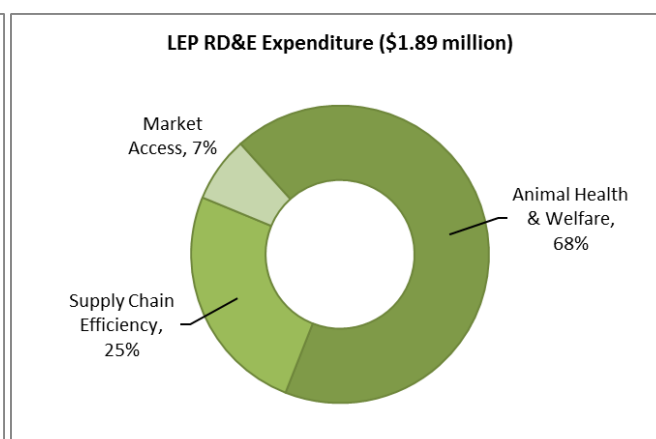


Figure 3. LEP RD&E expenditure 2017-18

The RD&E Program targets research to progressively identify, understand and seek to resolve key animal welfare risks, market access issues and supply chain inefficiencies. This is achieved through investment in projects to gather and analyse data, build knowledge, increase productivity and fill gaps in understanding, as well as to develop, trial and implement practical extension outputs.

LiveCorp looks forward to making its R&D available and providing any support needed to the ASEL Review Technical Advisory Committee (TAC) to inform its considerations during the ASEL Review. LEP R&D provides scientific information, findings and recommendations specific to the livestock export industry, which can play an important role in helping to determine what changes may be needed to meet the expectations and requirements of the Australian Government, the livestock export industry and the Australian community.

For this purpose, LiveCorp has included in its submission a full list of relevant past, current and planned R&D projects conducted by LiveCorp / MLA (**Appendix 2**). For ease of access, LiveCorp will provide the Committee Secretariat with copies of the key research reports discussed in this submission (these can also be downloaded from the LiveCorp website – at www.livecorp.com.au).

LiveCorp would also welcome the opportunity to present any of its research to the TAC / department, or discuss priority areas for future LEP research that could help inform the ASEL Review.

LiveCorp also notes that as part of the ongoing processes to continually improve its R&D program and ensure its relevance and value, the LEP engaged an independent consultant to complete a systems review of the program in 2017 – 2018. This review has recently been completed and the recommendations are being considered within LiveCorp and MLA, with a view to finalising an implementation plan shortly. A focus of the review has been to ensure that extension and adoption of R&D are factored in more strongly at the front end of the program strategy and project initiation processes, to improve uptake by industry.

Australian Standards for the Export of Livestock (ASEL)

ASEL has played a key role in ensuring good animal welfare outcomes during the preparation and transport of livestock during export. Together with improved practices, mortality rates have shown a progressive decline over the past 20 years – as shown in the graphs below (Figures 4 and 5). Ensuring that ASEL continues to be up to date, fit for purpose and based on practical outcomes and scientific research is essential to support continued improvements in animal welfare and enabling the continued sustainability, profitability and global competitiveness of the trade.

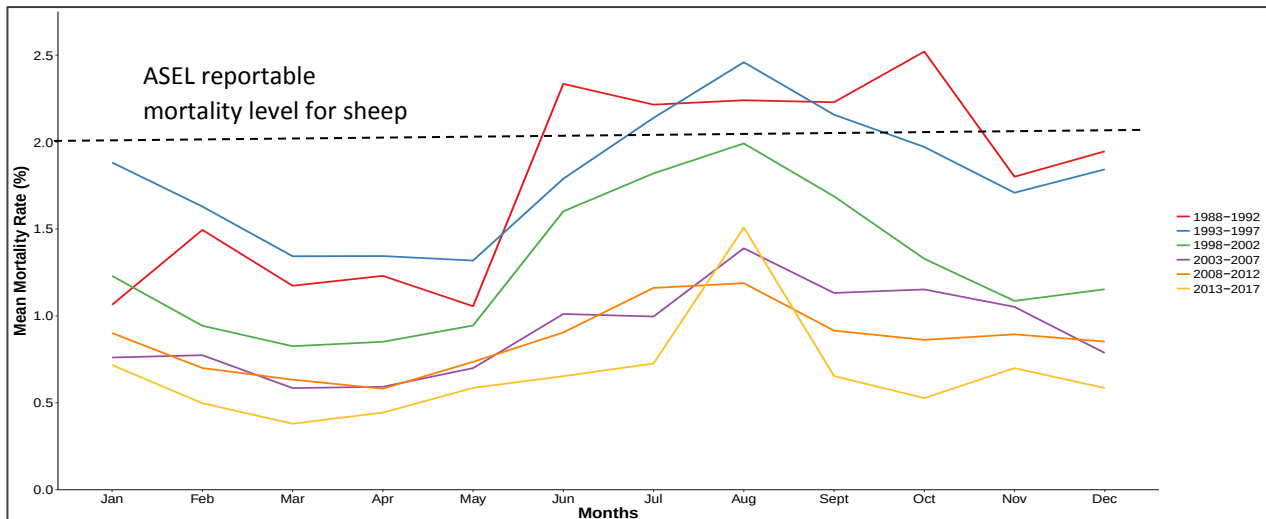


Figure 4. Performance of sheep exports by period (1995-2017)

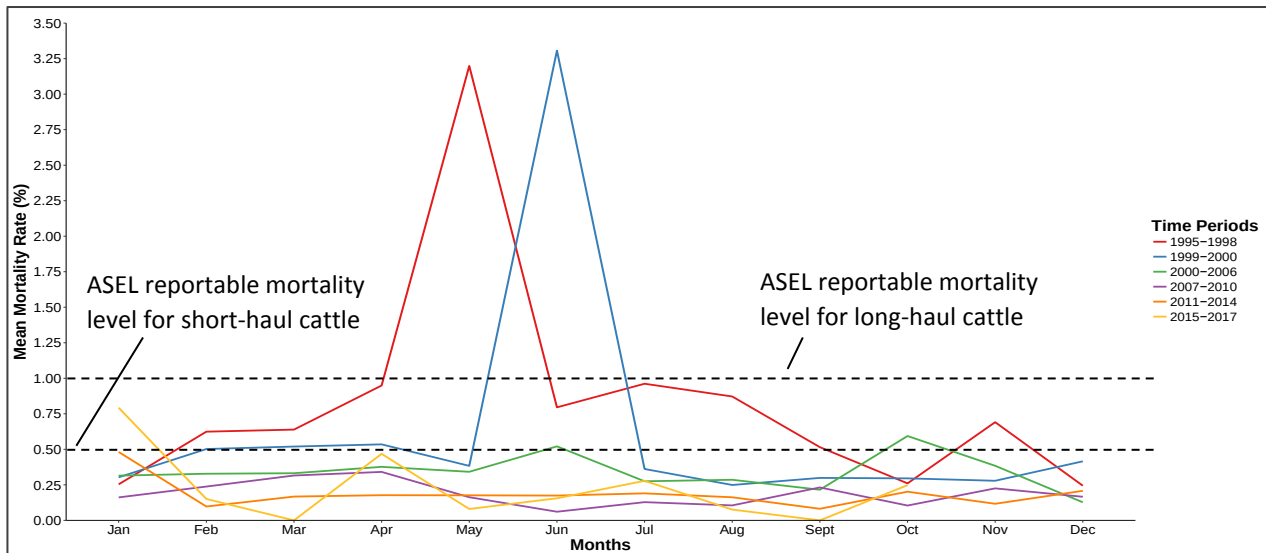


Figure 5. Performance of cattle exports by period (1995-2017)

This submission and links with other submissions

ALEC submission

The current government's review of ASEL presents a significant opportunity to improve and update the standards. Following the *60 Minutes* program in May 2018, the timeframe for the completion of this review was revised and accelerated to the end of 2018. As a result, the recent submission period has been shortened and it has been a challenging commitment for LiveCorp's resources. As such, we believe that it is important to advise the Committee that in this period, LiveCorp, as the industry RDC, prioritised ensuring that its peak industry council was well informed to prepare its submission, determine policy positions for the industry and address the ASEL Review issues paper questions. This involved the provision of extensive technical support and briefings to ALEC on the detail of the LEP RD&E portfolio, and a wide range of this content has been included in the ALEC submission.

Unfortunately, this has constrained the time LiveCorp has had to prepare its own submission. In our submission we have aimed to minimise duplication with the technical content from ALEC's submission. Further, we were cognisant that it is more appropriately the role of our peak council to provide positions on particular questions and as such we have focused on providing additional depth and information on key LEP R&D to effectively inform the recommendations of the TAC.

Previous LiveCorp submission

LiveCorp also requests that the Committee read this submission in conjunction with its Stage 1 submission, which provided additional background and detail on many of the research areas and specific projects discussed in this submission.

Moss Review submission

In June 2018, LiveCorp provided a submission to the *Independent Review into the Regulatory Capability and Culture of the Department of Agriculture and Water Resources in the Regulation of Live Animal Exports* (Moss Review). The submission sought to provide an outline of the key principles of best practice regulation – in line with LiveCorp’s 2016 submission the *Productivity Commission Inquiry into the Regulation of Australian Agriculture* – whilst reflecting on its experiences and observations as the service company to the industry.

In particular, LiveCorp discussed the area of transparent and independent data collection and reporting, providing commentary on the Independent Observer Program, AAV independence and the role of technology in improving the efficiency, integrity and transparency of data collection. LiveCorp made several recommendations / observations in relation to these issues that may be relevant to the ASEL Committee, replicated below:

- *Providing appropriate regulatory transparency on vessels is critical and can be delivered by an appropriate combination of personnel and technology. The right people collecting the right information.*
- *Independent Observers have an important role and function which aligns most closely with an auditor or inspector. A better regulatory approach focused on risk based, randomised sampling / audits would provide equivalent regulatory benefits while minimising logistical, cost and resource challenges.*
- *LiveCorp, through the LEP, is investing in the development of technologies that will support future data collection and information transfer.*
- *Automation can play an important role in providing independence over collection of key data, increasing transparency.*
- *On-board personnel – particularly AAVs – play a vital role in the success of livestock voyages and there is value in balancing independence with the ability for professional relationships to create improved performance.*

Key topics raised

Voyage mortality and reporting requirements

Collecting and reporting of data is important in achieving many objectives including supporting industry continuous improvement (including planning, standard setting and identifying developing issues), compliance monitoring / enforcement and transparency (e.g. with the community). However, achieving these objectives is possible only if the data collected and reported is repeatable (can be assessed clearly, objectively and consistently), meaningful (i.e. are understood and can be interpreted), statistically significant and used to fulfil a clear purpose.

The Department of Agriculture and Water Resources (department) currently collects a significant volume of voyage data, from Accredited Stockpersons and Australian Accredited Veterinarians (AAVs), as part of its daily and end-of-voyage reporting requirements. This information currently appears to be used primarily to inform diagnosis and analysis in regulatory investigations (such as for reportable mortality events). This is a useful purpose for this information and there are a range of reasons, outlined further below, why caution should be exercised in expanding the reporting requirements – particularly into a regulatory threshold – without a clear scientific basis. However, with further consideration this information could form an important basis for industry continuous improvement and benchmarking and this is being considered by the LEP’s animal welfare indicators development and pilot project.

- The LEP animal welfare indicators research project - *Development and assessment of animal welfare indicators – quantifying welfare improvements in the live export industry* – also identified the range of welfare measures already collected by the department through the daily and end-of-voyage reports, and that this information is not extensively used. The project is now looking at these measures and how they should be defined and collected.

LiveCorp also notes that before the TAC considers expanding or amending the existing voyage reporting requirements to a significant degree that it could consider conducting a retrospective analysis of the existing data held by the department. Coupled with consultation with the regulator and the users of the daily and end of voyage reports (AAVs, stockpersons), such an analysis could help to clearly define the purpose of each measure collected (i.e. what value and meaning it provides the regulator), and identify any gaps (i.e. what information would have been valuable to the regulator during an investigation) or problems (e.g. ambiguity in application or interpretation).

We also note that the LEP is well advanced in a research project that will allow the current voyage reports required under ASEL to be collected / recorded in an electronic / app based system. This approach will support the standardisation of reports (and hence compatibility of data), as well as improving the efficiency of data transfer, aggregation and analysis. This project falls within a broader LEP 'data pipeline' project that aims to establish standardised systems for data collection to improve how information collected by AAVs, stockpersons, researchers, etc can be used. Several forms within the app have been developed and are being trialled to enable potential real time recording of mortalities and animal health treatment records by AAVs and stockpersons. This app will also form the technical platform through which the collection of animal welfare indicators will be implemented. It is also worth noting that through this data pipeline project, the researchers have been working closely with those collecting the data (AAVs and stockpersons) to understand their training needs / user preferences and identify areas lacking clarity in what is required / expected.

Mortality and other animal welfare measures

LiveCorp would like to refer the TAC to ALEC's submission which has made significant comment on the use of mortality as a trigger measure for regulatory purposes.

LiveCorp has provided input to inform ALEC's position, however, it is important to highlight that our view caution needs to be exercised in using welfare indicators and data collection in a punitive sense – rather than using it in a structured manner to drive continual improvement. In this regard, we note that mortality provides a very effective regulatory measure – as it is undisputable, permanent, clearly identified, can be completed at the census level, and there is no doubt whether a threshold has been exceeded. Measures of welfare by their nature are less definitive. They can be temporary, have different degrees, are logistically difficult to record other than at a sample level, and may have a level of subjectivity in their interpretation (hence more training / skills to assess). It is important that any strict regulatory measures / thresholds are clear to the regulated and the regulator and there is minimal subjectivity in whether they have been met or not.

The LEP project – *Development and assessment of animal welfare indicators – quantifying welfare improvements in the live export industry* project – is a critical project and was previously commenced as part of an industry reform proposal initiated by ALEC to develop meaningful indicators of welfare along the supply chain that would move performance measurement away from a focus on mortality, support transparency and reporting to the community, and enable benchmarking of exporters and the industry. It is a key part of defining the measurement of welfare moving forward and is the basis on which a move from mortality to welfare can be pursued on a scientifically rigorous basis. We believe that the project should be completed (scheduled for 2021) before any decisions are made on which indicators industry should measure, and certainly before any additional 'trigger' measures are adopted.

For further detail on this project, please see *Animal welfare indicators* section below.

Automation of data recording

Providing appropriate regulatory transparency and independence on vessels is critical and is best achieved through a combination of personnel and technology – i.e. the right people collecting the right information. Automation is likely to be a key part in providing independence and efficiency in the collection of data and LiveCorp, through the LEP, is investing in the development of such technologies that will support future data collection and information transfer.

LiveCorp highlighted in its submission to the Moss Review that:

“Commentary following the recent incident involving the Awassi Express has raised questions about the reporting that the department receives from on-board livestock export vessels (including what is collected, who collects it and their independence), the checks or audits that the department performs to validate the accuracy of those reports and ultimately how that data is then used.

LiveCorp recognises that there is a need in the current regulatory environment for changes to enhance the line of sight of the regulator onto vessels. In the first instance, this has been implemented by the Minister for Agriculture and Water Resources’ introduction of Independent Observers. However, longer term reforms must consider and define the different information, evidences or assurances that the regulator requires from a vessel and the respective roles and responsibilities of the different parties (independent observers, AAVs, stockpersons) / technologies (e.g. automated data collection) and the relationships between them. Such consideration needs to take into account the logistical challenges and identify arrangements that support the best possible animal welfare outcomes, as well as the regulatory framework.”

“...the livestock export industry is undertaking research and development into animal welfare indicators to investigate improved methods of measuring and collecting welfare performance data using technology and automation. Achieving the right balance in data collection and technology will improve the integrity and breadth of data collected. Aspects of this research have been fast tracked in response to recent evidence of poor animal welfare outcomes of sheep exported to the Middle East and are currently being rolled out across industry through the industry welfare data collection program. This will increase the industry’s ability to collect meaningful animal welfare data through the supply chain to identify trends and opportunities for continuous improvement and further research and development.

In addition, the livestock export industry has commenced research looking at the use of different technologies that may play a role in supporting reporting and transparency in the future. LiveCorp, with the LEP, is also looking to commence research into technological solutions and opportunities to collect data on different measures to enhance transparency and independence.”

Automated data collection and the availability of supportive collection and analytical technology will be an essential element of the animal welfare indicators project to ensure that it achieves its goal and can be implemented. In particular, automation will be key to:

- Increase the irrefutability of the data;
- Reduce the reliance and workload impact on on-board personnel to collect data – particularly important under a welfare measurement system where there will be a reliance on sampling.
- Enable the collection and rapid analysis / processing of large volumes of information in different forms to allow for early warnings / alarms of potential issues to be alerted to on-board personnel and others that can check and respond.

Recognising the importance of integrating this technology into the industry and regulatory systems, the LEP has a number of projects in this space that it has been pursuing alongside the welfare indicators project. Current projects and activities – which the LEP expects will expand as there is more clarity on the indicators that may need to be collected – include:

- Trials of automated environmental monitoring for ammonia, temperature, humidity and carbon dioxide (initially on-board aircraft);
- Development of automated sheep counting technology to provide irrefutable counts at loading and unloading (and in turn, irrefutable mortality figures); and
- Mapping and scoping of proof of concept trials with a university provider for technologies that could support the automated measurement of animal welfare indicators from the animal welfare indicators project (for example, behavioural measures such as panting).
- Commercial scoping project for environmental recording technologies on vessels.

The above projects will provide a rigorous, science based structure for reporting, triggers and indicators that will benefit animal welfare and provide a clear framework for performance into the future.

However, while recognising the future role of automation, it is important to note that while technologies are becoming more available they are still transitioning into the agricultural space and it is a complex task to work through what is available and determine what may be right for the industry. There are also significant logistical and practical challenges that complicate roll out including not only cost, but also the challenges of connectivity on-board vessels and off of vessels, battery and processing power, and the impacts of saltwater / operational factors on sensitive equipment (for example, to measure environmental requirements many collection devices have temperature / humidity recording capabilities, yet they do not have the capacity to collect information on contaminants such as ammonia because the membrane systems required are more easily damaged, particularly in a sea going environment).

Heat stress on-board

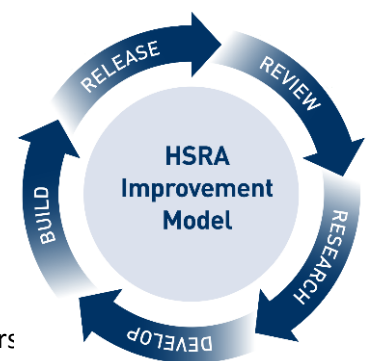
Heat Stress Risk Assessment Model (HotStuff)

The industry Heat Stress Risk Assessment model (HSRA), otherwise known as HotStuff, is a predictive heat stress risk assessment model developed by the LEP for the industry and which also provides a scientifically based regulatory tool for the department.

The LEP R&D Program has invested significantly into the development and continuous improvement of the industry HSRA model. The model is an engineer designed program that brought together the expertise of professionals in areas including engineering and ventilation, meteorology, livestock biology and physiology, etc. The HSRA model was designed to calculate the maximum stocking density of livestock within the parameters of a 2% chance of a 5% mortality event (as a result of heat stress) from a consignment. To do this, it considers the predicted temperatures during a voyage together with the calculated heat produced by the livestock, the vessel's ventilation and the animals' heat tolerance (including consideration of a series of animal specific characteristics such as acclimation).

Through a structured process, the HSRA has continued to improve over the years with reviews and updates to ensure its accuracy and validity in light of the best available science. The following summarises some key changes:

- Version 2: upgrade of biological assumptions
- 2008 – Independent review and validation of model
- Version 3: upgrade of risk assessment methodology
- Version 4: addition of port risk as a separate assessment to voyage risk, and updates to the crosswind estimates
- Version 5: additional ports & routes added (ready for implementation)
- 2018 – Pen air turnover audits, including assessment of re-ingestion factors
- Future – Changes to the ventilation of open decks (i.e. ventilation for open decks must be as per closed decks) to align with AMSA amendments on 1 January 2020



Research projects on the HSRA (HotStuff) include:

- *Development of a Heat Stress Risk Management Model* (Stacey, 2003)
- *Potential benefits of jetting to the 'Heat Stress' model* (Casey, 2005)
- *Upgrade of biological assumptions and parameters used in the HS risk management model version 2.3.* (Stacey, 2006)
- *Assessing a method of incorporating jetting in the HS model and its commercial implications* (Smith et al., 2007)
- *Review of the Livestock Export Heat Stress Risk Assessment Model (HotStuff)* (Ferguson et al., 2009)
- *HotStuff version 3.0 Revision of the heat stress risk assessment methodology to properly incorporate risk of heat stress while at port* (Eustace & Corry, 2009)
- *HotStuff version 4.0 – Revised methodology and additional ports* (Stacey, 2014)
- *HotStuff version 5.0 - Improvements to the Live Export Heat Stress Risk Assessment Method* (Stacey, 2017)

The HotStuff version 5 review addendum also provides details of the calculations behind the model and will be provided to the TAC.

The LEP also has a framework currently in place to make further updates to the HSRA. Prior to the commencement of the governmental HSRA Review, these included:

- Software upgrade to improve functionality and user interface,
- Incorporation of an additional tranche of voluntary observing ship data to update the weather, and
- Trials to better understand and define heat stress thresholds in sheep.

The HSRA model is obviously under review by a separate government panel, which recently released an issues paper. LiveCorp and the LEP will engage with this panel and provide a detailed submission for its consideration. We understand that the ASEL Committee will take into account the findings from this review.

Open Innovation – on-board heat stress mitigation for sheep exported to the Middle East

In May 2018, LiveCorp commenced an Open Innovation program to explore the existence and feasibility of new and developing solutions for managing the on-board environment, particularly wet bulb temperature.

While the LEP RD&E Program has invested in research to address the risk of heat stress to livestock during export (through risk assessment, management, planning, ventilation design, etc), interventions to change the ambient temperature or humidity in vessels (e.g. dehumidification / air conditioning) have traditionally been considered – based on expert advice – as almost impossible to achieve. The Open Innovation Program has now provided the industry with the opportunity to tap into the global innovation and technology ecosystem to identify new or emerging technologies that may have shifted the feasibility of such interventions.

To date, the project / process has conducted a thorough scoping of a range of technologies that could support improved detection and responses for dealing with the risk of heat / humidity based on real time conditions / assessments, rather than solely predictive or historical approaches. Areas that have been investigated included dehumidification, targeted rapid cooling, environmental monitoring, weather data / improved voyage route planning and artificial intelligence. LiveCorp is now commencing a trial phase to validate the effectiveness / viability of some technologies identified.

Bos taurus cattle to the Middle East

The ASEL Technical Advisory Committee should refer to ALEC submission for details on the LEP R&D relevant to this topic. However, LiveCorp would particularly like to note the role that the HSRA model has played in reducing heat stress risks for cattle exports to the Middle East and the subsequent outcomes of the long term research project completed in 2015 that assessed the causes of mortality in cattle exported to the Middle East.

This project, entitled *Identifying the causes of mortality in cattle exported to the Middle East* (Perkins *et al.*, 2015) – was undertaken to better understand the current risk factors for mortality during livestock export. The project had a number of components, including recording the on-board causes of mortalities on long-haul voyages and assessments of Bovine Respiratory Disease along the supply chain. The report found that mortality rates over the previous 17 years had significantly declined, and that heat stress was no longer the primary cause of mortality for cattle exported to the Middle East (although was still a risk that needed to be effectively managed). It identified that BRD was the primary cause of mortality. Figure 6 identifies the changes in mortality between 1995 – 2006, and 2007 – 2012.

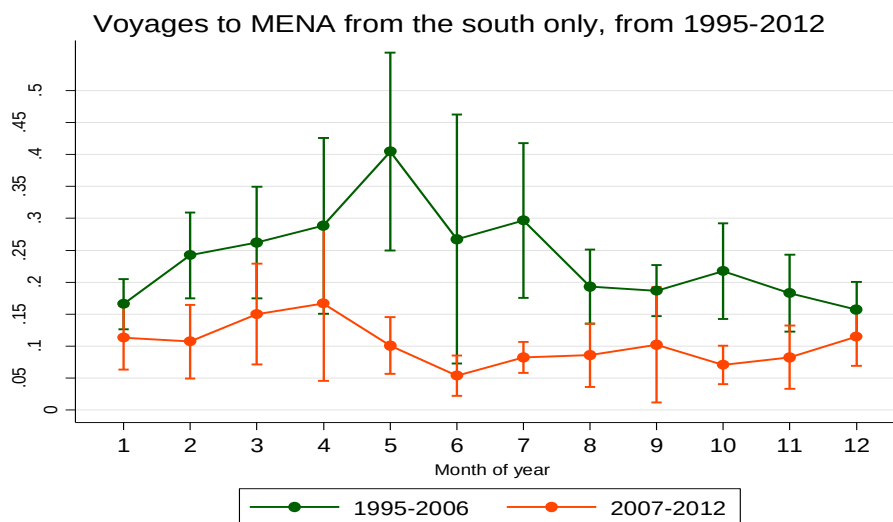


Figure 6. Average voyage cattle mortality (deaths per 1000 cattle days) by month of loading, for voyages involving cattle loaded in southern Australian ports and travelling to MENA. Bars represent 95% confidence intervals.

Shearing sheep and hair sheep

As highlighted in ALEC's submission, a literature review of the current science relevant to the pre-export shearing of sheep was conducted following the 2013 ASEL Review by Dr Andrew Fisher from the Animal Welfare Science Centre (*A Review of Pre-export Shearing of Sheep*). This review provided valuable insights and understandings into the physiological responses of shearing. In particular it identified that:

- shearing of sheep produces a strong physiological stress response that returns to baseline approximately an hour after shearing and the adverse consequences are likely to have resolved within 24 hours.
- where shearing tissue trauma occurs, inflammation and the risk of infection may persist for several days, however, the exact duration of susceptibility to infection is not known and will depend on the degree of the cut and environmental challenge.
- shearing alters the metabolic and thermoregulatory responses in sheep, increasing the risk of hypothermia for 1 to 2 weeks and possibly lowering feed intake for approximately 1 week (however, the findings of Lourdes-Angelica Aguilar Gainza in 2016 further informed the questions concerning feed intake – see below).
- wool-bearing sheep benefit from being recently off-shears in terms of reduced risk of heat stress arising from hot and humid conditions but the effect is not a step-change reduction below 25 mm of wool length, rather there appears to be increasing benefit as wool length becomes shorter.
- the scaling factors for wool (<10 mm, 10 – 25 mm and >25 mm) used in the industry heat stress risk assessment model were found to be reasonable in light of the data reviewed and other factors. The cost of research to generate more data on wool lengths may not be justified given that variation around other factors (acclimatisation etc.) may mean that such new data may represent a false accuracy in the real world.

- hair breed sheep have been shown in a number of international studies to be more heat tolerant than wool breed sheep under farming conditions in hot and humid environments. There is no data on heat tolerance effects of shearing hair breed sheep, as they are not typically shorn. Crossbred sheep (i.e. between wool and hair types) would likely benefit from being in short wool before export, but have not been studied.
 - It also noted, “given the fleece characteristics and length of the naturally short haired sheep types, it is difficult to identify a benefit that would accrue from shearing such animals.”

The report concluded that the 10-day minimum period off shears in ASEL was not justified by the duration of the stress response itself to shearing, but appeared to be based on risk management associated with feed intake, hypothermia and infection susceptibility off-shears. It noted that it was not possible in the context of the review to place an exact time limit on such effects, because of the interactions between the degree of environmental challenge and the susceptibility of the animal, which is in turn influenced by body condition, weight change and other factors.

It is noted that following the above literature review, an opportunity arose within the sheep feedlot trials conducted by Murdoch University under the LEP inanition project to explore any feed intake lag following shearing. The research project *The Effect of Shearing Sheep on Feeding and Behaviour in the Pre-Embarkation Feedlot* (Lourdes-Angelica Aguilar Gainza, 2016) assessed a sample of 20 animals and examined the effect of day of shearing on the time spent at the feed and water troughs, as well as the effect on observed behaviour. The project concluded that: there was no difference in time spent at the feed and water troughs for sheep shorn on any day, therefore the null hypothesis that shearing had no effect was retained; and that for this group of sheep, shearing could occur on any day that the sheep were at the pre-embarkation feedlot and that current management practices did not disrupt feeding behaviour (that is, the amount of time the sheep will spend at the feed and water troughs) and observed behaviour.

Maximum cattle weight

During a LiveCorp and ALEC co-ordinated communication workshop with AAVs in Melbourne in December 2016, there was agreement that heavy cattle were a higher risk category and needed to be managed differently. However, there was no consensus on what ‘heavy’ cattle were or what the best method of risk mitigation was given the differences between breeds, species and gender. It was also noted that welfare risks for heavy cattle were a complex function of pen space, trough space and feed availability. There was no suggestion that heavy cattle should not be exported.

- The final report from the AAV workshop provided the following finding and proposed pathway forward in relation to heavy cattle:
 - *Cattle of 500+ kg are recognised as higher-risk animals. Data on the relationship between weight and animal welfare outcomes should be collected to enable the current threshold of 650 kg to be reviewed.*

LiveCorp considered this proposal noting that to obtain statistically meaningful data on cattle weight relative to welfare outcomes would require significant volumes of data across a range of shipments. In turn, it was identified that the data collection structure being developed through the data pipeline / animal welfare indicators projects would be needed before such analysis could be completed. As noted earlier, there are trials underway for this data collection system.

Minimum time in RP – sheep

Scientific studies to date have shown that for sheep, the primary consideration for the minimum time in pre-export facilities is the management of inanition (feed transition) and salmonellosis (disease exposure). A recently completed project - *Strategies to reduce inanition in sheep* (Barnes et al., 2018) – looked at the time required for sheep to transition to pellets in pre-export facilities and whether adding oats or chaff, or being housed in

sheds vs paddocks, had any positive effect on the speed of transition. The project determined that on average, it took five days in the feedlot for the animals to transition. The following key findings were made:

- Feeding patterns associated with the development of salmonellosis include intermittent or interrupted feeding after exposure to salmonella. Feeding interventions assessed in the project did not markedly hasten feed acceptance or increase the number spending an acceptable period at the feed troughs. The only strategy which had some effect was the provision of chaff on the pellets, and this is used in industry with animals considered of concern; the data continues to support the practice.
- There was no gain to housing sheep outside the sheds for a short period before entering the shed.
- The study indicated that there is little economic advantage to be had in early detection and removal of those animals which are not going to the feed troughs, because the mortality was relatively low, and because not eating or eating for short periods of time on any day was not necessarily predictive of death, i.e. the feeding pattern of those that died was not consistently different from those that did not die. Removing sheep that had not attended the feed trough on any given day would mean disrupting the large group, with many misclassifications as to “at risk” sheep.
- Enteritis, mostly associated with isolation of *Salmonella* spp, combined with inappetence / inanition, was diagnosed as the most common cause of death (61.4%). Therefore control of salmonellosis appears key to reducing mortality. Any feeding interventions must limit exposure to *Salmonella* e.g. from environmental contamination. Inconsistency of feed intake appeared important in the development of salmonellosis, so maintaining consistent feed intake is important in limiting disease.
- Housing in raised sheds, where the animals have limited contact with faecal material and are dry undercover, may protect them from exposure to *Salmonella* (which is consistent with ASEL standards for at risk classes during the higher risk winter period).
- Other means of reducing contamination will be important in limiting *Salmonella* infection, for instance with all in/all out management, and not running newly received sheep through the same areas as those that leave (circular flow to limit exposure of new sheep to organisms). The continued development of a vaccine against salmonellosis is very likely to have an important impact on reducing mortality in similar situations to those tested.

Further detail on the salmonellosis vaccine is provided below.

Management of shy feeders and inanition in sheep

LEP R&D has shown that inanition and salmonellosis are the most common causes of mortality in exported sheep. The LEP has conducted significant research to better understand the interaction between these conditions and support exporters to minimise the risks that they present during livestock export. The timeline of this research and the complex causal relationship between the conditions are shown in figures 7 and 8 below.

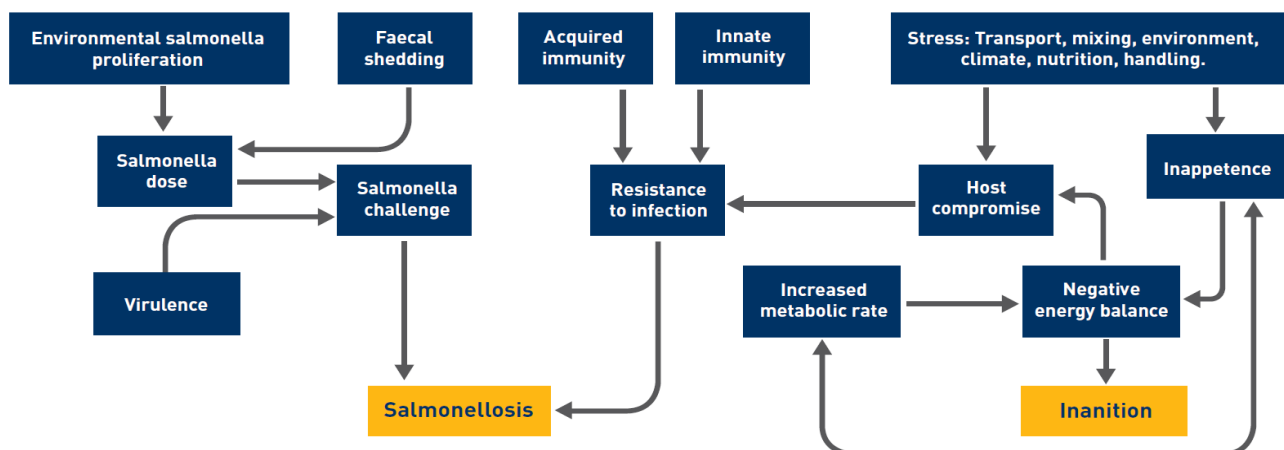


Figure 7. *Salmonella* / inanition causal web

Most recently, there have been two core projects underway in this space being:

- **Strategies to reduce inanition**

As mentioned above in *Minimum time in RP - sheep*, the LEP RD&E Program initiated a project to explore strategies to assist in reducing the incidence of inanition in sheep, entitled *Strategies to reduce inanition in sheep* (Barnes et al., 2018). The project determined that on average, it took five days in the feedlot for the animals to transition with the various feeding strategies having no significant effect on acceptance and consumption of the pellets. Of the overall mortality of the trial, 61.4% were due to Salmonella or inanition.

The project was recently finalised and outlined some best practice guidelines for pre-embarkation treatment of sheep to minimise the incidence of inanition and Salmonella.

- **Development of a Salmonella vaccine**

After early research investigating the causal pathways and potential management approaches to disrupt shedding / exposure / susceptibility (many of which are currently utilised) of Salmonella spp, industry decided to proceed on the long process of developing a vaccine. The process to date has proceeded comparably to other vaccine developments and although taking many years, each stage has shown positive results.

The industry has now imported a DAM attenuated *S. Typhimurium* strain of the salmonella bacterium as a modified live vaccine. This process required a number of core steps, firstly that the vaccine strain be imported from the United States of America to Australia and undergo Australian Government inspection. Now that the vaccine has been imported, it is anticipated that a commercial partner to the LEP will produce the vaccine at levels to provide for safety and efficacy testing in sheep before large field and safety studies commence in late 2018. Commercial availability of the vaccine – pending further success with trials and approvals – is anticipated around 2021.

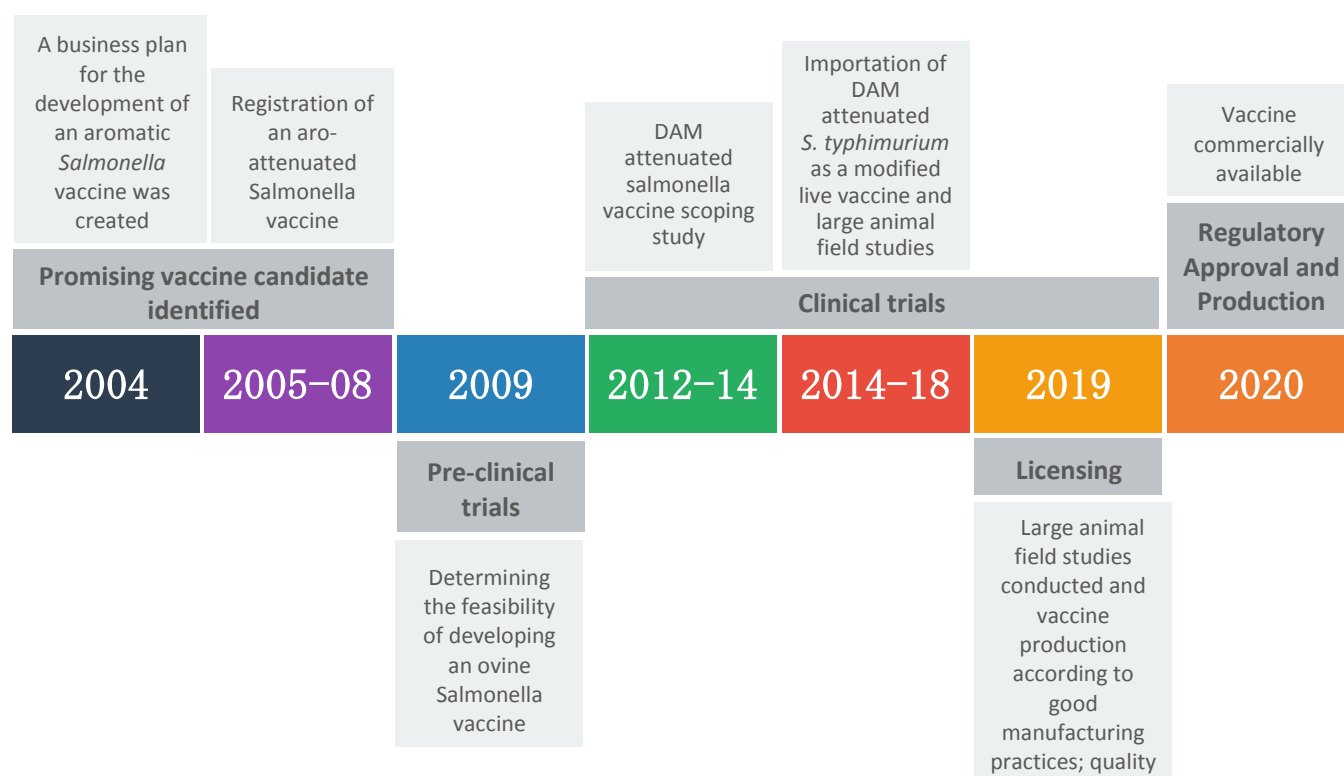


Figure 8. Development process of the Salmonella vaccine

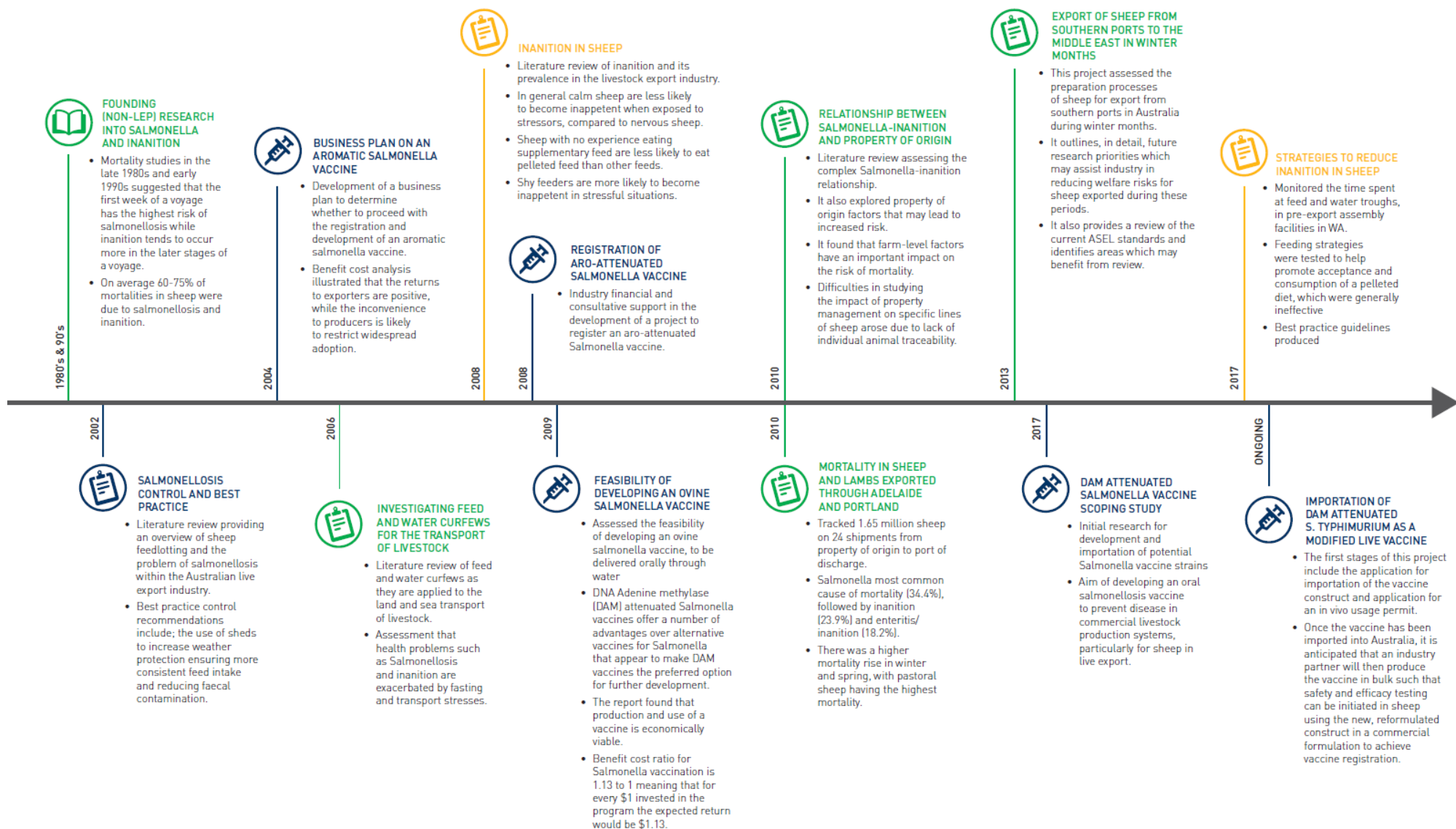


Figure 9. Timeline of salmonella and inanition research and development

Pregnancy test requirements and limits

Meat and Livestock Australia (MLA) are currently undertaking a research project (*Development of a National Pregnancy Diagnosis*) to investigate the nature, and quantify the extent of reported shortcomings in existing arrangements for pregnancy diagnosis in Australia; identify causes, and depending on those findings, make recommendations on how a National Standard for Pregnancy Testing Cattle might ensure the following:

- the availability of quality pregnancy diagnostic services which meet national animal welfare and biosecurity standards;
- regulatory control that will engender confidence in the standards and integrity of available commercial services;
- equitable market access where lay and veterinary pregnancy testers operate on a level playing field;
- a viable market structure based on a fee for service and/or cost recovery model.

The scope of the project includes the domestic industry (where there is little or no legislation covering pregnancy testing) and the export industry (where ASEL provides a good foundation). It is / will also be consulting with a range of stakeholders, including industry bodies and associations such as the Australian Veterinary Association and Australian Cattle Vets.

On-board stocking densities

Stocking density has a critical influence over the welfare of livestock exported from Australia and is one of the primary determinants over the productivity / profitability of the trade. However, it is a complex area with many factors interacting from an animal, infrastructure and journey perspective to influence the likely risks and outcomes. Please refer to LiveCorp's submission to ASEL Review – Stage 1 for further detail and discussion of stocking densities and the available science on allometrics.

A number of key projects conducted by the LEP are relevant in this regard and which LiveCorp would be pleased to provide further details of if required during the ASEL Review process:

- *Quantitative assessment of cattle behaviours on-board livestock ships* (Stockman, 2009) – this project analysed video footage of a shipment to the Middle East. It aimed to provide an informed estimate of what proportion of time animals spend performing certain basic behaviours on-board.
- *Refining Stocking Densities* (Ferguson & Lea, 2013) – this project assessed a range of welfare and performance indicators (including weight change, time spent lying, environmental conditions, etc) for two long haul sheep and one short haul cattle shipments against the following stocking densities – ASEL, ASEL + 10 per cent (or the space provided using an allometric K-coefficient of 0.027, whichever was greater), and ASEL - 10 per cent. The report noted that:
 - Any reductions in the ability of the animal to eat its normal feed allowance or rest for 6-8 hours / day will result in a profound compromise to their welfare.
 - The current ASEL stocking densities are appropriate based on the animal welfare indicators applied in these investigations but a 10 per cent increase should be further investigated. It was also noted that the project only considered voyages during periods when climatic conditions were relatively benign and the benefits of an increase (10%) may be more evident under warmer, more humid voyage conditions.
 - However, it was recognised that under such conditions, it would also be likely that stocking density reductions would be required based on HotStuff predictions.

Following this earlier research, a project has commenced between the LEP and the University of New England as part of a project partnership to conduct detailed research into stocking densities so as to expand and inform the scientific understanding of space use by groups of sheep and cattle on-board livestock export vessels. A consultative committee has been established to inform and support this project, entitled *Effects of stocking density on behaviour and group dynamics of cattle and sheep exposed to differing export conditions*. The project

will look at quantifying the extent and cause of variation in response to differences in climate conditions, stocking density and other stressors (e.g. availability of bedding, trough space and sequential feeding, etc), and how they affect the distribution, behaviour, welfare and performance of livestock. It will include land based studies, as well as on-board trials / data collection (in collaboration with the *Development and assessment of animal welfare indicators - Quantifying welfare improvements in the live export industry* project). The UNE project will ultimately provide robust science and information to the industry on optimal stocking densities for both sheep and cattle, which we expect will inform industry and regulatory standards.

Management of bedding and ammonia levels

Better understanding and managing the on-board environment is a priority area for LEP R&D to ensure exporters have the information needed to pursue continued improvements to the welfare and comfort of animals during export. Bedding and ammonia are key items identified in this regard in the ASEL Review issues paper.

Bedding was also a particular item discussed at a workshop coordinated by LiveCorp with AAVs in December 2016. At the workshop, AAVs reiterated that sawdust was mainly related to managing abrasions and strategic use. They also noted that flooring and feed availability were as important to achieving good outcomes in this regard. However, there was no consensus, and reasonably strong pushback, on any increase or extension in the current bedding volumes.

A range of research has also been conducted in this space (outlined in **Appendix 2**), and in 2016 a literature review was completed through the LEP – *Bedding management and air quality on livestock vessels: a literature review* (McCarthy and Banhazi, 2016) – focused on this matter. This report assessed the current scientific knowledge and previous bedding research (*Management of bedding during the livestock export process* (Banney *et al.*, 2009) to bring in greater scientific knowledge alongside anecdotal information and direct future R&D focused on continued improvement.

At the completion of this literature review, the LEP tendered and established a project to scientifically analyse the relationships between the different variables affecting bedding and the on-board environment (particularly ammonia) and develop practical predictive tools and interventions to identify and manage risks. This project is a significant investment will be delivered by the University of New England through its project partnership with the LEP.

Fodder and chaff requirements on vessels

During the 2016 AAV workshop, AAVs identified fodder as a particular important grouping of technical issues requiring further attention. The report from the AAV Workshop identified key technical issues related to pellet specifications, chaff / hay, calculating voyage fodder requirements and daily fodder requirements. The AAV workshop outcomes are included in the ALEC ASEL submission in full.

Following the workshop, the LEP initiated a research project to look at and provide recommendations on the fodder related issues raised by the AAVs (including shipboard fodder quantity and quality arrangements).

A key part of the new project is also to review and update the findings of a previous LEP report from 2011 to reflect current science and research:

- *Review of fodder quality and quantity in the livestock export trade*, Willis (2011).

The current project – *Identifying opportunities for continued improvements to the on-board live export feed ration* – is specifically addressing issues relevant to ASEL including fodder quantity, pellet specifications (including particularly the issue of ‘fines’), contingency / reserve volumes, chaff volumes, and how fodder requirements should be calculated. Extensive consultation has been undertaken with stakeholders including exporters, AAVs, stockpersons, pellet manufacturers and nutritionists. It has also taken a slightly different approach to assessing fodder needs from previous research by looking at young animals, growing animals and adult animals as separate groupings with different energy and nutritional needs. Once the project is fully completed, including normal review processes, it will be forwarded to the Technical Advisory Committee.

On-Board Personnel and the monitoring and management of animals

On-board accredited stockpersons and AAVs play a critical role in the management of the health and welfare of livestock throughout the export journey. For the successful outcome of voyages, it is essential that these roles are not jeopardised, compromised or over complicated. The roles and responsibilities outlined in the existing ASEL remain largely relevant and effective, however there is room for refinement and clearer definition – particularly in light of the introduction of Independent observers.

Accredited Stockpersons

LiveCorp is responsible for the training and accreditation of on-board stock people who care for livestock exported by sea from Australia through the stockperson accreditation program. The accreditation program for on-board stockpersons undergoes continual review and improvement to ensure that it remains up to date and effective in the training of on-board stock people who are responsible for the management of the health, welfare and physical needs of livestock exported by sea. Most recently, the Shipboard Stockpersons Accreditation course was reviewed and updated in 2017 and an Advanced Stockperson professional development program was developed. Both courses place strong emphasis on balancing technical knowledge, practical skills and crew culture to foster effective working outcomes. In early 2018, a review of the accreditation process was commenced to strengthen the integrity and accreditation pathway for shipboard stockpersons.

The LiveCorp Shipboard Accreditation course is held at least once per year by four expert trainers – including an industry expert, AAV, head stockperson and a livestock handling trainer. An average of 25 participants attend each session. The accreditation course covers topics including:

- Animal welfare
- Role and responsibilities of shipboard stockpersons (including life on board vessels)
- Effective (low-stress) livestock handling (including vessel loading and discharge)
- Management of livestock on-board (including heat stress, fodder, water, etc)
- Livestock health & diseases (diagnosing, treatments, responsible veterinary drug use, humane euthanasia, post mortem, carcase disposal, etc)
- Regulation (ASEL, ESCAS, Marine Order 43, etc)
- Reporting requirements
- Crisis management

Australian Accredited Veterinarians (AAVs)

AAVs have a significant role in the welfare of livestock during export and since the workshop in 2016 LiveCorp has sought to establish and maintain a continuing structured engagement with the AAV community to share information / research and seek feedback based on their expertise, knowledge and experience.

As noted, in 2016, LiveCorp conducted a consultation and workshop process with Australian Accredited Veterinarians (AAVs). The project included a survey of AAVs and a workshop which resulted in the exchange of diverse views in a constructive and respectful manner. The workshop attracted significant engagement and interest from the AAVs, who showed a keen appetite for R&D in particular. A final report of the 2016 AAV Workshop project was prepared highlighting the key outcomes, issues / priorities and proposed ways forward.

Following the consultation project LiveCorp developed an ongoing program of engagement with AAVs to advise them on progress on key items, update them on industry issues and exchange ideas and outcomes in the R&D space. This includes a bi-annual electronic newsletter tailored specifically to AAVs and an annual AAV RD&E Forum. The last AAV RD&E forum was held in November 2017 alongside the LIVEXchange Conference. This year's AAV RD&E forum will be held in Melbourne in November. As critical extension agents for R&D, LiveCorp believes it is essential that AAVs are engaged through these forums and will continue to refine them into the future.

In addition, LiveCorp has been working to address issues identified by the AAVs in the 2016 workshop as priorities allow. These have included the commencement of the fodder project (nearing completion) and the development and tendering of terms of reference for a research project looking at veterinary kit requirements. A key component of the veterinary kit project – *Best practice use of veterinary drugs at sea* – will be to assess the capability of shipboard personnel to diagnose and treat animal health events appropriately and determine if, when and where AAVs may be required to fill any skillset gaps. For further detail on this project and its objectives, please refer to LiveCorp’s submission to the ASEL Review – Stage 1.

Additional key research projects

Animal welfare indicators

As mentioned earlier, a key project for the livestock export industry is the *Development and assessment of animal welfare indicators - Quantifying welfare improvements in the live export industry* being delivered by Murdoch University. The aim of this project is to identify internationally accepted and current indicators of animal welfare for cattle, sheep and goats that could be used at each point along the livestock export supply chain. To identify these indicators, the project conducted a literature review of standards and regulations, as well as a stakeholder survey. The survey of over 900 people from the community, animal welfare groups and the industry found a high level of agreement in the perception and importance of animal welfare. From this research project, the researchers identified (54) candidate indicators. These included twenty indicators that are currently collected along the supply chain by the industry under regulation, including within voyage reporting and ESCAS auditing.

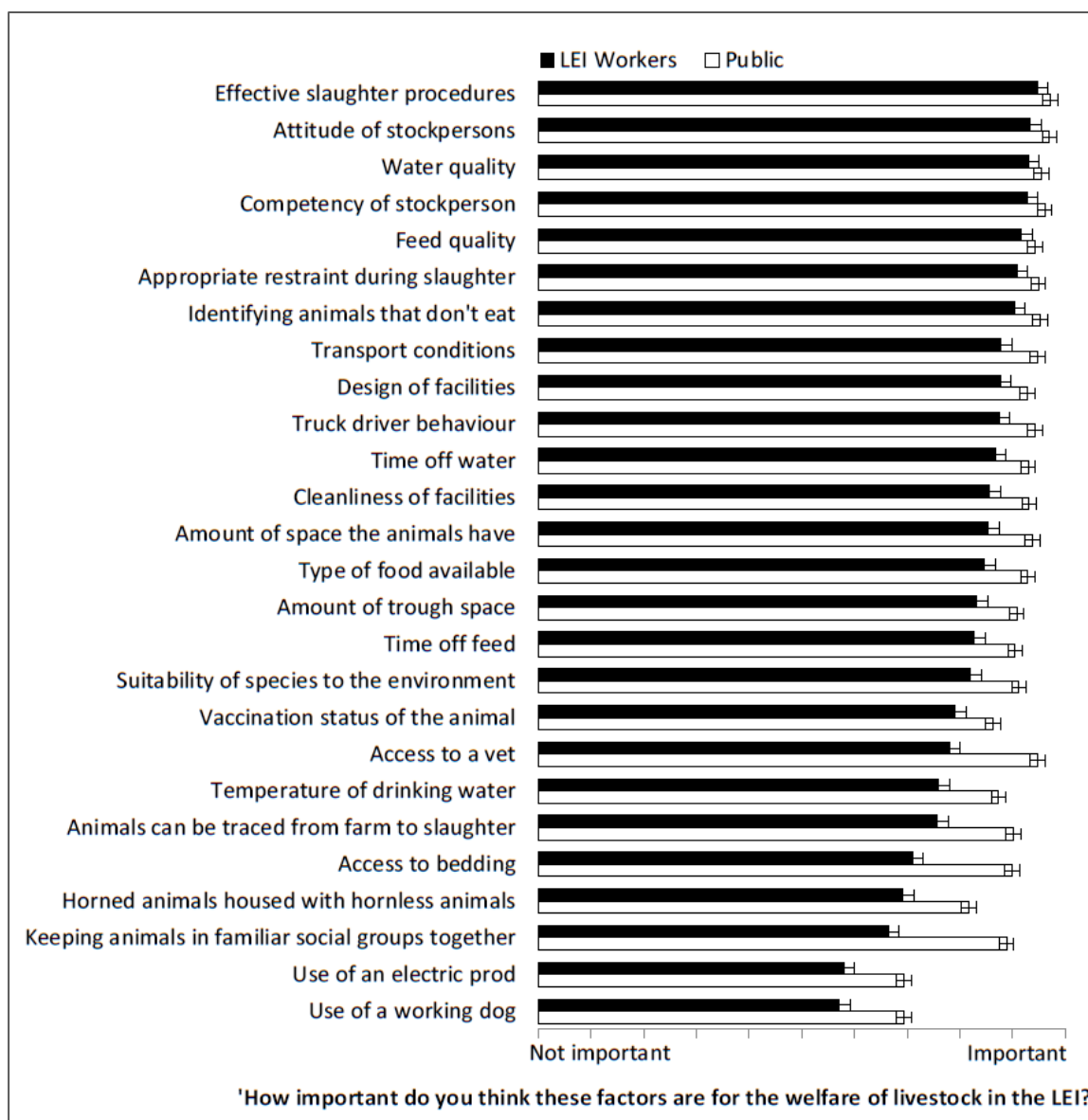
A comprehensive list of potential indicators – including qualitative behavioural assessments – are now in the process of being validated through supply chain pilots to determine a concise group of meaningful indicators of welfare that are practical, cost effective, efficient, repeatable, etc, and can:

- Provide the information to drive industry decision making, allow benchmarking of exporters and supply chain members, and enable planning for mitigation;
- Enable a system of early warnings to be built to enable proactive responses before issues occur; and
- Be understood across industry and community to form a common language and expectation.

However, the research challenge to achieve the above is significant and the selection of indicators is not an easy task. They need to underpin the collection of meaningful and comparable data - too many indicators will result in ambiguity and a lack of focus, while too few may not allow appropriate coverage of the range of animal welfare issues. Some of the aspects of welfare that the project will need to consider include that:

- Welfare is multi-faceted – many different elements contribute, in different degrees, to whether an animal is in a ‘good welfare state’.
- Each element can have multiple degrees of variation that need to be considered and tied back to an acceptable welfare state (for example, there can be variations in the duration and severity of exposure / experience that are relevant, and the scale in terms of how many within a group are affected).
- The patterns and interactions of welfare need to be understood individually and collectively – for example, is panting at a high level for a short time worse than panting at a moderate level but for a longer period?
- Indicators need to be meaningfully linked back to a welfare state through validated science.
- Indicators need to be assessed / measured consistently (can people easily recognise the differences, what level of training / education is needed)?
- Indicators need to have clear collection / sampling protocols that are meaningful – for example, welfare measures have to be based on sampling and if duration, etc. is relevant then there needs to be consideration of how monitoring can occur continuously.

Through the adoption of an app based real time data collection platform (currently being piloted) to capture the data, and further consideration and development of technologies to increase automation (both of the indicators and underlying data of relevance), the project will ultimately result in a platform to benchmark performance and identify areas of improvement using an integrated welfare assessment. Nevertheless, as discussed above, the use of animal welfare indicators needs to be carefully placed rather than immediately applied as regulatory thresholds or triggers.



National Livestock Export Industry Sheep, Cattle and Goat Transport Performance Report

Other resources / useful links

- **2018 LEP Research and Development Updates** – are available on the LiveCorp website www.livecorp.com.au/research-development/about-r-d
- **LEP R&D reports** – LEP research reports can be accessed via the LiveCorp website (www.livecorp.com.au/research-development/report) and key research reports will be provided to the ASEL Review Technical Committee Secretariat.
- **360° and conventional footage of livestock preparation and loading** – this footage of cattle or sheep preparation and loading onto a livestock vessel is available to watch on the LiveCorp YouTube channel www.youtube.com/channel/UCGtp5P8stHcg5ymsW-GrEeA

Appendix 1. Comments on proposed ESAL

Please note that LiveCorp will conduct a further detailed review of ESAL once the final version is released for consultation.

	Proposed ESAL	LiveCorp comment
1.	References to 'unless approved otherwise by the Australian Government' for certain requirements have been removed in the proposed ESAL.	The proposed ESAL appears to reflect a change in policy direction from ASEL v2.3 which provides flexibility and the possibility for departmental discretion on certain matters. LiveCorp notes that some, but not all, discretions have been included in the draft ESAL under Appendix M. Given Approved Arrangements are intended to provide an avenue for greater flexibility, it is questioned whether this is a consistent approach and suggest consideration of including an overarching statement to caveat the whole document – e.g. 'unless approved otherwise by the Australian Government'. It is also unclear how Appendix M in ESAL would be added to in the future.
2.	Euthanasia: The killing of an animal in a humane manner which causes immediate loss of consciousness and then rapid death of the animal while unconscious.	LiveCorp suggests that the definition for euthanasia reference the <i>Australian Welfare Standards and Guidelines, Standard 6 – Humane Destruction for recommended euthanasia practices</i> for consistency with ESAL clause 3B.7 (a).
3.	Importing country requirement: A reference to importing country requirements is a reference to: - The requirements of the relevant importing country protocol, and - The requirements or conditions of the relevant import permit ...	LiveCorp notes that importing country documents take the form of either a health protocol OR import condition. Therefore the wording of the definition should be amended to say "and / or".
4.	1A.1.1 (a) In addition to the inspection requirements of the Land Transport Standards, at a minimum, livestock to be exported by sea must be individually inspected by a competent person....	The current ASEL under clause S3.15 requires all livestock to be inspected daily by a competent person but it does not specify that this be individual animal inspection. LiveCorp suggests that 'individual inspection' be clarified to avoid confusion (i.e. it does not meet a detailed individual animal inspection but rather an assessment within a pen or cohort environment).
5.	1A.3.4 Rejection criteria – Sheep, section (d) For exports by sea, all sheep must: (ii) have wool not more than 25 mm in length.	LiveCorp questions why the proposed ESAL does not provide departmental discretion under an EAN to allow sheep with wool longer than 25 mm to be exported as per other discretions.
6.	1A.3.4 Rejection criteria – Sheep, section (f)	Appears to be missing subsection (ii) which in ASEL states: “(ii) For livestock held in paddocks or sheds: - full-mouth wethers with a body condition score greater than 4; - broken-mouth sheep; and - pregnant ewes.”

7.	2A.2 a) (v) the quantity of feed available should meet at least the minimum daily feed requirements, which are: B. Sheep and goats – 2 per cent of their bodyweight per day for sheep younger than 4 tooth and 2 per cent of their bodyweight per day for 4 tooth or older, of a quality feed able to meet daily maintenance requirements.	We note that no specification has been made regarding the feed volume requirements for goats.
8.	3A.3.2 Feed (h) for all voyages travelling through the Suez Canal, the statutory reserve of additional fodder that must be loaded must be increased to at least seven (7) days.	This requirement of ‘at least 7 days’ appears to be inconsistent with EAN 2016-15 - The export of Livestock on “extended voyages” – which states “Additional fodder (over and above the normal 3 additional days specified in the ASEL) or a plan to manage fodder shortage in light of the extended voyage length and route.”
9.	3B.7 (c) For export by air, arrangements must be made to remove or separate sick or dead livestock from pens carrying multiple animals in transit.	This clause is not practical or logistically possible to comply with during a flight. Mortality rates during export by air are very low and therefore the standard should focus on arrangements being made to remove any sick or dead animals on arrival at the destination.
10.	Appendix B, Table #6 – Maximum water deprivation and minimum rest times	It is noted that this table appears to have several inconsistencies and will require amending. For example, if a sheep is 9 months old it can be classified both as ‘over 6 months of age’ or ‘less than 12 months’ and therefore it is unclear whether a maximum time of 32 hours or 20 hours off water would be required.
11.	Appendix C, Table #7 – Stocking density requirements in registered premises.	LiveCorp notes that the stocking densities outlined do not specifically apply to groups of 31 animals (i.e. the groups specified are ‘16-30’ and ‘more than 31’).
12.	Appendix D, Table #9 – Sheep and goat premises hold time and feed requirements.	This clause refers to “All sheep, and goats to be exported by air”. This is an error as the requirements in this clause are not applicable to exports by air. “by air” should be deleted. It is also important to allow the flexibility to provide chaff to as well as pellets in registered premises to encourage sheep and goats to transition onto feed.

Appendix 2. Relevant LiveCorp / MLA research and development project reports (1999 –)

Livestock Mortality Rates and Performance

Code	Project Title	Summary	Finish Date	Author/s
SBMR.001	Research into cattle deaths and illness during sea	The report was published in 1999 following the rapid expansion of the trade of live cattle to the Middle East since 1995 and the lack of no scientific investigation into the causes of ill health or mortality or of the predisposing factors. The report describes an investigation into the health and welfare aspects of cattle during sea transport from Australia and identifies factors that contribute to illness and death of cattle and makes recommendations to reduce illness and death as well as develops a post-mortem protocol for voyages.	1/03/1999	RT Norris JH Creeper
SBMR.004	Shipboard mortality study - phase 2	This study was undertaken as a result of the recommendations from the report “Research into cattle deaths and illness during sea” published in 1999 that identified the need for further investigation to determine the cause(s) of cattle deaths and illness during sea transport from Australia to the Middle East. This report further identifies factors that contribute to illness and death and makes recommendations to reduce morbidity and mortality of cattle during sea voyages. The study identified heat stress/ventilation and pneumonia from pasteurellosis as two major causes of illness and death and supported the findings of the previous report that a larger number of detailed necropsies was required to determine the cause(s) of cattle deaths during sea transport are essential.	10/09/1999	RT Norris B Madin RB Richards
SBMR.004A	Investigation of Cattle Deaths and Illness during Sea Transport from Australia Voyage 4	This study was undertaken as a result of the recommendations from the reports “Research into cattle deaths and illness during sea” and “Shipboard mortality study - phase 2” published in 1999 that identified the need for further investigation to determine the cause(s) of cattle deaths and illness during sea transportation. The aim of the study was to improve the welfare of cattle during sea transport.	5/09/2001	RT Norris TF Jubb RB Richards
LIVE.0206	National Mortality Recording System for Export	This report summarised sheep and cattle mortalities during sea transport form Australia during 2001. The report is the first of subsequent annual mortality reports of the livestock export industry that evaluates mortalities based upon species, port of loading, destination, season and vessel and allows trends to be monitored over time.	31/07/2002	RT Norris GJ Norman
LIVE.0215	Minimising mortality risks during export of live goats by sea from Australia	This report outlines risks associated with high mortality rates of goats during sea voyages from Australia. The report identifies the most important risks for mortalities, risk management principles and the recommended management practices of goats on-ship.	31/01/2003	S More T Brightling
LIVE.0216	Mortality and morbidity risk factors for livestock during sea transport from Australia	This study analysed the existing causes of mortality and morbidity of cattle, sheep and goats within the livestock export industry. The report outlines causes of morbidity and mortality of livestock prior to loading as well as during voyages and includes the cause of death and	31/03/2003	RT Norris GJ Norman

		contributing factors, the port of loading, season (time of year) and species. The major cause of death in sheep and goats was salmonellosis and inanition and heat stroke in cattle.		
LIVE.0214	National livestock export industry shipboard performance report 2002	This report provides summary information about mortalities in sheep and cattle during sea transport from Australia in 2002 to allow industry, government and others to monitor mortality trends in the live sheep and cattle trades.	30/05/2003	RT Norris GJ Norman
LIVE.0220	National livestock export industry shipboard performance report 2003	This report provides summary information about mortalities in sheep and cattle during sea transport from Australia in 2003 to allow industry, government and others to monitor mortality trends in the live sheep and cattle trades.	30/08/2003	RT Norris GJ Norman
LIVE.0225	National livestock export industry shipboard performance report 2004	This report provides summary information about mortalities in sheep and cattle during sea transport from Australia in 2004 to allow industry, government and others to monitor mortality trends in the live sheep and cattle trades.	30/04/2005	RT Norris GJ Norman
LIVE.0235	National mortality recording system for the live sheep, goat and cattle export industries	This report provides summary information about mortalities in sheep and cattle during sea transport from Australia in 2005 to allow industry, government and others to monitor mortality trends in the live sheep and cattle trades.	1/07/2006	RT Norris GJ Norman
B.LIV.0241	National livestock export industry shipboard performance report 2006	This report provides summary information about mortalities in sheep and cattle during sea transport from Australia in 2006 to allow industry, government and others to monitor mortality trends in the live sheep and cattle trades.	30/04/2007	RT Norris GJ Norman
LIVE.0123	Investigating mortality in sheep and lambs exported through Adelaide and Portland.	The objective of this project was to determine the rate, causes and predisposing factors of mortality for live export sheep as well as the relative mortality risk for different lines of sheep. The project tracked Australian sheep exported in 24 shipments between September 2005 and June 2008, from the farm of origin to port of discharge. The report identified the most common causes of mortality and other associated risk factors and details recommendations for reducing mortality.	1/12/2007	J House K Makin G Curran N Perkins
B.LIV.0246	National livestock export industry shipboard performance report 2007	This report provides summary information about mortalities in sheep and cattle during sea transport from Australia in 2007 to allow industry, government and others to monitor mortality trends in the live sheep and cattle trades.	30/05/2008	RT Norris GJ Norman
W.LIV.0260	National livestock export industry shipboard performance report 2008	This report provides summary information about mortalities in sheep and cattle during sea transport from Australia in 2008 to allow industry, government and others to monitor mortality trends in the live sheep and cattle trades.	30/06/2009	RT Norris GJ Norman

W.LIV.0270	National livestock export industry shipboard performance report 2009	This report provides summary information about mortalities in sheep and cattle during sea transport from Australia in 2009 to allow industry, government and others to monitor mortality trends in the live sheep and cattle trades.	30/06/2010	RT Norris GJ Norman
W.LIV.0279	National livestock export industry shipboard performance report 2010	This report provides summary information about mortalities in sheep and cattle during sea transport from Australia in 2010 to allow industry, government and others to monitor mortality trends in the live sheep and cattle trades.	1/06/2011	RT Norris GJ Norman
W.LIV.0281	Live export mortality report 2011	The objective of this project was to summarise the performance of the livestock export industry in terms of mortality levels of sheep, cattle and goats exported by sea from Australia during 2011.	30/06/2012	RT Norris GJ Norman
W.LIV.0170	Performance data collection	This project has involved consideration of the current and likely future regulatory environments, external drivers, and current industry practices in relation to collection and management of data on animal health and welfare outcomes across the livestock export supply chain.	1/09/2013	N Perkins B Madin
W.LIV.0285	Live export mortality report 2012	The objective of this project was to summarise the performance of the livestock export industry in terms of mortality levels of sheep, cattle and goats exported by sea and air from Australia during 2012	7/10/2013	RT Norris GJ Norman
W.LIV.0252	Identifying the causes of mortality in cattle exported to the Middle East	This project originated from concerns over mortalities in cattle exported from Australia to the Middle East that had been attributed to respiratory disease. The findings from this project will contribute to the development of mitigation strategies to reduce respiratory disease risk during export. The success of this project offers lessons for future projects that can be implemented for industry benefit.	22/10/2015	N Perkins M O'Hara J Creeper J Moore B Madin M McCarthy
W.LIV.0288	2013 and 2014 shipboard mortality report	The objective of this project was to summarise the performance of the livestock export industry in terms of mortality levels of sheep, cattle and goats exported by sea and air from Australia during 2013.	30/06/2015	GJ Norman
W.LIV.0291	Live export industry transport mortality report 2015 and 2016	This report provides summary information about mortalities in sheep and cattle during sea transport from Australia in 2016 to allow industry, government and others to monitor mortality trends in the live sheep and cattle trades.	30/06/2017	GJ Norman
W.LIV.0295	Shipboard Mortality Data Base (SMDB) Version Two Upgrade	To answer the question of whether or not the SMDB can provide greater value for the industry and government by enhanced useability.	ONGOING	B Madin

W.LIV.0297	2017 and 2018 Live Export Industry Annual Mortality Report	These reports will provide summary information about mortalities in sheep and cattle during sea transport from Australia in 2017 and 2018 to allow industry, government and others to monitor mortality trends in the live sheep and cattle trades.	ONGOING	GJ Norman
W.LIV.0186	Standards and performance benchmarking of the livestock export industry	Whilst continuously improving animal welfare is a key priority for the livestock export industry, prior to this project the monitoring and reporting of animal welfare throughout the livestock export process was limited to a narrow lens of on-board mortality and non-compliances with ESCAS. Neither of these measures accurately depict the scale of industry effort and commitment to animal welfare throughout the livestock export supply chain to support continuous improvement. As a result, the community's perception of the trade is limited to a narrow prism of isolated but often brutal and unacceptable incidents of animal cruelty. The project to date has compared the welfare standards of the Australian livestock export industry throughout the supply chain against Australian domestic standards and international live export competitors.	ONGOING	A Small L Hewitt

Voyage Reporting

Code	Project Title	Summary	Finish Date	Author/s
W.LIV.3032	Development and assessment of livestock welfare indicators for the livestock export industry	The monitoring and assessment of animal welfare throughout the livestock export process is essential to demonstrate care, the desire for continuous improvement and a sustainable future for industry. However, animal welfare is complex and multifaceted, and it is therefore critical that valid, reliable and practical indicators are identified to underpin monitoring and assessment. The aim of the project was to identify internationally accepted and current indicators of animal welfare for cattle, sheep and goats that could be used at each point along the livestock export supply chain. To identify these indicators, the project conducted a literature review of standards and regulations, as well as a stakeholder survey.	15/05/2016	S Wickham T Collins
W.LIV.3047	Animal Welfare Indicators Pilot for the Live Export Industry Supply Chain	Develop, in conjunction with current reporting requirements, a comprehensive recording Welfare Dashboard to gather data relevant to animal welfare throughout the live export chain. Determine the practical requirements for data collection for the Welfare Dashboard (time taken at each point, the frequency of data points, number of animals sampled, storage and transfer of data.	ONGOING	T Collins et al.

Heat Stress

Heat Stress Risk Assessment Model (HotStuff)

Code	Project Title	Summary	Finish Date	Author/s
LIVE.0116	Development of a Heat Stress Risk Management Model	The report outlines the data analysis, mathematical modelling and software development of 'HS' known as 'HotStuff' the program that is used to estimate the risk of mortality due to heat stress in livestock decks on voyages from Australia to the Middle East.	7/05/2003	C Stacey
LIVE.0234	Potential benefits of jetting to the 'Heat Stress' model	The study evaluated the potential benefits of including the effects of 'jetting' into the 'HotStuff' (HS) model in place of the pen air turnover (PAT) parameter. Jetting refers to a component of the ship's ventilation where a controlled and measurable air velocity is directed across a specified area. The report determined the typical velocity ratio of an average pen and compared the use of a velocity ratio and the standard PAT within the HS model.	29/04/2005	R Casey
LIVE.0228	Upgrade of biological assumptions and parameters used in the HS risk management model version 2.3.	The overall objective of this project was to update and validate the animal parameters in the 'HotStuff' model released in 2001. The report found additional data sets were consistent with the original heat stress data applied in the HS software and recommended a slight change to the heat stress threshold, mortality limit and coat factor for <i>Bos taurus</i> dairy (Friesian) cattle.	17/05/2006	C Stacey
B.LIV.0240	Assessing a method of incorporating jetting in the HS model and its commercial implications	This study was undertaken to understand further the effects of 'jetting' of a particular pen or deck might affect the heat stress risk for livestock in accordance with the recommendations of the report entitled 'Potential benefits of jetting to the HS model'. The report details how a normalised jetting factor may be incorporated into the 'Hot stuff' model to consider the effects of jetting and outlines the information required and the possible animal welfare and commercial outcomes.	29/01/2007	S Smith C Eustace C Stacey
W.LIV.0264	Review of the Livestock Export Heat Stress Risk Assessment Model (HotStuff)	The aim of this study was to undertake a comprehensive review of the scientific basis of the core elements (animal physiology, engineering, climatology and statistics) that underpin the HotStuff model. The report includes the panel's conclusion that the methodology and assumptions underpinning the HotStuff model are sound, reasonable and supported by scientific literature and further recommendations that aim to either engender greater confidence in the technical elements of the model or potentially improve the model's accuracy in the future.	31/01/2009	D Ferguson
B.LIV.0249	HotStuff Version 3.0 Revision of the heat stress risk assessment	This study extends the existing methodology to of the HotStuff model to address risk estimates for both the sailing and discharge components of the voyage as the functionality for the separate treatment of each Middle Eastern port and for voyages discharging at	30/06/2009	C Eustace S Corry

	methodology to properly incorporate the risk of heat stress while at port	multiple ports. As part of the study, the software has been moved to a more up-to-date development environment and updated to incorporate the new methodology, improve a range of features and fix a number of problems with the previous version.		
W.LIV.0277	HotStuff Version 4.0 – Revised methodology and additional ports	The 'HotStuff' software for the assessment of heat stress risk on livestock voyages west from Australia has been revised, updated and expanded. The primary changes are: - the addition of ports in the Mediterranean, the Black Sea, West Africa and Russia route - the inclusion of port risk as a parallel assessment of the risk during the discharge phase (actually introduced at Version 3) - options via the Suez Canal or West Africa - the inclusion of more voyage weather data and re-analysis of all voyage and port data - removal of the hard-coded limit of 5 knots on the assumed effective crosswind while sailing - updating the software programming environment (Version 4 to 5).	15/06/2014	C Stacey
W.LIV.0277	HotStuff V5	The HS software implements an approach to the assessment of heat stress risk on live export voyages from Australia. It combines animal heat tolerance, weather statistics and vessel parameters to give a scientifically defensible estimate of the numerical risk of mortality in each line of livestock to be loaded. It is used as a risk management tool through the assessment of planned voyages so that unacceptable risk can be avoided well ahead of the loading. This project added to and updated both the method and the software. The software is now at Version 5.0.	1/02/2017	C Stacey

Heat Stress Management in Livestock

Code	Project Title	Summary	Finish Date	Author/s
LIVE.0104B	Use of electrolytes to alleviate stress: desktop study	The study reviewed the scientific literature and live export industry practices in relation to electrolyte supplementation of sheep and cattle during sea transportation as a result of the previous studies 'Investigation of ventilation efficacy on livestock vessels'. The report identifies sea transport stress factors and considers the benefits of electrolyte supplementation in treating physiological, clinical effects of the stress factors.	1/02/2001	Alliance Consulting & Management
LIVE.0209	Physiology of Heat Stress in Cattle and Sheep	This study was undertaken to define the physiology of clinical heat stress in cattle and sheep within an animal house through monitoring changes in body temperature, feed and water intake, respiratory and heart rates, and acid-base and electrolyte balance. The report detailed	31/10/2002	A Barnes D Beatty

		the findings of the experiments and assisted in the definition of the heat stress threshold for <i>Bos taurus</i> and <i>Bos indicus</i> heifers, Merino wethers and Awassi rams.		E Taylor C Stockman S Maloney M McCarthy
LIVE.0219	Wetting of Cattle to Alleviate Heat Stress on Ships	This study investigated the benefit of wetting heat stressed cattle by measuring the body temperature, respiration rate, feed intake and live weight change of cattle. The study found wetting cattle, using warm salt water reduced rectal temperature, respiration rate and panting score, increased cattle comfort, and did not result in worsening of the microclimate.	31/08/2003	J Gaughan S Lott G Gordon
LIVE.0224 V1	Electrolyte supplementation of export cattle and further investigations into the heat stress threshold of sheep and dairy cattle	This study was conducted in an attempt to repeat the findings of the previous project entitled 'Physiology of Heat Stress in Cattle and Sheep' that reported a weight advantage of cattle supplemented with water-based electrolytes. The project aimed to measure any animal performance and/or welfare benefits to cattle and sheep during and post electrolyte replacement therapy. The report found no evidence that conclusively supported the supplementation of electrolytes on board livestock vessels. However, the study identified heat stress thresholds for heavy rams, withers, ram lambs, and pregnant Friesian heifers.	27/02/2006	A Barnes D Beatty C Stockman S Maloney R Taplin
B.LIV.0247	Respiratory heat and moisture generation	The aim of this project was to recommend values for respiratory exchange and heat production of deer and goats that are appropriate for use in a project aimed at determining the ventilation requirements during transport via aircraft. A literature search was conducted and recommendations made for carbon dioxide production, oxygen consumption, heat production, evaporative water loss and loss of water in urine and faeces for various sexes of goats and deer of various physiological states.	15/12/2008	P Cronje
W.LIV.0191	Environmental and heat risk assessment for live export holding facilities in the Northern Territory	This project seeks to: a) Ascertain the environmental risks associated with live export facilities in northern Australia and provide mitigation and management recommendations; and b) Ascertain the risks associated with heat stress in live export facilities operating in northern Australia, including an assessment of heat load index (HLI) and accumulated heat load (AHL) utilising collected weather data, and provide mitigation and management recommendations.	ONGOING	M Thompson S Williams R Pattinson

Sourcing and Preparation of Livestock

Code	Project Title	Summary	Finish Date	Author/s
LIVE.102	Best practice standards for the preparation and husbandry of cattle for transport from Australia	This report outlines the best practices recommendations for the preparation and husbandry of cattle transported by sea on long-haul voyages from Australia. The recommendations were designed to be read in conjunction with the Live Export Assurance Program (LEAP) Rules and Standards (December 1999), the Shipboard Management Programs Stockman's Handbook and the Australian Standards for the Export of Livestock (ASEL).	1/05/2000	R Ainsworth M McCarthy
LIVE.0104A	Influence of pre-delivery management on livestock performance: Desktop study	This project examined the effect of livestock management during the pre-embarkation on animal performance throughout the remainder of the export process with a specific focus on management at the farm of origin to discharge at registered premises for both sheep and cattle. The desktop study incorporated a review of literature and industry standards together with a survey and identified key on-farm and transport factors associated with morbidity and mortality of livestock within the industry.	1/02/2001	Alliance Consulting and Management
LIVE.0301	Management of pre-delivery stress in live export steers	This project aimed to understand the effects of stress in transported cattle and attempted to minimise those effects by the use of novel oral supplements, fed prior to transportation. The report outlined new techniques for investigating the physiological responses of cattle to stress and quantified some of the physiological responses of cattle to transportation and handling stress and identified a novel prophylactic treatment that may aid in reducing the effects of stress in cattle.	31/10/2003	LA Fitzpatrick AJ Parker
W.LIV.0131	Linking pre-export factors to post-delivery performance in cattle exported from northern Australia to Indonesia	This report provides findings from a pilot study involving collection and information from consignments of cattle on export vessels travelling from Darwin to Indonesia. The study was designed to test assumptions and methodologies for data collection in order to determine the feasibility of a subsequent larger study. The report details the findings of two voyages and a range of factors important in the design of a larger project.	30/09/2010	N Perkins A Hill R Tynan

Salmonellosis, Shy Feeders and Inanition

Code	Project Title	Summary	Finish Date	Author/s
LIVE.0112	Salmonellosis control and best-practice in live sheep export feedlots	This study provided an overview of sheep feedlotting and the problem of salmonellosis within the Australian live export industry. The report outlines why the problem is occurring and long-term strategies to reduce the incidence of salmonellosis.	30/06/2002	S More

LIVE.007B	Preparation of a business plan on aromatic salmonella vaccine for sheep	This document is a business plan for the registration of the aromatic attenuated salmonella vaccine for the live sheep trade and was prepared to inform stakeholders of the costs and benefits of vaccine registration and assist with commercial negotiations between the vaccines manufacturer and the industry.	8/07/2004	M Clarke
LIVE.0243	Inanition in sheep - a literature review	A review of the relevant literature related to the inappetence of sheep was conducted, and factors that can influence feed intake were noted, and methods to alleviate inappetence were reviewed, and potential projects to investigate the issue were recommended.	31/08/2007	A Barnes D Beatty C Stockman D Miller
W.LIV.0133	Determining the feasibility of developing an ovine Salmonella vaccine	This project assessed the economic feasibility of developing a Salmonella vaccine for use in Australian sheep. The report details a literature review and a benefit-cost analysis that found the vaccination would be economically viable, based on a positive net present value (NPV) of returns over 10 years.	31/03/2009	N Perkins I Patrick J House
W.LIV.0132	Investigating the relationship between Salmonella-inanition and property of origin	This report provides a review of current knowledge concerning salmonellosis and inanition as causes of mortality in live export sheep and the potential associations between mortality and farm-level risk factors. The report then identifies several activities aimed at developing the capacity to monitor, investigate and improve health and welfare outcomes in export sheep.	31/05/2009	N Perkins J House A Barnes
W.LIV.0142	Strategies to reduce inanition in sheep	This project will produce a set of best practice guidelines for the pre-embarkation treatment of sheep that aim to minimise the impact of salmonella/inanition on the Australian sheep export industry.	28/02/2016	A Barnes

Stocking Densities

Code	Project Title	Summary	Finish Date	Author/s
B.LIV.0244	Stocking density in cattle shipments and animal health and performance - an assessment of existing data	This report assessed the potential use of data collected by live cattle exporting companies in observational studies and controlled trials to assess the effects of varying stocking densities on indicators of welfare. The aim of the study was to assess whether such data can be used for research purposes and the report identified limitations of using such data for research purposes.	31/12/2007	J Morton
W.LIV.0253	Refining stocking densities	A project was undertaken to assess effects of stocking densities on welfare outcomes during sea transport. Was concluded that the ASEL space allowances for the stock classes investigated are appropriate on animal welfare grounds. However, the suggested benefits of a small increase above the ASEL space allowance, particularly during the critical early stages of a voyage, are worthy of further consideration and evaluation.	31/01/2012	D Ferguson J Lea
	Effects of stocking density on behaviour and group dynamics of cattle and sheep in confined housing	This project will look at quantifying the extent and cause of variation in response to differences in climate conditions, stocking density and other stressors (e.g. availability of bedding, trough space and sequential feeding, etc), and how they affect the distribution, behaviour, welfare and performance of livestock. It will include land based studies, as well as on-board trials / data collection to ultimately provide robust science and information to inform the industry on optimal stocking densities for both sheep and cattle.	ONGOING	University of New England

On-board Resources and Management

Management of Bedding, Effluent and Ammonia Levels

Code	Project Title	Summary	Finish Date	Author/s
SBMR.002	Shipboard Ventilation Project	The study reviewed and summarised the available literature in order to collect current knowledge and guide shipboard work. The work then moved shipboard with a research veterinarian accompanying six voyages between Australia and the Middle East, making observations and recording parameters as guided by the study engineering team. Each voyage gave new information, either due to the vessel design, the livestock type and history, or the voyage conditions. The study produced a number of practical findings not only on the immediate topic of ventilation efficacy but also covering other livestock parameters and effects of some management activities (e.g. wash-down, course alteration).	1/07/2001	MAMIC Pty Ltd
SBMR.002A	Investigation of ventilation efficacy on livestock vessels	This study incorporated a review of the current knowledge and shipboard processes of ventilation in cattle and involved six long-haul voyages of cattle transported from Australia to the Middle East. The report found wet bulb temperature to be an important index of cattle comfort and identified the need to update ventilations outlined in AMSA MO43.	1/07/2001	MAMIC Pty Ltd
LIVE.0211	Practical ventilation measures for livestock vessels	This study was undertaken as a result of the report “Investigation of ventilation efficacy on livestock vessels” that identified the need for practical measures to be identified to improve ventilation and/or reduce the cost of ventilation on livestock vessels.	01/05/2002	MAMIC Pty Ltd
LIVE.0218	Determining critical atmospheric ammonia levels for cattle, sheep and goats - a literature review	The report details a literature review of the effects of atmospheric ammonia production on animal health and performance in livestock ships and feedlots and recommends the critical level of atmospheric ammonia for livestock being transported by sea be set at 25 ppm. The report also identifies the need for on-board monitoring of ammonia levels and areas where further research is required.	15/03/2003	N Costa J Accioly M Cake
LIVE.0213B	Investigating odour from partly loaded sheep vessels	This study was undertaken as part of the project entitled ‘Investigations into Reducing Odour Emissions from Partly Loaded Sheep Vessels while in Port’. The report outlines the findings of an indoor feeding trial designed to evaluate the effectiveness of four dietary treatments and five bedding additives in reducing ammonia and odour from sheep faeces and urine.	30/04/2003	SM Kitessa
LIVE.0202	Decreasing Shipboard Ammonia Levels	This study was undertaken to investigate reducing on-board ammonia levels through manipulating the nutritional composition of the diets of cattle. A series of feeding experiments were conducted to understand the effects of diet on animal performance, urinary nitrogen excretion and urinary pH. The report details the effect of high ammonium levels on cattle health and recommends diet compositions to reduce ammonium levels.	30/06/2003	G Tudor

LIVE.0213A	Investigations into Reducing Odour Emissions from Partly Loaded Sheep Vessels while in Port	As a result of complaints about odour emissions from livestock vessels in port, this study was commissioned to identify practical and cost-effective methods of reducing odour from partly loaded sheep vessel when in port. The report comprises a literature review and the benchmarking of baseline emission rates and outlines recommendations to reduce odour emissions of vessels when in port.	30/06/2003	M McCarthy
LIVE.0212	Investigation of Ventilation Efficacy on Live Sheep Vessels	This study/project was undertaken to investigate the ventilation effects of specific vessels carrying sheep and goats from Australia following the completion of 'Shipboard Ventilation Project' that mainly focused upon ventilation efficacy on cattle vessels. The report presents risk management options in the shipment of sheep, lambs and goats and provides options for heat stress management planning.	01/04/2004	Maunsell Australia Pty Ltd
LIVE.0221	Characteristics and Volume of Effluent Produced by Livestock Vessels	The report details the findings of a desktop study that investigated the nature, composition and volume of effluent produced by livestock ships. The report also compared effluent originating from livestock vessels with effluent from passenger ships. The report assisted in the development of the specific effluent handling and disposal practices for livestock carriers	30/06/2004	Landline Consulting
LIVE.0223	Pilot monitoring of shipboard environmental conditions and animal performance	This project involved the use of temperature, relative humidity, ammonia level, wind speed and direction sensors on livestock vessels transporting sheep and cattle to the Middle East to more accurately record and store details of environmental conditions. A major outcome of the project was a database of environmental information and livestock performance that was available to validate/ re-calibrate the 'Hot stuff' modelling software.	29/10/2004	M McCarthy
W.LIV.0254	Management of Bedding during the Livestock Export Process	In this study, the management of bedding on livestock export ships was reviewed, and current practices were evaluated against existing literature from the intensive dairy, beef, and equine industries and recommendations and guidelines for the management of bedding for cattle and sheep during the export of livestock by sea were developed. The report also identifies areas where further research, development and extension opportunities exist.	31/03/2009	S Banney A Henderson K Caston
B.LIV.0126	Review of effluent spillage and animal welfare during livestock transport: a discussion paper	The objectives of this project were to summarise current knowledge and opinion from stakeholders regarding livestock effluent spillage, livestock limb protrusion from livestock transport vehicles (road and rail) and provide recommendations to improve these issues.	31/03/2009	EJ McGahan KM Baker M Burger SG Wiedemann RJ Davis CM Ouellet-Plamondon PJ Watts

W.LIV.0290	Managing on board environmental conditions	An extensive literature review of bedding management and air quality on livestock export vessels was undertaken, and best practice management recommendations were developed. The review is divided into three sections focusing on air quality and environmental monitoring (temperature, pad moisture and emissions), bedding management (management strategies and ventilation), and the issue of reporting (advances in environmental monitoring technology)	31/08/2016	M McCarthy
	Trials to understand factors influencing pad moisture and ammonia emissions in livestock faecal pads and the effect of interventions	The purpose of these studies will be to develop and validate a clear understanding of the interactions of the different factors and how they affect cattle and sheep pads and influence outcomes, and how different interventions influence these factors and outcomes. A key output will be the ability to understand and predict pad moisture, ammonia issues and the likely effect of interventions during voyages using a consistent methodology, equations or other measures.	ONGOING	University of New England

Water, Fodder and Chaff Requirements

Code	Project Title	Summary	Finish Date	Author/s
LIVE.0205	Water consumption on cattle ships	This survey was undertaken to obtain objective data about water use of cattle exported from Australia a result of a preliminary analysis that identified the water consumption of cattle was affected by the type and class of cattle as well as ship design. The report evaluated data from 87 shipments of cattle and found minimum water requirements should be set as a percentage of bodyweight and the use of troughs and drinker bowls was found to affect water consumption.	1/12/2001	T Brightling
W.LIV.0256	Review of fodder quality and quantity in the live export industry	The key objectives of the study were to assess the suitability of fodder specifications in ASEL and evaluate their ability to ensure that industry best practice continues to be delivered in terms of feeding efficiency, economic performance and animal welfare. The report outlines several recommendation that include; modifications to the guidelines for shipping pellet formulation, feed provisioning and the supply of additional roughage for cattle on long haul voyages.	30/06/2009	G Willis
W.LIV.0298	Identifying opportunities for continued improvements to the on-board live export feed ration	Review the previous research and standards relating to fodder quality and quality within the Australian livestock export industry, consider and document why the recommendations from the previous research were not adopted. Review any material relating to pellet manufacturing and/or pellet handling systems that has relevance to the Australian livestock export industry with a view reducing and/or assuring against pellet 'fines'.	ONGOING	M McCarthy

On-Board Personnel, Animal Management and Care

Monitoring and Management of Livestock and Animal Welfare On-Board

Code	Project Title	Summary	Finish Date	Author/s
LIVE.0120	Identifying live animal condition scoring systems for the livestock export industry	A review was conducted to identify the systems used around the world to assess the condition score of livestock and determine the most appropriate systems for the Australian livestock export industry that recognises animals that are too lean or too fat to travel. The report details the most appropriate, simple, well-described 5-score systems for deer, alpacas, goats, sheep, camels and buffaloes and highlights the need to develop appropriate cut-off points for cattle to describe the minimum condition, particularly in tropical breeds.	30/11/2005	B Gaden
LIVE.0222 V3	Developing alternative methods of measuring animal welfare on ships.	This report describes the results of a study to identify potential welfare indicators for sheep and cattle transported by ship and amassed at pre-export assembly depots that can be used to measure less extreme welfare events. The analysis of a computer-based questionnaire identified seven welfare indicators, four of which were already in use.	3/11/2006	M Pines C Petherick J Gaughan
LIVE.0325	Identifying knowledge gaps and research priorities to assist the live export industry to continually improve best practice	The scope of this project was very broad and included the identification of demonstrative knowledge and application gaps as well as the assessment of the R&D program's capacity to materially assist the industry to achieve its goals. The report outlines a matrix to systematically address industry practices within the livestock export process and identified inconsistencies between industry guidelines and the research recommendations, parts and activities within the supply chain where formal or widely accepted guidelines do not exist and also identified and prioritised R&D requirements to support existing practices and guidelines.	14/12/2006	M McCarthy I Whan K Mulvahil N Perkins
W.LIV.0251	Quantitative assessment of cattle behaviours on board livestock ships	This study utilised video footage of cattle taken as part of the previous project (Assessing the welfare and feeding behaviour of horn and polled sheep and cattle during export) to make an informed estimation as to the proportion of the day animals spend performing certain basic behaviours. The report details common behaviours exhibited during a voyage of cattle.	28/02/2009	C Stockman

Requirements for Vulnerable / Special Classes of Livestock

Code	Project Title	Summary	Finish Date	Author/s
LIVE.0204	Identifying current best practice in the export of young cattle to Israel	This study examined the outcomes of 26 voyages of calves to Israel during 1999 and 2000 and summarised key observations and makes recommendations to improve the management of calves during the export process.	1/05/2001	R Ainsworth

LIVE.0208	The Best Practice Management of Pregnant Dairy Cattle on Long Haul Voyages	This study assessed the management practices of pregnant dairy cattle on vessels exported from Australia.	1/03/2002	M McCarthy
LIVE.0121	Investigating options to modify the aggressive behaviour of entire cattle, sheep and goats and the potential impacts on market acceptance and animal productivity	The objectives of the project were to identify and quantify the livestock export market preference for entire males and the basis of this preference (e.g. lean meat or cultural requirements) and to identify options for Australia to supply entire males whilst improving animal welfare and considering market sensitivities, production and commercial implications. The report outlines options available for the modification of behaviour patterns to minimise aggression of entire male livestock and highlights areas for further research	30/09/2005	K Entwistle S Jephcott
B.LIV.0242	Assessing the welfare and feeding behaviour of horned and polled sheep and cattle during live export	This report provides an overview of the behaviour, welfare and management of sheep and cattle with and without horns and the mixing or segregation of horned and polled livestock during sea voyages.	14/03/2007	A Barnes C Stockman
W.LIV.0130	Preparation of goats for export	This project has sought to review the current practices and performance of the live goat export industry following the previous project entitled 'Minimising mortality risks during export of live goats by sea from Australia'. The project was conducted at a time when the greater majority of goat exports are by air rather than long-haul exports by sea. The report details knowledge gaps and prioritises research to address identified issues and outlined a developed 'best practice' guide for the preparation of goats for export.	31/03/2009	S Williams
W.LIV.0171	Review of sheep pre embarkation inspection procedures	This report describes inspection and rejection procedures that may occur between the vendor property and port for live sheep exports from ports in South Australia, Victoria and Western Australia. The current systems are believed to be compliant with all requirements as stipulated in the ASEL and the Export Control (Animals) Order 2004. The report suggests that the current Fremantle wharf inspection procedures be retained as the final individual animal inspection procedure and that consideration be given to trialling this system in SA & VIC.	20/08/2012	N Perkins B Madin
W.LIV.0159	Preparation of rangeland goats for live export	This project sought to minimise the risks and barriers associated with the long-haul shipment of goats. The project objectives were as follows: 1. Develop industry guidelines for pre-export and on-board management of domesticated goats for long-haul voyages. 2. Based on experimental research outcomes define a domestication management process for wild, undomesticated goats so as to achieve successful long-haul shipment by sea. 3. Develop and validate a quality assurance program for long-haul goat shipments.	2/10/2015	D Miller

Other

Code	Project Title	Summary	Finish Date	Author/s
LIVE.0106	Automatic counting of sheep final report	The study evaluated technologies for automatically counting live sheep, as they are loaded on and off ships. The technologies investigated included machine vision, radio frequency tags, and races capable of counting singular sheep mechanically. An automated system must be accurate, cost-effective and efficient. The report found a mechanical system to be the most accurate and affordable option to be further developed, tested and trailed.	1/06/2001	M Kassler
W.LIV.3022	Sheep, Cattle and Goat Yard Manual	To upgrade and produce a manual of livestock handling facility designs that are suitable for ports, farms/feedlots and abattoirs in export markets. Truck specific designs for components such as pens, gates, side and flooring options will also be included. The manual is a one-stop-shop of facility designs for the live export trade, covering sheep, goats and cattle.	ONGOING	G Beere
	Automated sheep counting	This project will focus on an automated video-based counting system in an open area (e.g. vessel, saleyard or loading ramp). The software platform will perform the analysis on detecting and tracking of sheep for counting.	ONGOING	University of Technology Sydney

Livestock Disease Management, Control and Prevention

Code	Project Title	Summary	Finish Date	Author/s
LIVE.0101	Controlling scabby mouth in the live sheep trade	Scabby mouth is a common disease found in all sheep-raising countries but rarely causes problems of economic significance in Australia and is usually not observed by producers. This study was undertaken to establish the effectiveness of vaccination in controlling scabby mouth in live sheep trade. The report found single vaccination at lamb marking resulted in low levels of scabby mouth at discharge in the Middle East whilst two vaccinations (the second administered shortly before export) resulted in negligible levels and concludes that scabby mouth is no longer an issue of concern in most Middle Eastern markets.	1/05/2000	RT Norris DC Moir
LIVE.0113	Ringworm in Live Export Dairy Cattle	This study was undertaken in response to incidences of ringworm in dairy cattle exported to China that resulted in economic losses for exporters and had the potential to disrupt the export of dairy cattle to China.	31/10/2002	T Brightling
LIVE.0217	Investigating premature lactation in pregnant dairy females	This study was commissioned following the shipment of a consignment of dairy heifers that reported a high prevalence of heifers with distension of the mammary gland during a sea voyage. The report outlines the causes of udder distension that include feed and hormonal factors and outlines preventative measures as well as treatment measures for the condition.	25/02/2003	Bovine Research Australasia

LIVE.0114	Best Practice in the Use of Veterinary Chemicals and Drugs in Exporting Livestock	This manual was designed for exporters, managers of live export assembly depots, Masters and Chief Officers of livestock ships, and stockmen working with cattle, sheep or goats exported live from Australia. The manual include; The 'best-practice' use of veterinary drugs and chemicals – storage, record keeping, off-label use etc., a list of common veterinary drug uses for live export cattle, sheep and goats and a description of recommended injection techniques.	30/12/2004	T Brightling C Chapman P Reeves
LIVE.0125	Evaluation of Diagnostic Assays for <i>Chlamydophila abortus</i> in Australian Export Sheep	The project was undertaken to compare the performance of the Complement Fixation Test (CFT) and ELISA test for the quantification of <i>Chlamydophila abortus</i> antibodies in sheep. The report identified that ELISA gave the most repeatable and reproducible results in the detection of the <i>Chlamydophila abortus</i> antibody with equivalent sensitivity and higher specificity to the CFT and thus recommended replacing the CFT with ELISA.	15/03/2007	L McCauley
B.LIV.0245	Revision of Veterinary Drug Manual for Livestock Export	The report details the process undertaken in the review and revision of the Veterinary Drug Manual for Livestock Export to ensure it was as accurate and up to date as possible. Each drug was individually checked for registration status, availability, recommended use, meat withholding period and export slaughter interval (ESI) if this data was available. Drugs were then removed or updated accordingly. New drugs were added after searching by category to check for new and recent product registrations.	15/02/2008	A Campbell N Rolls J Larsen
B.LIV.0248	Respiratory disease of export cattle	This report outlines the findings of the literature review and industry consultation process related to feedlot Bovine Respiratory Disease (BRD). The report also outlines recommendations for future R&D to examine morbidity and mortality in cattle undergoing live export from Fremantle to the Middle East.	30/09/2008	C Eustace S Corry
W.LIV.0361	Detection, identification and treatment of ovine pink eye	Infectious Ovine Keratoconjunctivitis (IOK), Pink Eye, has a significant impact on rejection rates of sheep for live export and thus the feedlot and live export industries in Western Australia. The study aimed to determine the flora and sensitivity to antibiotics of eyes from sheep showing clinical signs of IOK.	20/06/2010	HM Chapman
W.LIV.0162	Management of Unfit To Load Livestock	A small proportion of livestock are identified as being unfit to load onto ships during pre-embarkation inspections. These animals are identified as sick, injured, weak or physiologically unsuited for transport and must be managed optimally to ensure welfare is not unduly compromised. A manual was produced that will assist in standardising the approaches to treatment and management of these animals.	31/07/2011	T Jubb
W.LIV.0278	Live Export Veterinary Disease Handbook	This project has developed a Live Export Veterinary Handbook in electronic format, suitable for dissemination as either a printed Handbook or as an electronic file. The Handbook is intended to serve as a concise reference source of practical information focused on conditions likely to be experienced across the live export supply chain, with a particular focus	7/08/2011	N Perkins

		on the steps from arrival at an assembly feedlot in Australia to discharge at a destination port in an overseas country. The Handbook is intended to be used by veterinarians and stockpersons and any other individual with responsibility for animal health and welfare during the export supply chain.		
W.LIV.0280	Management of premature lactation in dairy cattle	This study was undertaken to investigate the risk factors that lead to the occurrence of premature lactation in dairy heifers. The report details the findings of a literature review and survey of experienced personnel and recommends that further research is conducted to elucidate the presence and persistence of zearalenone in export pellets, and the occurrence of premature lactation in exported heifers are documented.	30/09/2011	PD Mansell DS Beggs TF Jubb MFS Pyman AD Fisher
W.LIV.0275	Investigating incidence of scabby mouth	This project reviewed the scabby mouth vaccination protocols in place for sheep travelling to Middle East markets. The study recommends that subject to the approval of appropriate authorities; a single vaccination strategy is considered to replace the current double vaccination strategy. The study concluded that the development of a killed or virulent field strain vaccine administered intramuscularly or subcutaneously would have immediate industry application and that the industry monitors any developments in this regard.	22/02/2012	M McCarthy
W.LIV.0163	Antibiotic medication for the treatment of Ovine Keratoconjunctivitis (IOK or pink eye) in pre-export feedlots	This report investigates the most effective treatments for Infectious ovine keratoconjunctivitis (IOK) or Pink Eye. A number of experiments were conducted to determine the most effective treatment for sheep with differing grades of IOK infection. Treatments that were tested included Oxytetracycline (OTC) delivered in-water, in-feed or by intramuscular injection.	30/04/2013	FR Murdoch M Laurence
W.LIV.0286	Zearalenone and premature lactation in exported dairy cattle	The risk factors that lead to the occurrence of premature lactation are poorly understood. A review of the available literature has been conducted previously, as well as an informal survey of personnel experienced in the long-haul transportation of dairy cattle. This indicated that exposure of exported dairy heifers to mycotoxins such as zearalenone in pelleted ship rations could be a plausible explanation for the occurrence of premature lactation in such animals.	15/03/2015	PD Mansell TF Jubb S Wilson
W.LIV.0181	Pinkeye on Long Haul Cattle Voyages	The objectives of this project are to review the current literature and gather epidemiological data from recent outbreaks. They also aim to identify microorganisms associated with the current syndrome and develop strategies for prevention	ONGOING	M Laurence
W.LIV.0188	Update of the Veterinary Handbook for Cattle, Sheep and Goats	The Veterinary Handbook app and website includes information on the diagnosis, treatment and prevention of associated syndromes and diseases in cattle, sheep and goats. The planned update to the app will occur in two phases. The first will see a significant update of the	ONGOING	NewtonGreen Technologies Pty Ltd

		content of the handbook and the second phase will introduce a suite of photos to help identify syndromes and diseases.		
	Shipboard drug use and resource package	This project has been initiated to assess the ASEL requirements for veterinary equipment and drugs. Additionally, the project will develop resources on best practice drug use and treatment recording.	PROPOSED	-

Regulation

Code	Project Title	Summary	Finish Date	Author/s
LIVE.0117	Review of Australian Livestock Export Standards	The aim of the study was to review the existing Livestock Export Accreditation Program (LEAP) rules and standards and their administration to enable consistent compliance with agreed animal health and welfare outcomes. The review makes innovative recommendations in a range of areas, including opportunities for continuous improvement, the management of animal health and welfare risks, the management of incidents, and achievement of compliance through accreditation and auditing processes.	31/08/2003	I Whan S More A Bryant S Bladeni
LIVE.0316	World livestock export standards	This study compared and contrasted the livestock export standards applied in all countries that participate significantly in the livestock export trade. The study was undertaken for benchmarking of livestock export standards. The report found there are no formal systems in place in other countries that would add significantly to the effectiveness of the Australian livestock export standards and from this point of view, our standards should be considered 'high quality' and not requiring immediate or drastic revision.	29/01/2007	I Whan M McCarthy J Hutchison
W.LIV.0284	Review of ASEL Scoping Study - Export of sheep from southern ports to the Middle East in winter months	This report provides a review of the current ASEL and regulatory framework with a particular focus on the preparation of sheep for export from southern ports in the Australian winter months. It also incorporates an assessment of government reports from investigations of reportable mortality events since 2006. The report makes recommendations concerning areas where the current standards may be changed to improve clarity and purpose and suggestions where further research may be implemented to both identify risk mitigation strategies for major risks and inform further refinement of standards.	9/04/2013	K Shiell N Perkins L Hewitt
W.LIV.3027	Global assurance for the Livestock export industry	This project developed a Global assurance programme for use by the Australian livestock export industry.	30/04/2016	A Schuster

Training Materials and Manuals

Code	Project Title	Summary	Finish Date	Author/s
LIVE.124	Developing an “Is it fit to export?” guide	The ‘Is it fit to export?’ guide was designed to complement the Australian Standards for the Export of Livestock (ASEL) as a field guide to assist in the maintenance of high standards of animal health and welfare by illustrating some types of animal that should not be supplied for export.	30/09/2006	-
B.LIV.0128	Producers guides to assist in preparation of livestock for export	Building on success of 'Is it fit to export?' guide, produce easy to follow guides for producers outlining what is required to prepare cattle and sheep for export, including a checklist.	1/09/2007	-
B.LIV.0356	Training Gap Analysis	This project involved the review of all six sections of the Standard for the Export of Livestock (version 2.1) together with the Export Control (Animal) Orders (2004) and the Export of Livestock to Saudi Arabia Order (2005) to identify competency requirements and then examine how those requirements may be met.	30/06/2008	-
W.LIV.0399	Sheep and goat Standard Operating Procedures	The purpose of this project was to develop a series of SOPs for the slaughter of sheep and goats to complement the documents produced for cattle. SOPs have been developed by gathering existing guidelines, standards, job descriptions and process information. The SOPs have been implemented in market.	14/10/2011	L Hewitt
W.LIV.0192	Development of a manual for the best practice design of quarantine premises and associated biosecurity management plans	To review biosecurity, quarantine, environment, animal welfare and other relevant regulations, customer requirements and operational obligations for the planning, establishment and operation of livestock export Registered and Approved Premises. To develop a Reference Manual and a suite of best practice materials to provide greater clarity and support to the livestock export industry to comply with regulation and biosecurity requirements.	ONGOING	M Thompson S Williams R Pattinson