Final report

Animal Welfare Indicators Pilot for the Livestock Export Industry Supply Chain

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Abstract

International transportation of livestock by sea is a specialised process that carries an inherent risk to animal health and welfare. Despite the implementation of stringent regulation to mitigate expected risk, the animal welfare impacts of the live export process remain largely undocumented. The Animal Welfare Indicators (AWI) Pilot for the Livestock Export Industry Supply Chain project commenced in August 2017. The project aimed to develop and pilot an industry applicable system for monitoring animal welfare.

Animal welfare indicators must provide insight into the physical and mental state of livestock in relation to how they are housed or transported. A list of animal welfare indicators identified for sheep and cattle (feeder and slaughter) was piloted during eight consignments from Australia to destinations in the Middle East and South East Asia. Indicators were tested at several supply chain sectors, including on farm, at pre-export registered establishments, on marine vessels, and in destination feedlot pens. During piloting, the feasibility of taking indicators was assessed, indicators were identified as sensitive to differences in animal management, and the required frequency of observations was determined.

The AWI project tested a total of 97 animal welfare indicators identified by reviewing internationally recognised scientific protocols for cattle and sheep, Australian Commonwealth regulations, industry resources, and research team experience. Of the 97 indicators identified, 26 are now collected under new industry regulatory reporting requirements, 46 have been determined not critical or impractical, 2 require further research prior to adoption, and 23 are proposed here for possible industry adoption across the live export supply chain.

The 23 proposed indicators address each of the four principles under Welfare Quality® (Good Feeding, Good Housing, Good Health and Appropriate Behaviour) and provide information on health and five elements of behaviour identified during the project. Behavioural elements identified were 1. activity and rest, 2. mental state, 3. heat responses, 4. feeding behaviour and 5. human-animal interactions. Monitoring these behaviour elements alongside routine measures of animal health will be reflective of livestock welfare. Each of the proposed welfare indicators has proven reliable and repeatable and is ready for adoption to facilitate a holistic approach to animal welfare monitoring throughout the live export journey.

Findings from the AWI project have already been adopted by industry in two forms: 1) the project established the Industry Welfare Data Collection (IWDC) project, which founded the development of LIVEXCollect, a data collection system now adopted by industry and 2) informed the Shipboard Animal Welfare Surveillance (SAWS) Committee report in 2020.

Executive summary

The export of livestock by sea imposes animal welfare challenges; however, an evidence-based approach to measuring and evaluating animal welfare outcomes during the live export process has not previously been implemented. The Animal Welfare Indicators (AWI) Pilot for the Livestock Export Industry Supply Chain project commenced in August 2017 as the Australian livestock export industry (hereinafter referred to as 'industry') responded to the need for more detailed livestock welfare monitoring. This project follows on from the W.LIV.3032 project (Wickham *et al.* 2017) in developing a welfare monitoring protocol for feeder and slaughter cattle and sheep across the complex export supply chain.

To address the project's six objectives, a suite of animal welfare indicators was developed into a practical protocol to monitor livestock transported by sea from Australia. This list was established using the Welfare Quality® framework outlining four principles of animal welfare (Good Feeding, Good Housing, Good Health and Appropriate Behaviour). Internationally recognised protocols for monitoring welfare in beef and dairy cattle and sheep were considered, along with industry resources and regulatory requirements described in Fleming *et al.* (2020b) and Dunston-Clarke *et al.* (2020). The welfare indicators were piloted by collecting data on farm (two Australian sheep properties in Western Australia), in pre-export registered establishments (across WA, NT and QLD), on livestock carrier vessels, in destination feedlots (for all consignments), and some slaughterhouse trader pens (one destination market).

Multiple steps are required to validate a welfare monitoring protocol, some of which were outside of the project's scope (details shown in Figure 1).

1.	Identify proposed indicators by adapting existing protocols and observations relevant to the live export industry.	**Completed**
2.	Determine the practical requirements of data collection, storage and transfer of data and reporting.	**Completed**
3.	Pilot indicators for feasibility of sampling and data collection over eight consignments.	**Completed**
4.	Investigate the frequency of sampling required for shipboard observations.	**Completed**
5.	Investigate the selection of sample pens and representative sample sizes.	**Initiated**
6.	Investigate the protocol's capacity to detect changes in animal health and behaviour under different environments, resource conditions and between livestock classes.	**Completed**
7.	Investigate the type and level of training needed for standardised data collection.	**Completed**
8.	Propose a list of welfare indicators along with recommendations on how and when to measure.	**Completed**
9.	Create industry applicable training materials for observers to standardise data collection.	**Beyond project scope**
10.	Collect industry wide data on all voyages.	**Beyond project scope**
11.	Collect industry wide welfare benchmarks, including thresholds.	**Beyond project scope**

Figure 1. *Animal Welfare Indicators Pilot for the Livestock Export Supply Chain project: step-by-step objectives in the development of an industry specific animal welfare protocol.*

The prospective animal welfare monitoring protocol tested 97 indicators that capture a range of information on how livestock respond to conditions throughout the export supply chain. Application of the protocol by industry will enable the collection of standardised welfare data, which over time could be used for industry benchmarking, and to inform strategies to manage and mitigate risk. Adopting an evidence-based welfare monitoring protocol provides industry with the opportunity to capture valuable data for informing regulatory reviews and proactively address societal animal welfare concerns.

Defining the specific purposes for welfare monitoring will guide industry decisions on whether to adopt each of the proposed indicators and determine the frequency of sampling and pen selection applicable for different supply chains or types of livestock. The protocol can be used for benchmarking to provide information on animal outcomes more broadly across routes or seasons, or it may be used for further research to capture detailed data addressing a specific risk factor or provide greater transparency in reporting to the public. For example, monitoring to benchmark the performance of lambs along the whole supply chain will differ from assessing the impacts of stocking density during short-haul cattle voyages.

Project conclusions:

- An additional 23 indicators are suggested; indicators address each of the principles under Welfare Quality® (Good Feeding, Good Housing, Good Health and Appropriate Behaviour) and provide information on health and the five elements of behaviour identified as important during the project. These elements (1. activity and rest, 2. mental state, 3. heat responses, 4. feeding behaviour, and 5. human-animal interactions) are detailed in the report below. The additional 23 indicators are mostly taken at pen-level and complement those required under the Australian Standards for the Export of Livestock (ASEL) 3.1 or suggested by the SAWS Committee.
- The protocol is practical to apply for all tested sectors of the live export supply chain (pre-export registered establishment, sea vessels and feedlots in destination countries).
- Inevitably, the full range of variations in environmental conditions (e.g. heavy sea swell conditions), and management practices (e.g. heavy cattle management) could not be monitored during the pilot phase; however, indicators have been included to account for conditions that can be reasonably expected to occur during commercial operations.
- The frequency for collecting each measure has been investigated. Some background indicators require input once for each supply chain location, while some indicators are recommended for once or twice-daily reporting.
- The degree of variability between pen conditions and classes of livestock was found to be significant. Therefore, it was not feasible to determine a precise number of pens required to provide a representative sample for each measure for an entire consignment of livestock.
- Data collection can be undertaken using either a digital interface (e.g. Kizeo forms) that outputs data into Microsoft Excel or by direct entry into an Excel platform. Microsoft Excel utilised with add-on Power BI can then facilitate real time data analysis and feedback.
- Training of observers is required to facilitate the collection of standardised data.
- Time constraints of collecting welfare data must be considered. As data collection platforms evolve and trained observers become increasingly proficient, additional pen replicates may become achievable in shorter time frames.
- The measures collected were meaningful in terms of welfare outcomes. For example, animal behaviours detected included resting, heat responses, feeding behaviour and human-animal responses. Findings demonstrated how animals responded to their environment and were indicative of their welfare. For instance, heat responses of cattle were detected on some pilot

voyages and not others. Collating more extensive datasets on animal outcomes in varied environments (such as periods of low versus extreme heat, or low versus heavy sea swell, or periods of *ad libitum* versus restricted feed), will facilitate informed prediction of risk.

- Significant challenges were identified when monitoring sheep and cattle across multiple supply chain points. Challenges were identified as 1. determining the appropriate sample size per consignment, and 2. total time taken to assess sample pens given the variability between pens on marine vessels. Ways to address these challenges are listed under 'further research and recommendations' below.
- The protocol detected meaningful changes in animal behaviour and health, and was sensitive to different environmental, resource and management conditions.
- Using this protocol, the industry can take a whole-of-supply-chain approach to welfare reporting. Monitoring animals along the supply chain can provide insight into how livestock selection, environmental conditions and management practices at each supply chain sector influences the overall live export animal experience.
- The Industry Welfare Data Collection (IWDC) project (a derivative of the AWI project) established the foundations for the development of an animal welfare dashboard prototype, known as LIVEXCollect. This system is now being used by industry enabling exporters to meet the increased reporting requirements of ASEL 3.1.
- The AWI project collaborated with the Shipboard Animal Welfare Surveillance (SAWS) Committee in 2020 and contributed significantly to their report to industry on the collection of animal welfare indicators on live export vessels.
- The full benefits of this project will not be evident until large data sets are collected and statistically analysed. The protocol has been designed and presented in a form that should facilitate straightforward data collection and analyses.

Further research and recommendations:

- It is recommended that the industry define specific purposes for welfare monitoring for each supply chain as this will influence the extent of data collection (number of sample pens) and human resource allocation.
- Further research is required to understand appropriate selection of pens for shipboard welfare monitoring, and to address variability within a voyage (considering consignment size, route, season, species, class, vessel type and the personnel resources associated with data collection).
- It is recommended that industry decides who will be responsible for the workload associated with welfare monitoring: should it be placed on Independent Observers, or shared amongst Australian Government Accredited Veterinarians (AAVs) and stockpersons? This requires consideration of the purpose of monitoring (e.g. continual benchmarking vs seasonal audit) and data ownership and usage.
- Following the adoption of the protocol across many voyages and to all regions, industry-wide benchmarking and thresholds regarding acceptable animal welfare outcomes can be considered; for this to be achievable, data should be collected over a period of at least two years.
- To determine thresholds for acceptable welfare outcomes, it is suggested that a panel of industry stakeholders and animal welfare scientists be convened to review the industry data. This would assist benchmarking and permit continued improvement in welfare outcomes.

- It is recommended that a further study be undertaken, addressing inter- and intra-observer reliability of animal welfare observations and the level and frequency of training required to ensure confidence in standardised assessments.
- It is recommended that industry considers research into automated or remote monitoring of animal behaviour such as posture, activity and panting, where applicable, as this would likely improve monitoring efficiency.

This project was made possible through the cooperation of the export industry, including livestock export companies, ship owners, stockpersons and veterinarians.

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1. Project background

The Australian live export industry recognises the importance of using an evidence-based approach to managing animal welfare. Previously incidents resulting in poor welfare outcomes for exported livestock have created disparity between community expectation, government regulation and industry performance (Coleman 2018). Animal welfare is complex and multifaceted, and underpinned by three components: animal welfare law, scientific understanding, and societal values. The consideration of these factors is critical when taking steps to improve livestock welfare in any industry. As the community's expectations and concern for livestock welfare increase (Rousing *et al.* 2001; Colditz *et al.* 2014; Fleming *et al.* 2020a), steps to improve animal welfare monitoring and industry transparency are required. The Animal Welfare Indicators (AWI) project addressed these concerns by developing standardised animal welfare monitoring protocols throughout the live export supply chain.

The present AWI Pilot for the Livestock Export Industry Supply Chain project commenced in August 2017. The purpose of the project was to investigate industry-relevant animal welfare indicators for slaughter and feeder cattle and sheep transported from Australia by sea. Specifically, indicators need to cover the behaviour and health of the livestock, be practical and applicable to various sectors of the supply chain, while being capable of detecting variations in environmental, resource and management conditions typically experienced by livestock throughout the live export process.

Since the commencement of this project, the Australian live export industry has experienced various challenges and changes.

- An industry review of the Australian Standards for the Export of Livestock (ASEL) was undertaken in 2018/19 by a Technical Advisory Committee appointed to review ASEL 2.3.
- During the initial stages of this review (April 2018), the television program *60 Minutes* released an exposé of extremely poor welfare conditions for sheep during sea voyages from Australia to the Middle East in 2017.
- In response, numerous industry and regulatory reviews were initiated, including the McCarthy Review, Moss Review, Heat Stress Risk Assessment (HSRA) review, and the report of the Inspector-General of Live Animal Exports (IGLAE).
- These reviews supported the need for improved animal welfare monitoring capabilities, with the McCarthy Review reiterating the need for animal welfare indicators that extended beyond mortality and morbidity reporting (McCarthy 2018).
- The Technical Advisory Committee addressed these concerns and recommended increased animal welfare monitoring requirements, many of which came into effect with ASEL 3.0 in November 2020 (DAWE 2020).

The authors have, therefore, been acutely aware of the relevance, application, and role that the AWI project can play in constructively shaping welfare improvements in the industry.

The project has been derived from an internationally recognised framework, Welfare Quality®, to ensure all aspects of animal welfare are captured. Importantly, the proposed protocol consists of environmental-, resource- and management-based indicators as well as animal-based indicators that describe how livestock are responding to the conditions they experience. The proposed protocol is a tool that industry can adopt to monitor animal welfare beyond regulatory requirements and better inform risk mitigation strategies while facilitating increased transparency.

The project findings have already been adopted by industry in two forms.

- Working alongside the Industry Welfare Data Collection (IWDC) project, the AWI project has been instrumental to the development and testing of a 'welfare dashboard protocol'. This dashboard,

renamed 'LIVEXCollect', provides an IT platform for data capture and was recently mandated by the regulator and adopted by industry for recording the animal welfare information required by ASEL 3.0 and 3.1.

- The Shipboard Animal Welfare Surveillance (SAWS) Committee was convened in March 2020 to report on the collection of welfare indicators and to address the Technical Advisory Committee's recommendations for shipboard reporting. The SAWS committee was an expert panel consisting of veterinary epidemiologists, statistical scientists, animal welfare experts and a representative of the AWI project. Importantly, the SAWS committee report drew on many of the findings of the AWI project.

The collaboration outlined above indicates how valuable and influential the learnings from this project have been for the live export industry.

In conclusion, a protocol is proposed that extends beyond regulatory requirements to ensure a holistic approach to welfare monitoring, while acknowledging the expectations of stakeholders. Industry can now consider adopting all or some indicators, as discussed in this document. The protocol consists of tested animal welfare indicators that are applicable to multiple supply chain sectors, providing a tool that will facilitate animal welfare monitoring throughout the live export journey.

2. Project objectives

This project addressed six objectives.

2.1 Develop, in conjunction with current reporting requirements, a comprehensive recording welfare dashboard to gather data relevant to animal welfare throughout the live export chain

The project piloted 97 welfare indicators applicable to the following categories:

- Animal outcomes (health and behaviour)
- Resource-based factors
- Environmental-based factors

Initially, 71 welfare indicators were identified as potentially practical (Fleming *et al.* 2020b); these indicators were identified by reviewing Australian Commonwealth legislation and live export regulatory requirements, industry reference documents (e.g. Veterinary Handbook; Jubb and Perkins (2015)), and indicators proposed by internationally recognised welfare protocols for sheep (AWIN 2015; AssureWel n.d.-c), beef cattle (Keeling *et al.* 2013; Welfare Quality® 2018; Kaurivi *et al.* 2020; AssureWel n.d.-a) and dairy cattle (Welfare Quality® 2009; AssureWel n.d.-b). After initial testing, further indicators were recognised by Dunston-Clarke *et al.* (2020) and 74 indicators applicable to the live export supply chain were proposed. These indicators were categorised under the four principles and 12 criteria from the Welfare Quality® framework.

All 74 indicators were then piloted to test for validity, feasibility, and applicability to industry conditions. During piloting, indicators were adjusted and refined, with new indicators identified to address deficits after each voyage. Consequently, a total of 97 indicators have been tested across eight consignments throughout the project. Of the indicators tested, 26 are currently captured under LIVEXCollect and ASEL 3.1 reporting, 46 are deemed not critical, 2 require further research and technology prior to adoption, and 23 are proposed for industry adoption (outlined in Table 2). Indicators have been proposed for inclusion to fulfil each of the criteria under the Welfare Quality® framework (Good Feeding, Good Housing, Good Health and Appropriate Behaviour) and on the basis of their contribution to identifying the five behavioural elements described below.

2.1.1 Behavioural elements derived from animal-based indicators

Multiple measures of livestock behaviour taken at the pen level during voyage consignments were analysed. Patterns of behaviour (called behavioural elements) were identified by such analyses. Five main behavioural elements were identified and were found to be consistent across the sheep and cattle consignments studied.

These were:

1. Activity and rest behaviour
2. Mental state
3. Heat response
4. Feeding behaviour
5. Human-animal interactions

These five behavioural elements were identified from the consignments studied and, therefore, not all possible environmental-, resource- or management-based circumstances were experienced. Heat and feed challenges were two of the key factors identified as influencing animal outcomes during some of the voyages. Correlations with environmental and resource conditions suggest that these behavioural

indicators represent meaningful welfare outcomes. Specifically, no health challenges, cold challenge or severe sea swell were experienced on any of the eight consignments. It is pertinent to assume that 'health' underpins behavioural responses and could arise as a contributing factor in behavioural outcomes. Records of ill-health may be compared against animal behaviour in the event of disease outbreak or high mortality events. Challenges not encountered in this study, such as disease outbreaks, severe sea swell or cold stress may be captured in animal responses under existing behavioural elements.

To illustrate how these five behavioural elements were identified, analyses of two cattle and two sheep voyages from Australia to the Middle East are shown in Figures 2-4. Each voyage was analysed twice, firstly using data collected at one time point per day for all observed lines of livestock (1TP) and secondly, using data collected from lines of livestock observed at three time points per day (3TP).

Table 1. Voyage details for two sheep and two cattle voyages studied under the project.

Voyage	Australian Port	Destination	No. voyage days	Month/ Year	Species	Class (average BW kg)	No. pens studied	No. animals studied
1	Fremantle	Oman	13	May 2018	Sheep	B wether (49kg)	6	265
						Ewe (55kg)	4	165
2	Fremantle	Oman	14	November 2018	Sheep	A wether (64kg)	4	158
						B wether (54kg)	6	259
						C wether (47kg)	4	200
3	Fremantle	Israel	19	August 2017	Cattle	*Bos indicus* cross bulls (270kg)	6	251
						Bos indicus cross heifers (280kg)	4	127
						Bos taurus bulls (360kg)	4	118
4	Fremantle	Israel	18	March 2018	Cattle	*Bos indicus* cross bulls (260kg)	6	195
						Bos taurus bulls (315kg)	4	158

Behavioural element 1. Activity and rest behaviours.

a. Sheep **b. Cattle**

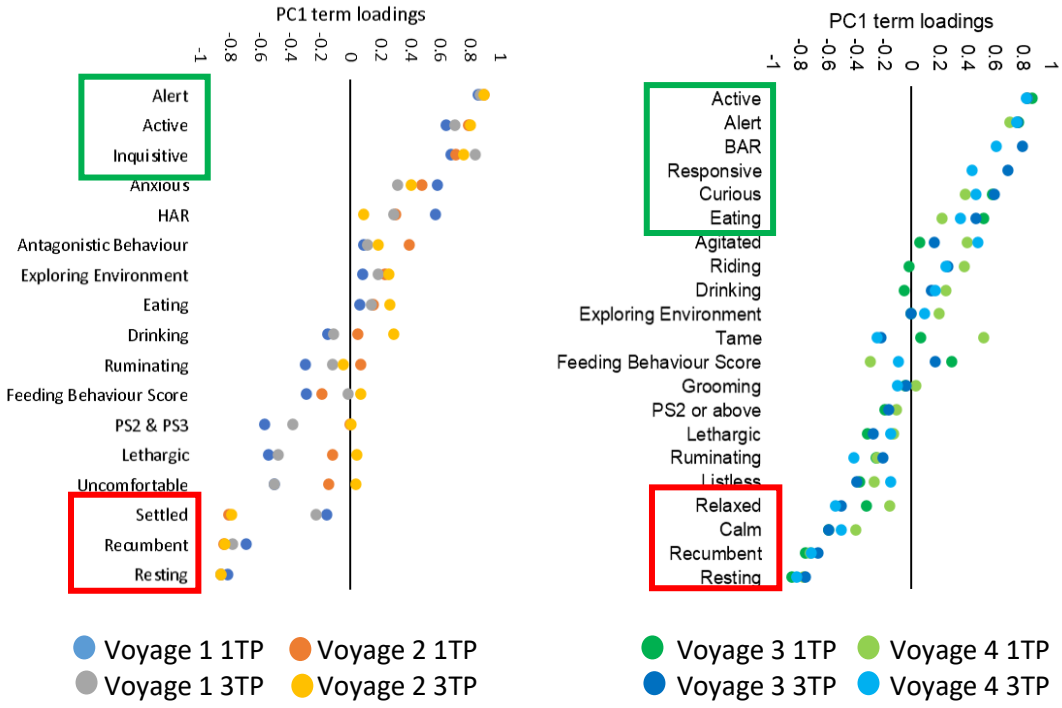
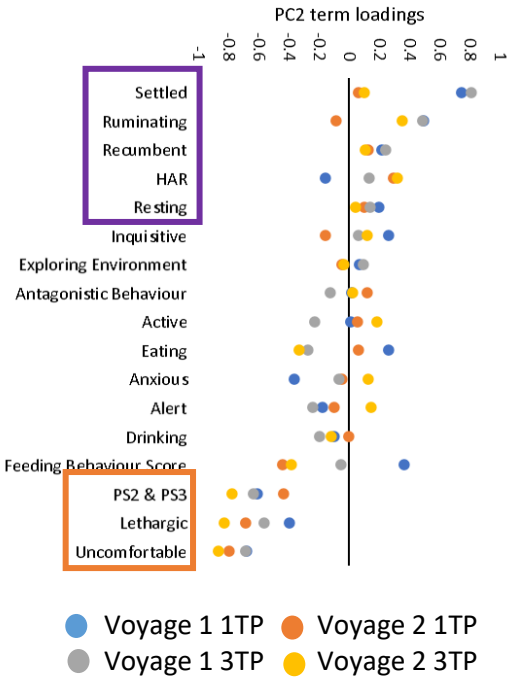


Figure 2. Principal component (PC) term loadings for a) sheep voyages to the Middle East and b) cattle voyages to the Middle East. PC1 described activity and rest behaviour for both species. Each dot represents the average score for each measure during a consignment. Boxes outline the terms at either end of the axis that were highlighted by this behavioural element.

Welfare elements 2. Mental state and 3. Heat response

c. Sheep



d. Cattle

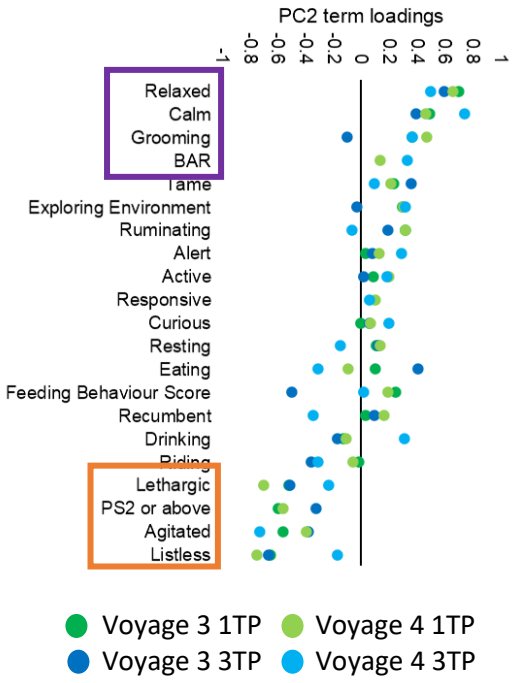


Figure 2 (cont.). Principal component (PC) term loadings for c) sheep voyages to the Middle East and d) cattle voyages to the Middle East. PC2, described mental state and heat responses for both species. Each dot represents the average score for each measure during a consignment. Boxes outline the terms at either end of the axis that were highlighted by these behavioural elements.

Welfare elements 4. Feeding behaviour and 5. Human-animal interactions

e. Sheep **f. Cattle**

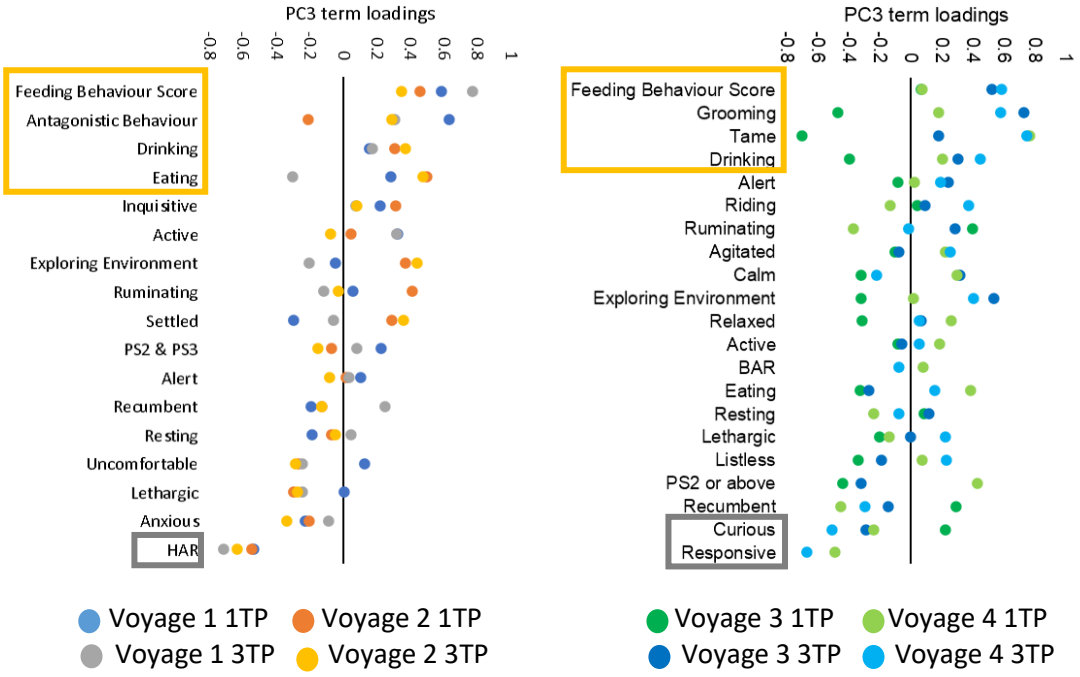


Figure 2 (cont.). Principal component (PC) term loadings for e) sheep voyages to the Middle East and f) cattle voyages to the Middle East. PC3 described feeding behaviour and human-animal interactions for both species. Each dot represents the average score for each measured during a consignment. Boxes outline the terms at either end of the axis that were highlighted by these behavioural elements.

Behavioural element 1. Activity and rest behaviour

What is this welfare element? Daily activity and rest patterns were identified as the primary component of assessed behaviour during voyages and in feedlot facilities. Intensive livestock management and sea transport restricts the expression of locomotion, but activity was still evident from our assessments.

The primary indicators of this behavioural element are:

- Posture
- Resting
- Negative and positive engagement
- Demeanour terms (e.g. settled, active, alert, curious)
- Stepping and balance associated with sea conditions

Benefits of monitoring: Activity and rest are innate behaviours and crucial to maintaining homeostasis. Behavioural outputs associated with activity and rest indicate the ability for animals to adapt to the conditions under which they are managed. This behavioural element, therefore, provides information on the ability for livestock to adapt to changes in housing, including confinement and social mixing, or other aspects influencing the pen environment such as continuous lighting or machinery noise.

Monitoring this behavioural element can inform best practices for:

- Pen space allocation (stocking density)
- Livestock handling and habituation to their environment

- Bedding management
- Livestock selection (ability for animals to adapt to intense management)
- Pen harmony
- Thermal challenges
- Sea conditions (e.g. heavy swell)

Behavioural element 2. Mental state

What is this welfare element? The mental state of animals can capture their demeanour and emotional valence and provide information on how animals are experiencing their surrounding environment. This behavioural element addresses affective states, an important aspect of animal welfare monitoring that has previously been difficult to capture and quantify. This includes if the animal may be suffering pain, fear or frustration or experiencing pleasure, comfort, or contentment. Positive experiences in confined livestock can be evidenced by activities such as play, exploratory and affiliative behaviours.

Indicators that contribute to this behavioural element include:

- Demeanour terms
- Ruminating
- Positive and negative engagement

Benefits of monitoring: This behavioural element has the capacity to describe how livestock are coping within the live export supply chain. Monitoring demeanour and mental state can show positive welfare outcomes, going beyond traditional welfare monitoring which is limited to demonstrating the absence of poor welfare. Avoiding stress and negative experiences is important for maintaining health and fitness. Monitoring this behavioural element enables industry to address community concerns, and can assist in identifying optimal environments, management techniques and resourcing for different types of livestock.

Behavioural element 3. Heat response

What is this welfare element? As expected, periods of increased heat and humidity were associated with changes in panting scores. These changes were also accompanied by variations in activity and resting behaviour, demeanour, and human-animal responses. This behavioural element, therefore, captured behavioural responses and affective states along with the physiological responses typically used to investigate heat stress.

This element involves the indicators:

- Panting scores
- Demeanour terms
- Feeding behaviour score
- Posture
- Resting
- Drinking
- Ruminating

Benefits of monitoring: Panting scores have been widely used in the live export context to indicate physiological responses to heat and humidity. However, to better understand the welfare impact of a heat challenge, monitoring a combination of physiological, health and behavioural indicators is recommended in pre-export registered establishments, during sea voyages and in destination country facilities. This element indicates the ability of different livestock types to cope with periods of heat and humidity, specifically:

- How heat loading and respite periods affect welfare outcomes
- Coping capacity of different types of livestock during heat challenge

Behavioural element 4. Feeding behaviour

What is this welfare element? This behavioural element captured livestock responses to daily nutritional management.

Indicators contributing to this element include:

- Feeding behaviour score
- Pellet (fodder) consumption (per head per day)
- Roughage feeds (access to supplementary chaff or hay)
- Feed trough space per head

Benefits of monitoring: Provision of adequate feed has previously been measured solely through input measures (i.e. the amount of fodder provided) or through reporting injuries or mortalities associated with competition to attend troughs (particularly lameness and smothering). Monitoring feeding behaviour by assessing a combination of animal behaviour, health and resource provision can identify and prevent animals experiencing hunger and optimise nutritional management practices both on marine vessels and in feedlot facilities where livestock are adapting to changing dietary composition, feed delivery methods and possibly restricted feeding regimens (e.g. during voyages where fodder resources are finite or when managing livestock during thermal challenge).

Benefits of monitoring this element include:

- Identifying the amount of fodder required (for daily provision and for allocation when planning sea voyages)
- Comparing between type and composition of fodder (e.g. benefits of feeding roughage during sea voyages)
- Identifying optimal frequency of feeding
- Checking the ability for livestock to access troughs (pen design, stocking density and pen harmony)

Behavioural element 5. Human-animal interactions

What is this element? This behavioural element described how livestock were responding and habituating to people. General husbandry procedures frequently expose intensely managed livestock to close proximity to people. The influence of observer presence on animal behaviour is inevitable when performing pen-side assessments. However, this in itself was an indicator of animal responses to intense management as the influence of human presence will reflect either aversion or habituation to stock handlers.

Indicators contributing to this element:

- Reactivity Index
- Posture
- Resting
- Positive and negative engagement
- Demeanour terms

Benefits of monitoring: Aversion to stock handlers is a significant welfare concern in the live export context where livestock sourced from extensive grazing systems are required to adapt to intensive management and stock handling practices throughout the supply chain. Furthermore, the reactivity of livestock to humans can impact the safety of stock handling for both animals and humans, and the ability to provide individual care in the event of injury or disease. Monitoring this element throughout the supply chain can improve our understanding of:

- Animal temperament and the ability to adapt to intense management
- The impact of prior and current livestock handling practices

2.1.2 Individual animal welfare indicators

The full list of 97 indicators considered by the AWI project is detailed in Table 2. Care has been taken to ensure that expected animal responses and environmental or resource variables can be captured using the ASEL 3.1 LIVEXCollect reporting platform.

While SAWS and LIVEXCollect focus on indicators recorded on vessels, the proposed list (Table 2) contains indicators that are applicable to multiple sectors of the live export supply chain. Indicators have been categorised as 'not critical'; 'already captured' (usually on marine vessels) under either LIVEXCollect, routine voyage planning or ASEL 3.1; 'proposed' — indicators for industry to consider for adoption; and 'requires further research' indicating that the data collection methodology requires further development prior to industry adoption.

Details have been provided on the sectors of the supply chain that each measure is applicable to. Where indicators are already collected during sea voyages, suggestions for additional supply chain sectors have been put forward for consideration where applicable.

Note, all indicators in this table were tested by pen-side observation and are proposed for assessment at a pen level (with some exceptions for details specified for collection at a livestock line, or consignment level.

Table 2A-G. Welfare indicators tested for inclusion within the Australian live export welfare assessment protocol. Highlighted indicators are those proposed under the AWI project for industry adoption. Societal concerns: **PH** = Positive health: relates to the health of individual animals and that the provision of appropriate treatment to ensure recovery, quality of life or where necessary, prevent suffering. **C** = Animal comfort: relates to animal comfort within their environment, e.g. having a comfortable place to rest and exist. **AC** = Animal care: relates to the management and handling of animals, specifically the quality of human-animal relationships. **QoL** = Quality of Life: relates to consumers wanting to ensure that animals are provided with an acceptable quality of life, at every stage of life. QoL considers animal sentience and wellbeing and goes beyond merely meeting the needs of animals.

A. Assessment details

Measure	Ready for uptake?	Recommended Frequency	Collection Point	Societal Concern	Welfare Principle
Assessor	Proposed	Once daily unless changed	All sectors	AC	NA
Date and time	Proposed	At each pen-sampling, can be automated	All sectors		

B. Pen details

Measure	Ready for uptake?	Recommended Frequency	Recommended Collection Points	Societal Concern	Welfare Principle
Location	Proposed	Once per location	On-farm, pre-export registered establishment, vessel, and destination facilities	C, AC	Good housing
Pen area	Proposed	Once per location unless changed	Pre-export registered establishment, vessel, and destination facilities	PH, C, AC	
Animals per pen	Proposed	Once per location unless changed	Pre-export registered establishment, vessel, and destination facilities		
Access to shade/shelter	Proposed	Once per location unless changed	On-farm, pre-export registered establishment, vessel, and destination facilities	C, AC	
Feed trough space	Proposed	Once per location unless changed	Pre-export registered establishment, vessel, and destination facilities	AC, QoL	Good feeding
Number of water points	Not critical	Number per pen	Captured under 'Potable water'		

Function of water points	Not critical	Category			

C. Livestock details

Measure	Ready for uptake?	Recommended Frequency	Recommended Collection Points	Societal Concern	Welfare Principle
Body Condition Score	Proposed	On entry for each facility and possibly prior to slaughter	Pre-export registered establishment, vessel, destination facility	AC, QoL	Good feeding
Species and breed	Proposed	Once per consignment	On entry to the supply chain	C, AC, QoL	Good housing
Horn length	Approved arrangement	Once per consignment	On entry to the supply chain		
Class	Approved arrangement	Once per consignment	On entry to the supply chain		
Average body weight (kg)	Approved arrangement	Once per location where feasible	On-farm, pre-export registered establishment, vessel, and destination facilities		
Fleece/coat length	ASEL 3.1/HSRA	Category recorded once per location	Pre-export registered establishment, vessel, and destination facilities		
Ear tag colour	Not critical	Once per sheep consignment	Colour associated with year of birth (sheep)		
Evenly drafted livestock	Not critical	Once per location unless changed	Captured under ‘Negative engagement’		
Stocking density	Not critical	Once per location unless changed	Captured and calculatable from ‘Pen area’ and ‘Animals in pen’		

D. Animal outcomes

Measure	Ready for uptake?	Recommended Frequency	Recommended Collection Points	Societal Concern	Welfare Principle
Reactivity Index	Proposed	On entry and exit for each supply chain sector	On-farm, pre-export registered establishment, vessel, and destination facilities	AC	Appropriate behaviour
Posture	Proposed	Twice daily on elected days	Pre-export registered establishment, vessel, and destination facilities	C, QoL	
Resting	Proposed	Twice daily on elected days	On-farm, pre-export registered establishment, vessel, and destination facilities		
Ruminating	Proposed	Twice daily on elected days	On-farm, pre-export registered establishment, vessel, and destination facilities		
Negative engagement	Proposed	Twice daily on elected days	On-farm, pre-export registered establishment, vessel, and destination facilities		
Positive engagement	Proposed	Twice daily on elected days	On-farm, pre-export registered establishment, vessel, and destination facilities		
Demeanour: nine qualitative descriptive terms (*alert, active, anxious, dull, uncomfortable, settled, content, curious, sociable*)	Proposed	Twice daily on elected days. Methodology requires further research and development	On-farm, pre-export registered establishment, vessel, and destination facilities	PH, AC, QoL	
Panting score	Proposed	Twice daily on elected days	On-farm, pre-export registered establishment, vessel, and destination facilities		Good housing
Sailing conditions (stepping and balance)	LIVEXCollect	Twice daily on elected days	Vessel	AC, C, QoL	Good housing

Feeding Behaviour Score	LIVEXCollect	Once daily on elected days	Pre-export registered establishment, vessel, and destination facilities		Good feeding
Drinking	Not critical		Water access captured under 'access to potable water'	C, QoL	Appropriate behaviour
Eating			Captured under 'Feeding Behaviour Score'		
Visual/looking			Captured under 'Resting'		
Pushing			Captured under 'Negative engagement'		
Mounting/riding					
Aggressive interaction					
Chewing fence					
Abnormal					
Self-grooming			Captured under 'Positive engagement'	C, QoL	Appropriate behaviour
Allogrooming	Not critical				
Affiliative social					
Play					
Exploring environment					
Agitated			Captured under 'Anxious'	PH, AC, QoL	
Calm			Captured under 'Settled'		
Flighty			Captured under 'Reactivity Index'		
Frustrated			Captured under 'Anxious' and 'Active'		
Happy			Captured under 'Sociable'		
Inactive			Captured under 'Active'		
Inquisitive			Captured under 'Curious'	PH, AC, QoL	
Isolated			Not applicable to industry		
Lethargic			Captured under 'Dull'		
Listless					

Positively occupied			Captured under 'Curious'		
Relaxed			Captured under 'Settled'		
Responsive			Captured under 'Reactivity Index'		
Tame					
Flight distance	Not critical		Captured under 'Reactivity Index'	AC	Appropriate behaviour

E. Animal health

Measure	Ready for uptake?	Recommended Frequency	Recommended Collection Points	Societal Concern	Welfare Principle
Nasal discharge	Proposed	Once daily on elected days	On-farm, pre-export registered establishment, vessel, and destination facilities	PH, AC	Good health
Ocular discharge	Proposed	Once daily on elected days	On-farm, pre-export registered establishment, vessel, and destination facilities		
Pink eye	Proposed	Once daily on elected days	On-farm, pre-export registered establishment, vessel, and destination facilities		
Coat/fleece contamination	Proposed	Once daily on elected days	Pre-export registered establishment, vessel, and destination facilities	PH, AC, C, QoL	Good housing
Wounds/Lesions	LIVEXCollect	Once daily on elected days	On-farm, pre-export registered establishment, vessel, and destination facilities	PH, AC	Good health
Lameness					
Unable to stand					
Scabby mouth					
Ocular lesions					
Diarrhoea/scours					
Bloat					
Hollow sides					
Illthrifty/shy feeder					

Animal needing further care					
Offspring born					
Aborted pregnancies					
Animals moved to hospital pen					
Mortality					
Coughing	Not critical		Not found to correlate with collected data and captured under other health/behaviour indicators		
Hair loss					
Sneezing					
Vocalisations					
Belching					
Drooling/salivating					
Lesions			Captured under wounds/lesions		
Hair loss					

F. Resource access

Measure	Ready for uptake?	Recommended Frequency	Recommended Collection Points	Societal Concern	Welfare Principle
Roughage availability	Proposed	Once daily on elected days	Pre-export registered establishment, vessel, and destination facilities	AC, QoL	Good feeding
Fodder ration availability	LIVEXCollect	Once daily on elected days	Pre-export registered establishment, vessel, and destination facilities		
Feed quality	LIVEXCollect	Once daily on elected days	Pre-export registered establishment, vessel, and destination facilities		
Access to potable water	LIVEXCollect	Once daily on elected days	Pre-export registered establishment, vessel, and destination facilities		
Water contamination	Not critical		Captured under 'Access to potable water'		
Feeding regime			Captured under 'Fodder ration availability'		
Amount of food in troughs			Time of day dependent		

G. Pen environment

Measure	Ready for uptake?	Recommended Frequency	Recommended Collection Points	Societal Concern	Welfare Principle
Manure pad moisture and depth	Proposed	Once daily on elected days	Pre-export registered establishment, vessel, and destination facilities	AC, C, QoL	Good housing
Wet bulb temperature	LIVEXCollect	Measured twice daily on elected days Recommended for continuous automated monitoring	On-farm, during land transport, pre-export registered establishment, vessel, and destination facilities		
Dry bulb temperature					
Relative humidity					
Noise	Requires further research		Subjective measure with low repeatability that will likely require collection using a decibel meter. Maybe reflected in animal demeanour and activity/rest behaviour		
Ventilation and air quality	Requires further research	Recommended for continuous automated monitoring	Pre-export registered establishment, vessel, and destination facilities		
Sea swell	Not critical		Captured under 'Sailing conditions'		
Days since last deck wash	Not critical		Captured under 'Manure pad moisture and depth'		

2.2 Determine the practical requirements for data collection for the welfare dashboard

This includes the time taken at each point, frequency of data points, number of animals sampled, storage and transfer of data, and use of paper versus digital technology/automation in various environments.

2.2.1 Time taken to record data

The time taken to record the various animal welfare indicators differed across contexts. When piloting the full list of indicators, researchers took 5–10 min per pen to monitor livestock at feedlots. This included behavioural monitoring and taking environmental records prior to walking through the pen to inspect livestock for health conditions, and assess the manure pad, water sources and feed troughs. Feedlot pens typically held >100 animals at each location studied.

On vessels, initial pen recordings took researchers 10–12 min per pen to collect information on static pen details (e.g. pen area, feed trough space), livestock factors (e.g. weight, class, fleece/coat length) followed by animal-, resource- and environment-based measures. Subsequent pen-side assessments took between 5–8 min per pen as only animal-, resource- and environment-based measures were required. The time taken to record data was minimised by using a smartphone application facilitating efficient data entry at the pen-side and eliminating repeat handling of data.

2.2.2 Frequency

Animal responses recorded on pen-side assessments for sheep and cattle differed significantly by voyage day and between morning and afternoon pen assessments. Behaviour relating to activity and rest fluctuated on most voyage days reflecting circadian rhythms, while heat responses also varied from morning to afternoon in some situations (Willis *et al.* 2021b). However, it is noted that twice daily data collection considerably increases the time investment associated with welfare reporting. Consequently, the optimal frequency for monitoring each indicator is dependent on the expected daily variance for each behaviour, and how industry aims to use collected data. Recording welfare data during morning and afternoon livestock inspections will be more feasible if data entry can be performed on a mobile device and environmental monitoring can be automated where appropriate.

Considerations regarding frequency of performing pen-side assessments are outlined below and details on the optimal data collection frequency for each individual measure are outlined under Sections 4.1 and 4.2.7 of this report.

Once per sector: Provides industry with a snapshot of livestock responses to each supply chain sector. Collecting pen-side data once may be appropriate when livestock are within a specific sector for a short duration, such as yards on-farm, during land transport and in destination country trader/slaughter pens.
Benefit: a snapshot of livestock welfare status at each supply chain sector.

At entry and prior to exit: This provides industry with an indication of whether livestock have been able to adapt to the novel environment, increased human handling and other management factors. This frequency of monitoring may be suitable for some indicators and/or sectors of the supply chain where livestock are housed for short periods during pre-export preparation, or post voyage.
Benefit: indication of livestock adaptation.

Once-daily per sector: Provides industry with daily insight to livestock responses. If collected at a consistent time each day, animal responses can be identified and compared as they develop. Such data has the capacity to indicate animal responses as challenges are encountered and enable timely implementation of management changes or risk mitigation. Once-daily recordings will, however, only show one dimension of some behavioural elements, e.g. morning recordings typically show livestock activity, not rest, or may

record lower daily panting scores if environmental temperatures peak in the afternoon. Therefore, recording measures once-daily when livestock are housed intensively or facing environmental challenges will not provide information on diurnal behavioural fluctuations. Benefit: indication of how livestock are adapting and coping with welfare challenges on a daily basis.

Twice-daily per sector: Twice-daily recording of specific livestock behaviour relating to activity and rest behaviour, demeanour, and panting scores is informative when livestock are confined to pens during sea transport or facing thermal challenge. Twice daily observations can provide the following benefits:

- Understanding of animal adaptation and habituation to intensive environments and demonstrating whether livestock are able to perform innate diurnal behaviour.
- Indicate animal responses to challenging environmental factors that are likely to change over a 24 hour period; for example, extreme weather conditions or sea swell.
- Changes in animal behaviour and demeanour may provide early indication of imminent conditions that require the timely implementation of risk management processes.

As detailed in sections 4.1 and 4.2.7, not all indicators are recommended for twice-daily monitoring. For example, the prevalence of ill-health is likely to be cumulative and is recommended for daily monitoring at most. Therefore, only specified indicators may warrant twice-daily observations under certain conditions (such as during weather extremes, restricted feeding, or heavy sea swells).

2.2.3 Representative samples

Animal welfare indicators were piloted by making pen-side assessments on individual pens of livestock. Historically, daily voyage reporting under ASEL 2.3 involved recording information, such as respiratory character, as an overall average for the whole vessel. This average response of all livestock on board was not informative or sensitive to differences in animal responses between types of livestock and different locations within the vessel. Currently, LIVEXCollect for ASEL 3.1 requires information to be entered as an average for each species on each deck. While this approach minimises the time spent reporting, it lacks the sensitivity to detect differences between lines of livestock, variations in climate between pen locations on a single deck, or divergent behaviour for individual animals.

Pen-side assessments are advantageous as observing livestock at a pen level allows accurate assessments of all animals within the sample – this is of particular importance when assessing behavioural indicators and demeanour terms. However, this approach means that sample pens must be selected to accurately represent each consignment of livestock. During sea voyages, there are multiple variables that can impact animal welfare. Animal experiences differ between classes of livestock; therefore, selecting pens of the predominant livestock type will not capture the range of welfare outcomes on each voyage (e.g. wethers vs lambs); thus observations from pens of different livestock species and classes will be required. Each marine vessel will have different environmental conditions, pen design and the infrastructure; therefore, pens must be selected to capture variable environmental, resource and management conditions by sampling regular shipboard pens as well as those in higher risk locations (e.g. pen areas exposed to radiant heat from the engine or upper deck, ventilation hot spots, or open decks exposed to cold weather or sea spray). The selection of sample pens from feedlot facilities is less complicated as there are fewer pens for each class of livestock and less variability between pen conditions.

Analysis of data collected during cattle voyages to Israel showed that activity and rest behaviour, and reactivity to humans, varied between different lines of livestock on each voyage. This reflects expected differences in temperament between lines of *Bos indicus* and *Bos taurus* cattle. Interestingly, heat responses did not vary between lines of livestock, yet a difference was recorded in heat responses between the same line of livestock travelling on different decks. These results are a good example of management planning to ensure stowage of less heat tolerant livestock (*Bos taurus*) in the lowest risk areas of the vessel,

and more heat tolerant livestock (*Bos indicus*) in areas known to have higher deck temperatures (Willis *et al.* In prepration).

During sheep voyages to the Middle-East, heat responses were the only behavioural element to vary between lines on each voyage (Willis *et al.* 2021a). Furthermore, a difference in heat response was noted between the same line of sheep (B Wethers) stowed on different decks, but not across all three decks (Willis *et al.* 2021b). This identified that areas of the vessel are prone to environmental variation, but this variation is not necessarily seen between each deck. Therefore, monitoring similar lines of livestock on all decks may not be warranted; however, representative pen samples will need to account for predicted variations of climate that occur between areas of the same deck.

The optimal number of pens that must be monitored to achieve a representative sample during sea voyages is currently unknown. Determining the degree of variability between pens and livestock classes was beyond the scope of the current project and further study is advised to determine the definitive number of pens required to form a representative sample. To determine variability between pens, a minimum of three replicate pens of livestock with similar stocking densities, species and class, per environmental, resource and management condition is required to provide sufficient replication to facilitate statistical analysis on collected data. A database that contains variability in animal welfare outcomes (considerate of consignment size, route, seasonal weather variations, species, class, vessel type) can improve the understanding of differences and similarities in welfare outcomes between pens and decks of livestock. Until such data becomes available, the selection of representative pens must account for differences between lines of livestock, the predicted variability between microclimates on each vessel, and the personnel resources associated with data collection.

2.2.4 Paper or digital technology

Throughout this project, various methods of data collection were used, including paper-based systems, digital tablet interface and a smartphone application. Paper-based data collection is time consuming, with double and triple handling of data required, while it also increases the potential for transcription errors when entering information into a computer database. Similarly, tablets were not ideal given their size and fragility. A smartphone application, Kizeo Forms (Kizeo 2017) proved convenient and portable when making pen-side observations in all research contexts. Kizeo Forms provided editable software for data recording. The application could be used offline with captured data uploaded to a secure online cloud when internet connection became available. Data could then be downloaded into Microsoft Excel sheets for subsequent data analysis and reporting.

During the welfare dashboard protocol testing stage for the IWDC project, an online secure dashboard was developed to facilitate real-time reporting of captured data powered by Microsoft add-in Power BI. During this testing phase, it was identified that the training of industry stockpersons and Australian Accredited Veterinarians (AAVs) to use a smartphone application was not seamless, and at times, not feasible. In response, specialised Excel spreadsheets were developed to allow data entry via a personal computer interface with the recorded data then being uploaded to the online dashboard. The industry is now using a derivative of this system, renamed LIVEXCollect, to report against ASEL 3.1. The potential remains for industry to use a smartphone application to communicate with Excel, thereby reducing recording times and the need to double handle data recorded in hard copy format while on decks, or during data collection in other sectors of the industry. This method will improve the accuracy of reporting by eliminating the tendency for observers to report from memory at a later time.

There is significant room for improved efficiency of data collection through training of observers, portability of IT systems, automation of environmental data and prioritisation of observations that prove valuable indicators of welfare. Increased frequency of data collection will be more feasible if data entry can be performed on a mobile device during morning and afternoon pen inspections. The current version of LIVEXCollect requires observation and recording of data during deck inspections to be entered manually

into an Excel spreadsheet on a desktop interface at a later time. If this inefficiency is removed, the implementation of twice daily pen-side assessments becomes more practicable.

2.2.5 Storage and transfer of data

Using a secure cloud data system is imperative to protect captured data. The development of an online dashboard system allows flexible and secure sharing of reports to exporters, industry, and the regulator, and the information shared to each user can be filtered and controlled. Using a secure cloud data platform will enable industry to have increased data access in the future, as required and when appropriate.

2.2.6 Pen-side assessment technique

It is recommended that indicators be observed at a pen level, from sample pens.

Before each assessment, the observer approaches the pen and allows animals time to accustom to their presence before recording commences. Indicators must be taken prior to, or at least 30 minutes after any animal handling or pen disturbance. It is suggested that the observer approaches the pen and makes observations when standing in front of the pen, between 1–5 steps back from the pen fence if the environment allows. This position will generally allow the majority of the pen/livestock to be observed and is an appropriate position for recording other behavioural indicators. As livestock are impacted by human presence, which can influence some behavioural indicators, the order of observations is important. The pen-side assessment technique has been previously described in Willis *et al.* (2021a) and Willis *et al.* (2021b):

'Recordings firstly involve the collection of static information (time and date, location, voyage day and pen ID) while allowing livestock to acclimatise to human presence before collecting animal indicators (outlined in **4.2.7 D**) *over a period of 5–8 minutes per pen. Behavioural indicators record animal activities, and how animals were behaving (demeanour), during each assessment period. Health and mortality were then assessed* (**4.2.7 E**)*, along with resources* (**4.2.7 F**)*, and environmental data* (**4.2.7 G**)*.'*

2.2.7 Welfare indicators for pen-side assessments

The method of recording and scientific basis is provided below for each newly proposed measure. Measures already collected under the LIVEXCollect daily reporting have been included in details below to show how the proposed indicators could be adopted into a whole-of-supply chain system.

A. <u>Assessment details:</u>

A1. Assessor name

A2. Date and time of assessment (including voyage day if applicable)

B. <u>Pen details:</u>

Recorded once for each supply chain location unless parameters change during the period livestock are managed within each facility. Enables across-supply chain data analysis and comparisons against health and behavioural outcomes to identify potential risk factors.

B1. Location

Records the supply chain location by selecting from a categorical list:

- On-farm
- Pre-export registered establishment
- Marine vessel
- Destination country facility

B2. Pen area

Pen area (m^2). Can be used to calculate stocking density. This information can potentially be included automatically if it remains constant for each location.

B3. Number of animals in pen

The number of animals in the pen is recorded once at each location per consignment and updated if the number of animals changes.

B4. Feed trough space

This contributes to Behavioural Element 4. Feeding behaviour

Feed trough space available to the pen (linear m). Can be used to calculate trough space per head. This information can potentially be included automatically if it remains constant for each location.

B5. Access to shade/shelter

Records the shade and shelter available by selecting from a categorical list. This information could potentially be included automatically if it remains constant for each location. Categorical descriptors:

- None
- Trees/windbreak
- Partial shade
- Roofed pen / open deck of a ship
- Roof and sides / enclosed deck of a ship

C. <u>Livestock details:</u>

Recorded once per cohort of animals unless otherwise specified or a parameter changes (e.g. fleece length or average body weight). Enables across-supply chain data analysis and comparisons against health and behavioural outcomes to identify potential risk factors.

C1. Species and breed

Livestock details are recorded at various points along the supply chain. However, as recommended in the SAWS report, simplification and standardisation of these parameters is recommended.

Cattle	**Sheep**
Bos taurus	Wool sheep
Low *Bos indicus* content	Hair sheep
High *Bos indicus* content	
Dairy	

C2. Class

Cattle	**Sheep**
Bulls	Wethers
Steers	Lambs
Cows	Ewes
Heifers	Rams

C3. Average body weight (kg)

Recorded during pre-export preparation of animals; may be applicable at other supply chain points where facilities permit or where animals are managed for extended periods.

C4. Fleece /coat length

Selected from categorical list:

Cattle	Sheep
1 – Slick, short summer coat	< 25 mm
2 – Coat is mostly shed (~75% shed)	25–50 mm
3 – Coat is halfway shed (~50% shed)	>50 mm
4 – Coat exhibits initial shedding (~25% shed)	
5 – Full winter coat (0% shed)	

Scientific basis: Fleece and coat length affects thermoregulation and is currency required for industry heat stress risk assessments (HSRA) for specified voyages. We propose the inclusion of this indicator as not all consignments require a HSRA, and coat and fleece length can influence the ability for livestock to cope with cold conditions, or impact fleece and coat contamination. ASEL 3.1 stipulates that sheep must have wool or hair no longer than 25 mm at the time of loading for transport to the port of disembarkation; however, if sheep are retained in destination country feedlots for extended periods, fleece length may impact welfare outcomes.

C5. Body Condition Score (BCS)

Body condition scores are recommended for recording on initial assessments at each supply chain sector and possibly prior to slaughter. (Body condition scoring systems for cattle and sheep are outlined in ASEL 3.1 Sections 1.4.3 Table 2 and 1.7.4 Table 4).

Scientific basis: The relationship between poor welfare and low BCS has long been established with condition scoring routinely used as an indicator of long-term nutritional status. This measure may indicate poor nutrition and be an indicator of disease (Leach *et al.* 2009; Roche *et al.* 2009). Therefore, measuring BCS as animals move through the supply chain can indicate the long-term nutritional status of livestock. High body condition scores can affect the thermoregulatory or locomotor capabilities of animals (Fleming *et al.* 2020b) and can influence their ability to cope with confinement to pens, manure pad conditions, high environmental temperatures and possibly sea conditions. These risk factors may not be captured by solely recording body weight.

D. Animal outcomes:

D1. Reactivity Index (Animal outcome, recorded first)

Behavioural Element 5: Human-animal interactions

A new measure, 'Reactivity Index' (Table 2e) was described and piloted for this project. This measure provides a pen level method of quantifying animal responses to humans. This measure is collected as observers first approach a pen and does not require the observer to enter the pen. The Reactivity Index captured livestock reactions to the close presence of the observer and was indicative of livestock responses to human activity within their environment. It is a simple, non-invasive, and practical method that can be applied as an alternative to other commonly adopted fear of human and avoidance tests. Flight distances are difficult to measure in a live export context where animals are closely confined and approaches to the pen side can be obstructed. Furthermore, recording flight distance captures the response of the most reactive animals within a pen, while Reactivity Index captures the responses of all livestock. The direct

assessment of stock handling was not feasible under this project; therefore, the Reactivity Index provided information on the experience of the entire pen of livestock when a stock person was in close proximity. Recorded by taking note of how livestock respond as the observer approaches and then stops at the pen side.

Estimate the percentage of the pen within one of the following categories:

- No response
- Look at observer
- Stood up in response to observer
- Retreat from observer
- Approach observer

Scientific basis: Exported livestock are predominantly sourced from extensive grazing enterprises. On entering the live export supply chain, they are exposed to frequent periods of human interaction and handling, and their responses to human presence and habituation to handling changes. Handling methods and intensity of animal management vary between supply chain sectors; the ability to measure livestock responses to human interactions is an important welfare consideration. Application of Reactivity Index on a cattle voyage during piloting showed that cattle were more reactive in the pre-export registered establishment, during the first and last days of the sea voyage and at the destination country feedlot. This provided an indication of how cattle were responding to close human exposure in new environments, and during the voyage where time to acclimatise occurred (Dunston-Clarke *et al.* In preparation). Therefore, Reactivity Index was found to be a useful indicator of the human-animal relationship in confined environments.

D2. Posture

Behavioural Elements 1: Activity and rest, 3: Heat response, and 5: Human-animal interactions

Recorded as the percentage (%) of the pen lying down.

Scientific basis: Data collected from voyages and in feedlot facilities identified livestock activity and rest patterns as the primary behavioural element. Posture is an important indicator with the percentage of animals observed to be lying down repeatedly associated with resting percentages and positive demeanour terms. These findings were particularly evident on pen-side assessments made in the afternoon or evening (Willis *et al.* 2021b). Stocking density during sea voyages is a pertinent issue, and posture observations taken on a twice-daily basis can indicate the provision of a suitable resting surface and sufficient space. Conversely, reduced ability to lie down may be related to unsatisfactory bedding surfaces, insufficient space, thermal discomfort, or poor pen harmony (Jørgensen *et al.* 2009; Napolitano *et al.* 2009; Sun *et al.* 2011; Richmond *et al.* 2017). This measure can also be applicable to other supply chain sectors. For example, markedly wet, muddy or flooded pen conditions in pre-export establishments that inhibit animals from lying down are likely to impact animal health later in the supply chain.

D4. Resting

Behavioural Elements 1: Activity and rest, 3: Heat response, and 5. Human-animal interactions

Percentage (%) of the pen resting (in a state of sleep or minimal activity and engagement with their environment; posture can be either standing or lying down).

Scientific basis: Resting is an essential behaviour and, when balanced with periods of activity and positive engagement with the surrounding environment, demonstrates the ability for livestock to adapt and cope with their surrounding environment (Piccione *et al.* 2008; Maloney *et al.* 2013). Data collected during this

project consistently identified resting and activity as dominant behavioural contributors in feedlot facilities and on voyages. Observations of sheep travelling from Australia to the Middle East showed that sheep on one voyage were likely to be described as lying down and resting during afternoon and evening assessments, particularly in the latter stages of the voyage (Willis *et al.* 2021b). The ability for livestock to rest appropriately during sea transport indicates a positive welfare outcome.

D5. Ruminating

Behavioural Elements 1: Activity and rest, 2: Mental state, and 3: Heat response

Percentage (%) of the pen chewing their cud.

Scientific basis: When piloting the proposed protocol, ruminating was identified as a contributing indicator under Behavioural Element 2 (mental state) as described in Section 4.1.1. When piloting the pen-side assessment protocol, cattle traveling from Northern Australia to SE Asia showed significant correlations between percentages of cattle ruminating and the demeanour terms *settled* and *content.* Cattle in pens with a high percentage of animals ruminating were also more likely to be resting, grooming, lying down, and less reactive to the proximity of the observer (Dunston-Clarke *et al.* In preparation). These findings demonstrate good welfare outcomes and show that these cattle were able to perform innate behaviours and essential physiological functions during sea transport. The inclusion of rumination as a welfare indicator has the potential to provide evidence of positive animal outcomes in a live export context.

D6. Negative engagement

Behavioural Elements 1: Activity and rest, 2: Mental state, and 5: Human-animal interaction

Percentage (%) of the pen performing one or more of the following behaviours — pushing, mounting, riding, aggressive interaction, persistently chewing, or other abnormal behaviour.

Scientific basis: The occurrence of behaviours such as aggression, pushing and engaging in abnormal behaviours can indicate negative affective states (Richmond *et al.* 2017). A confined environment has been found to increase the incidence of livestock aggression directed towards humans (de Vries *et al.* 2013). While incidences of negative behaviours are likely to occur, especially as livestock adjust to new environments and establish new social orders, elevated incidence and occurrence over many consecutive days can indicate a negative environment that may require changed management, such as adjusting stocking densities or the removal of bullies or subordinates.

D7. Positive engagement

Behavioural Elements: 1: Activity and rest, 2: Mental state, and 5: Human-animal interactions

Percentage (%) of the pen performing one or more of the following behaviours — self-grooming, allogrooming, affiliative social behaviour, exploring the environment or play.

Scientific basis: The project identified that when exposed to a new environment, cattle responded by exploring and positively engaging with their surroundings during a voyage from northern Australia to SE Asia (Dunston-Clarke *et al.* In preparation). It has been recognised that animals experience both positive and negative emotions (Wemelsfelder and Mullan 2014), and the absence of negative behaviour does not guarantee animals are experiencing good welfare (Napolitano *et al.* 2009). It is important that a welfare protocol is capable of capturing the occurrence of positive welfare states. The inclusion of play, exploration, social and self-grooming and affiliative social behaviours are all indicators of a positive emotional state (Napolitano *et al.* 2009; Richmond *et al.* 2017) and pen harmony.

D8. Panting score

Behavioural Element 3: Heat response

Recorded as a percentage of livestock at each panting score per pen. Panting score categories used in this study were sourced from Jubb and Perkins (2015):

Cattle	Sheep
0 – No panting	0 – No panting
1 – Slight panting, mouth closed, no drool or foam	1 – Slight panting
2 – Fast panting, drool or foam present, mouth closed	2 – Fast panting and open grin
2.5 – Fast panting, drool or foam present, occasional open mouth	3 – Open mouth panting
3 – Open mouth, some drooling, neck is extended, head is up	4 – Open mouth panting, tongue out
3.5 – Open mouth, excessive drooling, neck is extended, head is up, tongue is slightly out of the mouth	
4 – Open mouth, tongue is fully out of mouth, neck is extended, head is up	
4.5 – Open mouth, tongue is fully out of mouth, neck is extended, head is held down	

Current reporting requirements during sea voyages (ASEL 3.1) stipulate that panting scores are recorded as an average at a deck level. However, recording panting scores at a pen level is more likely to capture differences in individual animal responses to thermal challenge.

Scientific basis: Panting scores are currently recorded during sea voyages to indicate animal responses to hot and humid environmental conditions. However, as outlined in Willis *et al.* (2021a), panting is a physiological response and when measured in isolation has limited capacity to indicate the welfare implications and animal experience associated with hot humid conditions. During this study, panting scores observed by pen-side assessment increased in response to heat and humidity, as expected. Notably though, these changes in panting score were also associated with changes in activity and rest, demeanour, and health outcomes (Willis *et al.* 2021a, In prepration). Recording such measures can improve our understanding of the welfare impacts of thermal loading in a live export context, as well as the degree and duration of heat that types of livestock can cope with and respond to. These recordings can clarify when hot humid conditions are causing significant discomfort or distress, and are therefore meaningful to collect.

During hot humid conditions on sheep and cattle voyages, recorded heat responses changed significantly by voyage day and between morning and afternoon pen assessments (Willis *et al.* 2021b, In prepration). During a heat challenge, morning assessments can indicate whether periods of respite were experienced overnight, while afternoon recordings provide information on heat accumulation during the day. Therefore, in hot conditions we propose twice-daily recording of panting scores and other measures associated with heat responses (as outlined under Behavioural Element 3 in Section 4.1.1). In addition to these recommendations, a whole-of-supply chain approach to monitoring heat responses is strongly advised, as heat stress is a considerable animal welfare concern for specific destination markets during northern hemisphere summer periods.

D9. Feeding behaviour score

Behavioural Elements 3: Heat response, and 4: Feeding behaviour

Behaviour of livestock when fresh feed is delivered at the most recent feeding time prior to the pen assessment.

Observations were scored using the following categories:

- Disinterested (no animals attending troughs)
- Some interest (some animals eating, trough space available)
- Keen (no trough space available and animal waiting to attend troughs)
- Jostling (no trough space available, animals pushing to attend troughs)
- Aggressive/smothering (no trough space available, some animals pushing, climbing or lunging to attend troughs – high risk of injury)

Captured under LIVEXCollect at a deck level. Suggested to be recorded at a pen level on selected sample pens. Could be adopted at each sector of the supply chain.

Scientific basis: In the initial stages of the AWI project, feeding behaviour was identified as an important indicator of appetite, short term nutritional satiety, and the ability for animals to access troughs at feeding times (Willis *et al.* 2021a, 2021b). A scoring system was developed and has since been adopted as a daily reporting requirement on live export vessels. Nutritional management of livestock is an important element throughout the whole supply chain where animals can have significant periods of time off feed during land transport and during the inspection processes and procedures required for pre-export preparation. Livestock must also adapt to different feeding management systems between supply chain sectors. It can be beneficial to monitor feeding behaviour in other supply chain sectors to understand the impact of different nutritional management practices.

D10. Sailing conditions / stepping and balance

Behavioural Element 1: Activity and rest

Animal output categories to describe livestock behavioural responses to sea conditions as outlined in the SAWS report:

1. Calm: slight or no impact of sea swell on the ability of livestock to stand or rest
2. Moderate: livestock are stepping and making some stance adjustments but minimal balance problems
3. Rough: marked balance issues for livestock

Captured under LIVEXCollect on a daily basis during sea voyages.

Scientific basis: The effects of sea conditions on livestock is a significant societal concern. Although stress responses to short periods of simulated sea motion have previously been demonstrated in land-based studies on a small sample of sheep (Santurtun *et al.* 2014; Santurtun *et al.* 2015; Navarro *et al.* 2017; Navarro *et al.* 2020), the effects of sea conditions on livestock welfare during transit have not previously been documented. Positive correlations between scores describing sea swell and cattle behaviour were identified during this project. However, it proved difficult to accurately describe sea conditions during pen-side assessments. Therefore, a system to record sea conditions in relation to livestock stepping and balance was put forward in collaboration with the SAWS committee. The importance of this measure can be affirmed by AWI project findings relating to livestock behaviour during rough sea conditions.

D11. Demeanour terms (active, alert, anxious, dull, uncomfortable, settled, content, curious, sociable)

Behavioural Elements 1: Activity and rest, 2: Mental state, 3: Heat response, and 5: Human-animal interactions

Livestock demeanour is observed and each term is scored as 0 - 5, where 0 is indicative of the term not being expressed by the livestock at all, and 5 indicative of the term being expressed to the fullest by all livestock in the pen. Scoring remains considerate of context; for example, animals are able to be more 'active' in body movements in feedlot pens compared to farmyards or vessel pens. Current ASEL 3.1 requires AAVs and accredited stockpersons to select one demeanour term to describe a deck of livestock, daily. This method lacks sensitivity and does not detect variation in demeanour between individual animals or the range of demeanour expression exhibited by groups of animals. There is also no robust method to allow statistical analysis of such data. Ideally, all terms would be scored against a Visual Analogue Scale (VAS); however, until the adoption of a portable data collection interface and appropriate training of observers, the method proposed above may be more user friendly.

Recommended terms include:

- **Active**: energetic, lively, characterised by busy or lively activity (body movement and actions)
- **Alert**: wide awake, fully aware, attentive (how engaged the animals are with their surrounding environment)
- **Anxious**: showing worry, nervousness, or unease; increased vigilance behaviour
- **Dull**: lacking interest, dispirited, apathetic, slow moving, listless, lethargic
- **Uncomfortable**: showing signs of physical discomfort, unease, or irritation
- **Settled**: quiet, calm, relaxed and not tense
- **Content**: satisfied, peaceful, state of positive emotion, the animals have their needs being met
- **Curious**: showing a positive interest or curiosity towards surroundings
- **Sociable**: playful, confident, and friendly towards other animals, engaging with other animals, including nuzzling, grooming

Scientific basis: Demeanour terms are commonly used by stock handlers when describing livestock behaviour as the demeanour of animals reflects activity and their mental and emotional state. Methods to standardise the assessment of demeanour will provide information on the animal experience additional to exclusively recording activities, such as standing or panting scores (i.e. *what* the animals are doing). The establishment of methods for quantifying demeanour has been validated using robust experimental testing under a range of industry-relevant conditions including road transport (Stockman *et al.* 2011; Wickham *et al.* 2012; Stockman *et al.* 2013; Wickham *et al.* 2015; Collins *et al.* 2021). Assessment of demeanour has a strong foundation in good stock handling skills. Demeanour can provide detail on *how* animals are coping in their physical environment; for example, if livestock may be described as *dull* or *uncomfortable* during periods of stress, as opposed to other more neutral terms, such as *alert* or *active* during routine management. Reporting a measure of demeanour can, therefore, provide industry with the means to provide information about the animal experience and their mental state — an increasingly important aspect for addressing societal concern towards animal welfare.

The demeanour terms selected above describe positive, neutral, and negative states, with the project finding these terms to be appropriate for livestock under confined environments. Demeanour terms were found to correspond with animal responses to their environment and management. Livestock were described as *alert, active, curious* when engaging in active behaviours, *settled* when resting, *uncomfortable, listless* when responding to heat, and *curious* when engaging with humans. Demeanour terms were shown to vary across the duration of a voyage from northern Australia to SE Asia, where cattle were more reactive and engaged (*active, alert, anxious, curious*) at the beginning of a voyage, and more habituated and disengaged with their environment towards the end of the journey (*settled and content, or uncomfortable*

and frustrated) (Dunston-Clarke *et al.* In preparation). Assessments of demeanour can demonstrate livestock affective states, an important component of the Five Domains model (Mellor and Beausoleil 2015) and is currently the only measure available to quantify this. The importance of demeanour is detailed earlier in Section 4.1.1.

E. Animal health

E1. Nasal discharge

Percentage (%) of pen with serous or mucopurulent nasal discharge from one or both nostrils

Scientific basis: Nasal discharge can indicate inflammation or irritation of respiratory mucosa and is also recognised as an indicator of animal responses to heat challenge (Jubb and Perkins 2015). Data taken during two sheep voyages from Australia to the Middle East correlated nasal discharge with increases in wet bulb globe temperatures, increases in manure pad moisture, and heat response behaviours including increased panting scores (Willis *et al.* 2021a). Nasal discharge also has the potential to indicate animal responses to poor air quality (such as increased ammonia or dust).

E2. Ocular discharge

Percentage (%) of pen with serous or mucoid ocular discharge from one or both eyes.

Scientific basis: Ocular discharge is associated with irritation of the cornea and conjunctiva, and indicates animal response to infection, poor air quality, dusty environments, flies and other irritants (Jubb and Perkins 2015). Excessive lacrimation is associated with poor air quality and heat stress in sea transport conditions (Phillips and Santurtun 2013). This was evident in data derived from the piloted welfare monitoring protocol, with data showing that ocular discharge increased significantly at higher wet bulb globe temperatures during sheep voyages from Australia to the Middle East (Willis *et al.* 2021a).

E3. Pink eye

Number of sheep with conjunctival or ocular inflammation affecting one or both eyes.

Currently captured under LIVEXCollect only where animals require individual treatment or care. Recommended for inclusion in pen-side assessments.

Scientific basis: Pink eye in both cattle and sheep can be highly prevalent in the live export supply chain (Murdoch and Laurence 2014). Pink eye cases requiring treatment are currently reported during sea voyages; however, most cases do not require treatment and are, therefore, not recorded. Pink eye prevalence has been proposed for inclusion in pen-side assessments as cases not requiring treatment can still be a welfare concern. Pink eye is a painful condition associated with reduced access to feed and water, and difficulty handling livestock with vision impairment. AWI data taken on sheep voyages demonstrated localised areas of the vessel with a significantly higher prevalence (Willis *et al.* 2021a). Recording pink eye cases during pen-side assessments can improve our understanding of both the welfare impacts of pink eye, and factors contributing to disease prevalence.

E4. Scabby mouth

Number of sheep with ulceration or scabbed lesions affecting the lips, mouth, nose or face.

Currently captured under LIVEXCollect at a deck level on each voyage day when prevalence is >1%. Can be adopted at each sector of the supply chain.

E5. Individual cases of ill-health requiring treatment or resulting in mortality

Currently captured by LIVEXCollect at an individual animal level for the whole consignment during sea voyages, and as daily mortality rates in pre-export registered establishments. Records of ill-health beyond

mortality rates can be recorded in pre-export or destination market facilities where disease prevalence is deemed a welfare risk. Doing so will improve whole-of-supply-chain monitoring capabilities as disease prevalence is frequently associated with environment and management factors in earlier stages of the supply chain.

E6. Coat/fleece contamination

Scored as the modal score for the pen using the following categories as outlined in the SAWS report:

- Clean and dry
- Leg up to thighs contaminated
- Bellies also contaminated
- Upper body also contaminated

Scientific basis: Many internationally recognised welfare protocols use coat cleanliness as an indication of manure coverage of livestock (Welfare Quality® 2009; AWIN 2015; Kaurivi *et al.* 2020). This measure may indicate pen hygiene as contamination is related to the cleanliness and moisture content of the bedding surface (Munoz *et al.* 2018). In addition, fleece and coat contamination can impede an animal's ability to thermoregulate during cold conditions or heat stress and can lead to ill-health (Grandin 2016).

F. Resource access

F1. Pellet consumption

Behavioural Element 4: Feeding behaviour

Amount of feed as an approximate percentage of body weight per head per day (total pellet consumption for the decks for 24 h /total heads/ average body weight x 100).

F2. Roughage feeds

Behavioural Element 4: Feeding behaviour

Number of feeds to include long fibre roughage (chaff or hay) in the previous 24 hours.

Scientific basis: Long fibre roughage is essential for the maintenance of rumen health and is used on marine vessels as an adjunct to feeding shipping pellets. Identifying feed management strategies to optimise the benefits of long fibre roughage when managing feed consumption, feeding behaviour or heat stress has the potential to improve animal welfare outcomes.

F3. Feed quality

Scores the quality and palatability of feed using the following categories as outlined in the SAWS report:

- Satisfactory quality (no feed abnormality obvious)
- Minor feed quality issues (due to dust, reduced palatability, etc.)
- Major feed quality issues (due to dust, reduced palatability, substantial contamination, etc.)

F4. Access to potable water

The number of hours water quality or supply has been compromised or interrupted in the 24 hours prior to the pen assessment.

Records the approximate number of hours the supply of potable water has been restricted (for example, by mains supply interruption, marked trough contamination or inadequate access with animals queuing to attend the trough).

G. Pen environment

G1. Manure pad moisture and depth

Visual perception of the moisture content of the manure pad:

- Dry and dusty
- Firm
- Tacky
- High moisture
- Sloppy
- Flooded

Visual perception of the average depth (cm) of the manure pad:

- 0-5cm
- 6-10cm
- 11-15cm
- 16-20cm
- >20cm

Manure pad details are currently recorded using LIVEXCollect; however, the scores proposed here are deemed to be more considerate of all supply chain sectors and can be used to score manure pads in feedlot pens as well as shipboard pens.

Scientific basis: Manure pad depth and moisture can influence health and welfare due to effects on air quality, pen hygiene, fleece or coat contamination, comfort of resting surfaces, traction on flooring and freedom of movement within the pen (Jubb and Perkins 2015; McCarthy and Banhazi 2016). Measurements describing manure moisture were significantly correlated to health and behaviour during two sheep voyages (Willis *et al.* 2021a), while measures describing manure pad moisture and pad depth were correlated to behavioural outcomes such as activity and rest, and heat responses during two cattle voyages from Australia to the Middle-East (Willis *et al.* In prepration). A whole-of-supply chain approach to manure pad monitoring is recommended to facilitate effective risk mitigation strategies. For example, recognising optimal manure pad maintenance in pre-export establishments to minimise lameness prevalence during voyages and in destination facilities.

G2. Wet and dry bulb temperature, and humidity

Captured under LIVEXCollect at a deck level during sea voyages. Suggested for continuous automated recording on sample pens to provide information on micro-climates that occur within a deck. Can be informative if adopted at each supply chain sector to understand the whole of supply chain animal experience.

G3. Ventilation and air quality

Suggested for automated recording on sample pens to provide information on micro-climates that occur within a deck. Can be informative if adopted at each supply chain sector where animals are managed in intensely stocked pens. Future research is needed to clarify ventilation requirements during voyages.

G4. Noise

The effects of noise and vibration on livestock species is unclear but can have adverse effects depending on the exposure and intensity. Future research is needed to guide best management of noise, particularly on certain areas of the vessel.

2.3 Determine the level and type of training required for accurate data collection at each supply point (e.g. veterinary inspection required at some points?)

1. Training of observers is required to facilitate standardised data collection. Experience gained in training researchers, AAVs and accredited stockpersons throughout the AWI project and the development of the welfare dashboard protocol project, indicated that veterinary expertise was not required for pen-side reporting. However, the level of training required will likely vary between people, depending on their understanding of and motivation to collect indicators as well as their ability to use a digital data collection interface (Excel vs smartphone application).

2. It is recommended that a manual of training materials be produced to explain how each measure is collected, including images and, where required, video explanations. This resource will be vital, not only in the initial training of personnel, but also for use as a reference for LiveCorp Accredited Stockpersons and AAVs with ongoing use of the reporting platform. It is recommended that data collection sheets and reporting programs remain in English to maintain continuity of reporting. However, where welfare reporting is implemented across the whole supply chain, training materials should contain translation of specific terms to the first language of the intended user, assisting with observer understanding and collection of standardised data.

3. The frequency of ongoing training required to achieve and maintain standardised data collection between observers when scoring demeanour terms in a live export context is currently unknown. During the AWI project, a Bachelor of Animal Science student (Schoonens 2020) was enlisted for a pilot study to address inter- and intra-observer reliability when utilising a methodology called Qualitative Behavioural Assessment (QBA). Observers who scored livestock behaviour who were experienced in handling livestock, were compared to those with no prior experience. Observers were assessed on their ability to score cattle demeanour from videos using QBA after receiving rudimentary training in scoring techniques. Schoonens (2020) found that those who had experience working with livestock did not necessarily have better reliability in QBA scoring than those with no prior livestock handling experience. However, there was poor reliability between the observers participating in this study; this result contradicts findings of other QBA studies that have found a high level of agreement between observers after more comprehensive training in large groups (Wemelsfelder *et al.* 2001). Comprehensive training of observers is therefore likely required to achieve valid results between observers when scoring demeanour. Inter- and intra-observer reliability testing on all animal-based welfare indicators can determine the reliability of standardised scoring by people experienced in monitoring and reporting welfare indicators.

2.4 Determine if the data collected is meaningful in terms of welfare assessment (predictability of risk of adverse event)

Throughout the project, observers used indicators of animal welfare to describe and define meaningful animal responses to variations in environmental, resource and management conditions. Animal responses were documented in comparison to variable conditions or by differences between classes of livestock. Many of the animal outcomes described by the data demonstrated expected or previously documented responses to environmental and management conditions. For example, sheep and cattle were shown to habituate to stockpersons in their proximity during all sea voyages. Feeding behaviour scores were linked to pellet consumption, roughage access and trough space per head on one voyage (Willis *et al.* 2021a), while on another voyage, responses to heat and humidity differed between the same line of livestock penned in areas of the vessels with varying climatic conditions (Willis *et al.* 2021b). Although it was not

possible to pilot indicators under all possible environmental and management conditions, or for all types of livestock exported, it is anticipated that if poor conditions or adverse events occur, the proposed welfare indicators will sufficiently describe animal experiences during the event.

When using animal welfare data to predict risk, industry wide data collection can be used to identify trade practices with reliably positive outcomes, along with those that may cause significant welfare compromise, or unacceptable outcomes. Results from individual consignments cannot be used in isolation to predict risk but must be compared against a robust dataset gathered from repeated consignments. In the long-term, the collection of industry wide data, or repeated data from a specific supply chain, can facilitate the benchmarking of performance for individual exporters, livestock classes or marine vessels.

Sufficient industry data must be collected before welfare thresholds can be developed. It is estimated that data collected from multiple consignments over at least two years will enable the collection of sufficient replicates per trade route and season, pre-export facility, vessel type, destination feedlot, species, breed, and class of livestock. Industry data could then be analysed by an expert panel of industry stakeholders and animal welfare scientists to formulate industry appropriate thresholds for acceptable and unacceptable welfare risk, related to specific trade routes, season, species, and breed.

2.5 Identify challenges involved in the data monitoring of sheep and cattle across multiple supply chain points and potential solutions

Monitoring animal welfare throughout the live export supply chain raised the following challenges:

1. Marked differences in environmental, resource and management conditions between supply chain sectors created extensive variability in the type of stressors livestock are exposed to. For example, feedlot infrastructure and management can greatly differ between facilities within Australia and in destination countries (pen size, stocking densities, feeding management etc.).

   Differences between facilities were captured by ensuring all input indicators included categories encompassing the components predicted to significantly influence animal welfare outcomes. For example, the requirement for provision and type of shade varied between supply chain sectors. The protocol can be further refined in time to ensure critical variations between facilities are recorded. Comprehensive animal-based indicators have been included within the protocol; ergo, it is predicted that they will be sensitive to health and behavioural responses that may arise due to variable environment or management practices.

2. Monitoring target livestock from individual sources throughout the supply chain is challenging. Mixing of livestock from various sources occurs at the pre-export registered establishment, prior to loading on the vessel, and in destination feedlots. The total number of head per pen varies across all sectors of the supply chain, making it impractical to follow the same cohort of animals from the beginning to end of their journey. Importantly, the number of livestock in pens at feedlots were often >200 for sheep and >100 for cattle, while on the vessel, sheep pens held 30-60 animals, and cattle pens 7-40 animals (varied with vessel design). It was not possible to observe and compare individual livestock from different sources at the pre-export facility, during the voyage and again at the destination feedlot. This complicates comparisons of data between supply chain sectors. It is currently not logistically feasible for industry to individually mark a representative sample of livestock to follow throughout the entire supply chain, nor ensure they are penned together throughout the journey. Furthermore, it is difficult to make accurate pen-side welfare assessments on selectively marked animals while they are penned with other livestock.

Researchers ensured that the same livestock were assessed throughout the supply chain by selecting several large pens of each specific livestock class at the pre-export registered establishment, then several pens of the same class of livestock on the marine vessel, followed by selecting the same livestock classes upon arrival in destination feedlots. Thereby, livestock in specific targeted locations were assessed during voyages and it can be reasonably assumed that these same animals were monitored throughout other supply chain sectors. This is a method that could be adopted for following a cohort of livestock if welfare monitoring is conducted along the supply chain.

3. Standardised data collection between observers and between various sectors of the live export supply chain is also a challenge. This can be addressed through comprehensive and ongoing training of observers, applying indicators with a well-defined collection methodology, and using standardised language to facilitate comparable welfare data collection across the supply chain.

2.6 Identify whether differences in animal management can be detected by the QA dashboard.

The AWI project identified that animal welfare indicators can be used to describe differences between environments, resource access and livestock management.

- As described in Willis *et al.* (2021a) the proposed protocol encompasses input indicators that cover all commonly predicted environmental, resource and management variations, while using animal output indicators that describe how different classes of livestock respond to varying conditions.
- Pen-side assessments detected differences in animal responses at different stages of two sea voyages transporting sheep from Australia to Oman as described by Willis *et al.* (2021b).
- To provide an example of a particular indicator developed and tested under this project, Feeding Behaviour Score is an animal output measure that reflects the level of competition for food and reflects the accessibility of troughs and the amount and palatability of feed available. This measure can be used to record information used by stockpersons, AAVs and feedlot staff as they manage feed resources.
- Long-term monitoring of livestock responses compared to the associated environmental and management variables can be used to predict how livestock may respond to certain conditions, with deviations in responses being detectable once a base knowledge is achieved.

3. Milestone objectives

This milestone contains five objectives:

3.1 Introduction, materials and methods, statistical methods, results, and discussion

This project commenced in August 2017 and collected data from eight consignments to various destination markets across the Middle East and South East Asia. Data were collected at various sectors of the supply chain, including on farm (two sheep farms in Western Australia), in pre-export registered establishments across Western Australia, the Northern Territory and Queensland, on ships, in destination feedlots and for one consignment, in trading pens at the slaughterhouse.

The statistical analysis, results and discussion for this project are detailed in publications outlined under Objective 3.5.

3.2 Digital copy of all project data (including metadata) from the project analysis provided to MLA in Microsoft Excel format

Supplied.

3.3 Short PowerPoint Presentation outlining key outcomes for industry stakeholders

Supplied.

3.4 Magazine article summarising the project outcomes for stakeholders (600 words maximum) with 1 high resolution photo

Supplied.

3.5 Scientific publications and theses

Published:

- Ursula M.C. Anthony (2017) Feasibility and observer consensus of real-time and video welfare assessments of sheep in the domestic live export industry. Honours Thesis, School of Veterinary and Life Sciences, Murdoch University.
- Dunston-Clarke *et al.* (2020) Developing an Animal Welfare Assessment Protocol for Livestock Transported by Sea, *Animals*, 10(4): 705.
- Ebony R. Schoonens (2020) Determining observer reliability for the scoring of beef cattle using Qualitative Behaviour Assessment. Honours Thesis, School of Veterinary and Life Sciences, Murdoch University.
- Willis *et al.* (2021) Animal welfare indicators for sheep during sea transport: The effect of voyage day and time of day, *Applied Animal Behaviour Science*, 238: 105304.
- Willis *et al.* (2021) Australian Livestock Export Industry Workers' Attitudes toward Animal Welfare. *Animals*, 11: 1411.
- Willis *et al.* (2021) Animal welfare indicators for sheep during sea transport: monitoring health and behaviour. *Applied Animal Behaviour Science*, 24: 105354.

- Collins *et al.* (2021) Feasibility of a sheep welfare assessment tool in the pre-export phase of Australian live export industry. *Frontiers in Animal Science – Animal Welfare and Policy*: Accepted Manuscript 31st May 2021, 687162

Fully drafted (to be submitted to the Management Committee shortly):

- Dunston-Clarke *et al.* (In preparation) Variations in cattle behaviour during sea transport from Australia to South East Asia. To be submitted to *Animal Frontiers*.
- Dunston-Clarke *et al.* (In preparation) Animal welfare indicators for cattle during short-haul voyages: the effect of voyage day, time of day and deck. To be submitted to *Applied Animal Behaviour Science.*
- Willis *et al.* (In preparation) Animal welfare indicators for cattle during sea transport: monitoring health and behaviour. To be submitted to *Applied Animal Behaviour Science.*

Other documents in preparation:

- Renée S. Willis (In preparation) Doctor of Philosophy Thesis, Murdoch University.
- Sophie Ellis (In preparation) Qualitative Behavioural Analysis to investigate cattle demeanour during sea transport: time of day and time of voyage. DVM p=Project thesis, School of Veterinary and Life Sciences, Murdoch University.
- Dunston-Clarke *et al.* (In preparation) Developing an Animal Welfare Assessment Protocol for Livestock Transported by Sea: Assessing the feasibility of identified indicators. To be submitted to *Animal Frontiers*.

4. Project limitations

As this was an applied project, some limitations arose in the data collection phase, described below:

- The initial list of indicators and method of collection (time point and frequency) was amended throughout the project. Collection techniques were refined for each consignment and progressively applied to the pen-side assessment protocol; this created some inconsistencies for statistical analyses between consignments.
- The limited availability of accommodation on vessels prevented researcher access for some proposed voyages. For six of the eight voyages, a researcher was required to fulfil many shipboard roles alongside the collection of data. Additional roles included the AAV, head stockperson and on one occasion, the reporting role *in lieu* of an Independent Observer (IO). This reduced their capacity to conduct assessments on all pens at all three time points throughout the voyage, and also limited the number of pens that could be monitored during each pilot voyage.
- Data collection for the four South East Asia voyages occurred over three years. Subsequently, the list of indicators, sample frequency times, and method of application showed some variance, thus, comparisons between voyages for some indicators were limited.

Throughout the duration of the project, the industry has incorporated many operational changes. Some of these have subsequently impacted the project:

- Independent Observers (IOs): The Department of Agriculture, Water and the Environment required vessels leaving Australia to travel with an IO from April 2018. Vessels have limited crew space and the introduction of the IO program restricted the opportunity for researchers to be accommodated on vessels.
- Australian Government imposed travel restrictions associated with COVID-19 prevented the research team from collecting data on one final South East Asian consignment.

Indicators applicable for loading/unloading and road transport were not tested or considered by this project. Therefore, industry may consider the inclusion of other animal-based and stockperson interaction indicators to account for these specific supply chain sectors.

5. Project conclusion

The proposed protocol includes animal-based indicators that capture welfare outcomes under different environmental, resource and management conditions throughout the live export supply chain. By piloting the proposed protocol in various supply chain sectors, a pen-side assessment dashboard has been developed using indicators that are considerate of industry conditions. The AWI project has outlined the benefits of different sampling frequencies, with daily or twice-daily monitoring most informative where livestock may be exposed to high-risk conditions. The selection of representative sample pens has been investigated and recommendations have been made for consideration; however, the degree of variability between pen conditions and classes of livestock was found to be significant. It was not feasible to determine a precise number of pens required to provide a representative sample for each measure for an entire consignment of livestock. Consideration has been given for the personnel who will likely be making welfare assessments, with training of observers required to facilitate standardised data collection. The use

of a smartphone application interface when making assessments has been described, which will reduce recording times and improve the accuracy of reporting.

The live export industry has already implemented many of the AWI project's findings via the SAWS Committee report and the introduction of LIVEXCollect as the reporting system. This final report for the AWI project provides additional animal welfare indicators to be considered for adoption in various sectors of the live export supply chain. The additional indicators are complementary to those required under ASEL 3.1 or suggested by the SAWS Committee; and they address Welfare Quality® principles 'Appropriate Behaviour' by providing information on comfort around resting, mental state, heat response, feeding behaviour and human-animal interactions. Industry can consider adopting all or some indicators, according to the purpose of assessment and reporting, as outlined in this document.

Adoption of an evidence-based welfare monitoring protocol provides industry with the opportunity to capture information useful for informing future regulatory reviews and to proactively address societal animal welfare concerns. In real-time application, the protocol has the potential to be used for early identification and management of risks as consignments are transported. Efficient data collection and reporting systems will enable risk assessments and management decisions to be timely and reportable, while permitting improved animal welfare outcomes over time.

5.1 Key findings

Key findings from the project are:

- The protocol enables welfare monitoring of slaughter and feeder cattle and sheep via pen-side observations of animal health and behaviour, using existing measures and 23 new indicators throughout the live export supply chain.
- Analysis of eight consignments established five elements of behaviour that contribute to understanding the animals' response to their environment and hence their welfare (1. Activity and rest behaviour, 2. Mental state, 3. Heat response, 4. Feeding behaviour, 5. Human-animal interactions). Larger datasets could identify additional welfare elements as not all environmental, resource or management challenges were experienced in our eight consignments; for example, high disease prevalence.
- Daily monitoring on vessels captures animal responses to management and environmental conditions encountered during a sea voyage. Daily monitoring of indicators could be applied to other sectors of the supply chain if required.
- Twice-daily reporting of some indicators (panting scores, activity and resting behaviour, demeanour) provides information on daily heat loading or respite periods, diurnal behaviour, comfort around resting and animal experience. Twice-daily reporting of indicators could be applied to other sectors of the supply chain if required.
- Monitoring of pens that are exposed to different environmental, resource and management conditions can capture the range of variables and the corresponding animal responses.
- Monitoring of different species and classes of livestock in each consignment captures variations in animal responses and their capacity to adapt to conditions. This data will aid management and selection of livestock in risk mitigation.
- Long-term, industry-wide adoption of the protocol will enable the collection of robust and standardised data regarding animal welfare outcomes for all Australian livestock export supply

chains. Such data could be used for industry performance benchmarking, to increase industry transparency and inform risk management and mitigation strategies.

5.2 Benefits to industry

5.2.1 Practical application of the project insights and implications to the red meat industry

The AWI project provides animal welfare indicators for slaughter and feeder cattle and sheep to address the current understanding of animal welfare science by providing a framework for a holistic evaluation of animal welfare. The benefits of adopting individual indicators have been outlined in this report, as have the benefits of different observation frequencies. The full implication for industry will not be evident until large data sets are collected and statistically analysed for benchmarking.

Due to changes adopted by the live export industry in recent years, some animal welfare indicators proposed by this project have been included in the reporting requirements of ASEL 3.1. The adoption and application of LIVEXCollect means industry has made significant progress towards the collection of standardised data to meet ASEL 3.1 reporting requirements. The SAWS report provides industry specific advice on the collection of additional animal welfare indicators underpinned by this project. Adoption of the additional indicators under the current LIVEXCollect system over a period of time could enable standardised data collection that can facilitate industry to better communicate, benchmark, and increase transparency.

5.2.2 Benefits to the wider red meat industry as a result of this project and its outcomes

The AWI project provides an industry specific animal welfare protocol that is applicable to most sectors of the live export supply chain. Adoption of the project findings will demonstrate that the live export industry takes a progressive and scientific approach to animal welfare and is responding to community concerns. This has the capacity to promote consumer confidence in production animal industries as a whole.

Although the proposed protocol was not tested as a long-term monitoring protocol for farm and feedlot locations, the indicators are applicable to these locations, and others such as saleyards, and could be considered for use by other cattle and sheep producers.

6. Future research and recommendations

6.1 Future research and development

- It is recommended that the industry should determine the specific purpose of welfare monitoring, so that the protocol can be tailored for broad industry benchmarking or to address specific objectives or risk factors. This will inform the extent of data collection (number of sample pens) and human resource allocation.
- For known risk factors (e.g. pen location, stocking density, livestock class), a specifically designed project using the protocol will identify the variability in conditions and assist in determining ways to mitigate such risk.
- Adoption of the protocol across all voyages would provide large, standardised data sets suitable for statistical analysis and permit robust industry benchmarking. Gaining this knowledge would permit better management of resources and bring animal welfare and production benefits.

- It is recommended that studies into the effect of air quality and ventilation capacity, and noise levels be performed. These will require specific technology and equipment.
- To determine thresholds for acceptable welfare outcomes, it is suggested that a panel of industry stakeholders and animal welfare scientists be convened to review the industry data. These thresholds could be set for performance by species, breed/class, trade route, season, and vessels, and allow welfare improvements over time.
- Livestock handling during loading and unloading of trucks and vessels is known to be potentially stressful for animals. Further study is recommended to develop indicators to quantify animal welfare during times of handling. A whole supply chain approach to animal welfare monitoring could incorporate assessments of human-animal interactions during livestock handling.
- Further research to establish if the proposed indicators are applicable to other exported livestock species; specifically, breeding animals, such as dairy cattle, and buffalo.
- A study into inter-observer and intra-observer reliability for some of the newer welfare indicators can report on the level of initial and ongoing training required.
- Further research into automated or remote monitoring of animal behaviour, such as posture activity and panting, where applicable, would likely improve monitoring efficiency.

6.2 Practical application of the project insights

The AWI project has developed and tested an extensive list of science-based animal welfare indicators, has assisted in formulating the SAWS report, and has been instrumental in the development of LIVEXCollect reporting. Insights presented justify the adoption of the list of indicators in an industry specific welfare monitoring protocol.

6.3 Development and adoption activities which would ensure the red meat industry achieves full value from the project's findings

- Industry wide adoption of the protocol to gather robust data sets for analysis would provide significant additional value from the project's findings.
- A training manual and detailed collection methodology will assist in the uptake and standardisation of data collection. The industry has provided support to stockpersons and AAVs to assist in fulfilling the new reporting requirements by ASEL 3.1; this material could be further developed to assist with the adoption of additional welfare indicators suggested by the AWI project.

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