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Revision of the heat stress risk assessment methodology to properly incorporate risk of heat stress while at port

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Abstract

The existing methodology for estimating the heat stress risk for livestock destined for Middle Eastern ports has been used successfully for a number of years. While the methodology provides an adequate approach to mitigating heat stress risk while sailing, the approach does not explicitly address heat stress risk during discharge for open decks. The described study extends the existing methodology to address this issue. Risk estimates for both the sailing and discharge components of the voyage are incorporated in the revised methodology as well as the functionality for the separate treatment of each Middle Eastern port and for voyages discharging at multiple ports.

As part of the study, the software has been moved to a more up-to-date development environment and updated to incorporate the new methodology, improve a range of features and fix a number of problems with the previous version.

Executive summary

The purpose of the study described in this report is to revise the methodology used to estimate the heat stress risk to livestock on sea voyages to the Middle East. The revision is focused on improved treatment of risk on open decks during the discharge phase of the voyage. En-voyage the new methodology also does not allow reliance to be placed on crosswinds any greater than 5 knots, rather than being left to the discretion of the user. The revised methodology is implemented in version 3.0 of the Heat Stress Risk Assessment Model (HotStuff). This supersedes the previous version 2.3. Readers of this report are assumed to have knowledge of the earlier work and the HotStuff approach generally.

The revised methodology introduces a port-specific heat stress risk estimate, which should be considered independently of the voyage risk estimate. The two risks estimates have been implemented in the HotStuff software as:

1) For the sailing component of the voyage, heat stress risk for both open and closed decks is assessed on the worst case web bulb temperature distribution.
    a) For closed decks, there must be sufficient pen air turnover (PAT) to achieve a 2% or lower risk of a 5% mortality.
    b) For open decks, a “minimum crosswind” no greater than 5 knots must be sufficient to achieve a 2% or lower risk of a 5% mortality.

2) For the discharge component of the voyage, the heat stress risk for both open decks and closed decks is assessed against a port-specific wet-bulb temperature (T_{WB}) probability distribution.
    a) For closed decks, the heat stress risk is assessed in the same way as for the sailing component of the voyage, but with a port-specific T_{WB} distribution developed from land based data for the majority of Middle Eastern ports, as discussed in the W.LIV.0267 report. That is; there must be sufficient PAT to achieve a 2% or lower risk of 5% mortality when assessing against the port-specific T_{WB} distribution.
    b) The crosswind at port is assumed to be zero. For this reason, the heat stress risk assessment considers the effects of natural convection and mechanical ventilation only. There must be sufficient PAT to achieve a 2% or lower risk of 5% mortality when assessing against the port-specific wet-bulb temperature distribution.

The wet bulb temperature distributions used in the methodology as described in this report include:

- The same T_{WB} distributions used in Hotstuff version 2.3 based on the analysis of oceanic zones for the sailing component of the voyage. These distributions are not port specific.
- Land based T_{WB} distributions for seven of the ten ports and VOS based T_{WB} distributions for the remaining three ports for the discharge component of the voyage (Adabiya, Dhahran, Muscat). Only the T_{WB} distributions used for the discharge component of the voyage for these three ports are based on the revised data analysis approach as discussed in the report.

Revised data analysis has been undertaken for the sailing component of the voyage. The results of the revised data analysis are not used in the current implementation for the sailing component of the voyage.

The development work completed during the study also involved a major upgrade of the HotStuff software including porting the software to a new development environment to ensure continued maintainability of the software and improved opportunities for future enhancement. Significant new features have also been added to the software such as:

- The ability to generate risk profiles over a whole year for a particular voyage type and stocking configuration.
- The ability to select different base stocking density tables.
- Improvement of a number of other aspects of the software, including; the security of the database, visual indication of stocking levels, and improvements in the consistency of calculation methods have also been undertaken.

Included in the updated HotStuff software is a change in the weather component of risk analysis (see Section 2.3.1); animal thresholds are unchanged.

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1 Introduction

The existing methodology for estimating the heat stress risk for livestock destined for Middle Eastern ports has been used successfully for a number of years. Heat stress risk estimation procedures are embodied in the Heat Stress Risk Assessment Model software (known as HotStuff), the acceptable output of which is a prerequisite for all Middle Eastern voyages. While the methodology used provides an adequate approach to mitigating heat stress risk while sailing, the approach does not address heat stress risk at the discharge port for open decks. This report describes an extension to the existing methodology and software implementation to address this and other issues.

1.1 Background

This project follows a number of previous studies by AECOM related to the Heat Stress Risk to Livestock on Sea Voyages. These projects include:

- SBMR002 Original literature review, Voyage, observations and analysis
- LIVE.116 Development of a Heat Stress Risk Model
- LIVE.212 Ventilation of Sheep Vessels
- LIVE.228 HS Review
- LIVE.229 The Effects of Jetting on Heat Stress in Livestock

The documentation in this report assumes that the reader has a reasonable understanding of the material covered in the previous reports (particularly LIVE.116) and the associated outcomes. A good understanding of the basics of the methodology described in the LIVE.116 report is an essential prerequisite to understanding the modifications to the methodology described in this report.

1.2 Purpose and Description of the Current Study

The prior method for estimating the mortality risks for livestock on open decks did not adequately assess the risk of incidents where there is a lack of required cross wind, especially while unloading at port. The improvement of the risk estimate approach for open decks is vital to the continued good management of animal welfare within the industry. The purpose of the current study is to extend the current methodology to deal directly with the risk of a heat stress incident while at the discharge port. The study also involves incorporating the new port-specific risk estimate methodology into the HotStuff software. It will help the industry mitigate the risks of mortality events on open decks.

During the initiation phase of the current study, the intention was to use sea surface temperature data and related methodology to develop a revised risk estimate approach for open decks at discharge. After initial investigation and consultation with industry, a sea surface temperature approach was considered to be unacceptable, due to the embedded assumption that the effects of cross wind at the ports are not considered. For this reason, an alternative approach was adopted using port-specific wet-bulb temperatures to generate a port-specific risk estimate. The port-specific wet-bulb temperature approach and the shortcomings of the sea surface temperature approach are described in more detail in Sections 2.3 and 2.2 respectively.

1.2.1 Objectives for the Study

The initial objectives for the study were:

1. Develop revised methods for calculating open deck mortality risk estimates based on both historical and real-time sea surface temperatures
2. Upgrade the HotStuff software to VB.Net
3. Repair current problems with the existing version of the software including printing problems with some installations, compatibility issues with newer operating systems and access to database files
4. Implement the revised methods for risk assessment in the HotStuff model and deliver an updated version and associated manual/support material
5. Communicate to industry stakeholders the changes to HotStuff through 3 workshops.

The objectives relating to the use of historical and real-time sea surface temperatures were revised as the project evolved.

2 Methodology

2.1 Existing Methodology as Described in LIVE.116 and Implemented in HotStuff 2.3

A number of studies were conducted in the late 1990s through to 2001 in response to systemic weaknesses in the understanding of risk factors and in the corresponding standards and procedures, exposed through a number of mortality incidents in livestock exported to the Middle East. The studies were coordinated by LiveCorp and MLA, managed principally by Dr Conrad Stacey of AECOM Australia and Dr Simon More of AusVet Animal Health Services and were targeted at understanding and documenting the science relating to heat stress, ventilation and salmonellosis issues relevant to livestock export by sea.

Using the scientific understanding of the causes of heat stress established during these studies, a software tool (HotStuff) was developed in a subsequent project to provide a means of calculating heat stress risk estimates. The software captures weather statistics, animal parameters, ship and stocking parameters, and develops heat stress risk estimates through a comparison of the risk of high on-deck wet-bulb temperatures with the ability of the livestock to withstand such conditions.

The heat stress risk methodology employed in HotStuff is described in detail in the LIVE.116 report “Development of a Heat Stress Risk Management Model”. The basic concept behind the production of a heat stress risk estimate is explained below and shown graphically in Figure 2-1.

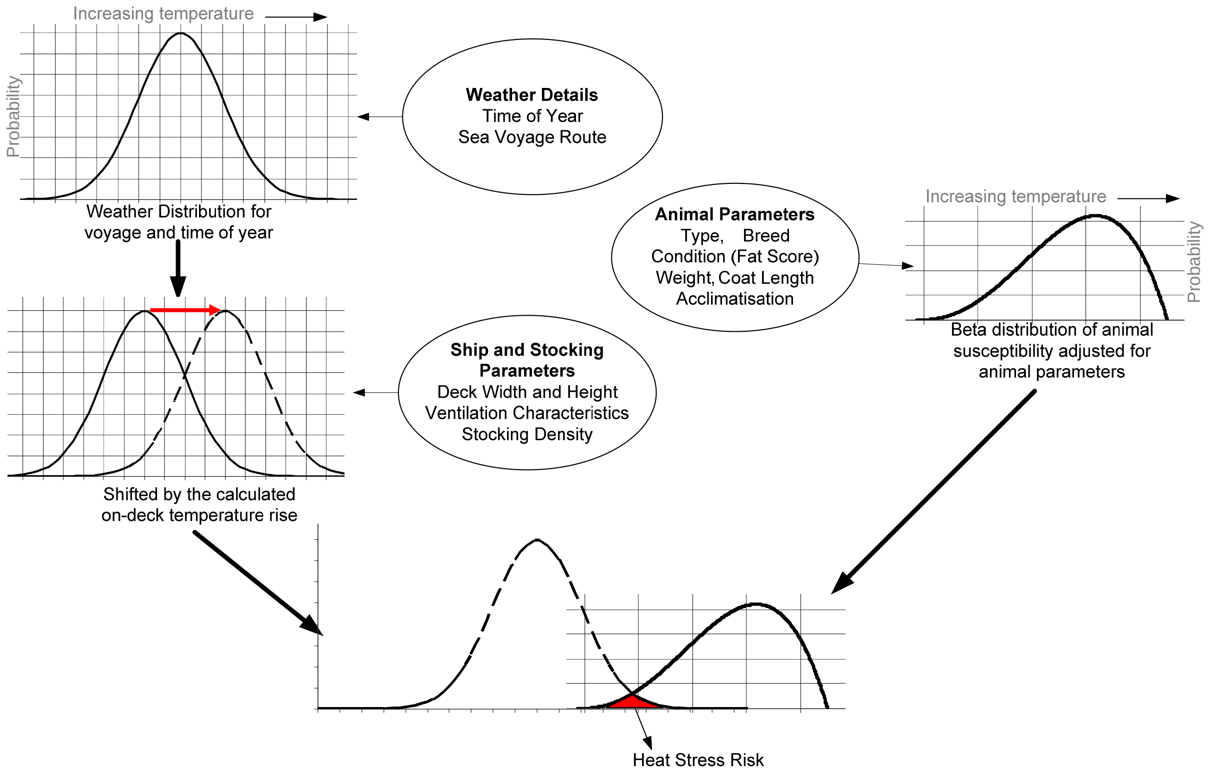

Figure 2-1: Summary of the Risk Estimate Methodology

2.1.1 Capture of Weather Details

The risk assessment methodology includes consideration for acclimatisation conditions, weather en route and weather at the destination. Wet-bulb temperature distributions for each month and zones of roughly constant climatology were developed from the Voluntary Observing Ships (VOS) dataset obtained from the National Climatic Data Center. Temperature distributions were adjusted to be consistent with available landside data which were considered to be more reliable. For a particular voyage route and time of year, the appropriate wet-bulb temperature distributions are sampled, providing the likelihood of a particular wet-bulb temperature being reached or exceeded.

2.1.2 Animal Parameters

Using available mortality limit data, beta distributions which describe mortality (proportion of livestock) as a function of wet-bulb temperature are configured to reference animals for each livestock type. Scaling factors related to weight, acclimatisation zone, condition and coat type are used to adjust the reference beta curve to reflect each stocking line.

2.1.3 Ship and Stocking Related Influences

The on-deck wet-bulb temperature rise is influenced by the heat generated by the livestock and the amount of airflow available to remove it. Heat generation is driven by metabolic rate and stocking density and the fresh air flowrate is measured as pen air turnover (PAT) for closed decks, or as a crosswind on open decks and converted to an effective PAT.

2.1.4 Heat Stress Risk Estimates

Calculation of the risk of heat stress for a particular stocking line is a process of estimating the wet-bulb temperature which would cause 5% mortality and then finding the same temperature, adjusted by on-deck temperature rise, on the voyage temperature probability distribution to determine likelihood of occurrence.

2.1.5 Shortcomings of the Existing Methodology

The existing methodology uses the worst case wet-bulb temperature distribution for each voyage to determine heat stress risk. This approach is effective for the sailing component of the voyage where the heat stress related mortality rate on both open and closed decks is driven predominately by the highest wet-bulb temperatures. The approach is also effective for closed decks at the destination port since the closed decks are ventilated by the same means, whether they are at the destination port or en route.

However, at sea, open decks are ventilated primarily by crosswind and mixing induced by the forward speed of the vessel. When in still air, and motionless in port, ventilation is only through mechanical plant and natural convection. For this reason, it is possible that the primary risk of heat stress for livestock on open decks may be at the port where wet-bulb temperatures are lower than those encountered while sailing (i.e. not worst case), but where there is no cross wind ventilation to minimise the on-deck wet-bulb temperature rise. There is no specific assessment of this risk in the methodology implemented in HotStuff 2.3. To assess heat stress risk for open decks properly two risk calculations are required, based on different conditions, either one of which could give the higher risk. The two conditions are:

1) The worst case voyage wet-bulb temperatures with consideration for crosswind (or mixing due to vessel speed).
2) Port-specific wet-bulb temperature without consideration for crosswind or vessel motion.

2.2 Sea Surface Temperature and the Original Intentions for the Study

The original intention for this study was to use sea surface temperature (SST) as a proxy for wet-bulb temperature at the port of discharge. SST gives an indication of the wet-bulb temperature that may be achieved if the wind speed at the port drops to zero. It is under conditions of little or no wind that heat stress incidents at the port of discharge are most likely. SST also changes relatively slowly over time and SST data can be accessed via satellite. This enables reliable predictions to be made a week or so out from arriving at the port of discharge.

The relative heat stress risk of discharging livestock at a particular port in the Middle East is influenced by the wind speed statistics at the port. Using SST as an indicator of the possible wet-bulb temperature, in the place of actual wet-bulb temperature data, implies an assumption that wind speed is neglected in port risk estimates. Since different ports have different wind speed statistics, neglecting the influence of wind speed has different effects on the risk estimates for each port. Reliable wind speed data at the ports are unavailable.

Preliminary SST data analysis for discharge ports in the Middle East was undertaken followed by an industry workshop. Questions were raised about the use of SST as a proxy for wet-bulb temperature when it became evident that Kuwait, which has similar SST's to Muscat (although later in the year), may receive similar treatment in the discharge risk analysis. Shippers and exporters have anecdotal knowledge that Kuwait is generally a much less risky port for discharging livestock and reasonably expected the calculated estimate to reflect this.

The outcome from the workshop was that the assumption that the crosswind will drop to zero in port would produce an unfair relative treatment of the port risk, and possibly inappropriate absolute risk results. As a result, port-specific wet-bulb temperature is used to develop port-specific risk estimates for open decks. The wet-bulb temperature will generally not reach the SST when there is wind, and so the move from SST to T_{WB} as a measure is a de-facto inclusion of wind statistics, when accurate wind data are not available for use directly. A detailed description of the methodology used is provided below. SST may still be useful as an indicator of risk approaching the time of discharge and more investigation into the use of SST data for the improvement of heat stress risk estimates is warranted to aid understanding of port conditions.

2.3 Revised Methodology

The revised methodology for estimating the risk of heat stress produces two risk estimates:

1) The risk of 5% mortality in each stocking line en route.
2) The risk of 5% mortality in each stocking line at the ports of discharge.

For the en route risk calculations (sailing component of the voyage), risk is calculated using the oceanic zone encountered during the voyage with the highest T_{WB} distribution.

For closed decks, the method of ventilating the deck remains the same throughout the voyage. In the case of open decks, methods for ventilating the deck vary throughout the voyage. While sailing, crosswinds, or at least mixing by buffeting, can be generated to provide deck ventilation. While berthed, natural convection or mechanical ventilation is required to ventilate open decks in cases of little or no prevailing crosswind. Given different methods and effectiveness of ventilation on open decks for different components of the voyage, the limiting risk may not be at the location of the worst ambient conditions. The previous approach captured the heat stress risk while sailing, but did not include a risk assessment applicable while discharging. The revised methodology extends the previous approach by:

- Using the same approach while sailing. This uses the worst T_{WB} distribution for the voyage, with a deck T_{WB} rise that considers the influence of crosswinds. The revised methodology does not allow reliance to be placed on crosswinds any greater than 5 knots.
- Using a port-specific assessment during discharge. This uses a port-specific T_{WB} distribution with a deck T_{WB} rise that considers only mechanical ventilation on the deck, with zero crosswind.

The methodology for assessing closed and open decks is consistent, with explicit treatment of both the sailing and discharge components of the voyage. However, the risk assessment outcomes may differ depending on the deck characteristics and conditions. Either the sailing risk or the discharge risk may be the limiting risk for open decks, because the ventilation methods for the two components of the voyage are different.

The described methodology has been implemented in the HotStuff software as:

1) For the sailing component of the voyage, heat stress risk for both open and closed decks is assessed on the worst case wet-bulb temperature distribution. “Worst case” is taken

as the oceanic zone along the appropriate voyage route with the highest wet bulb temperature distribution during the time of the voyage.

   a) For closed decks, there must be sufficient PAT to achieve a 2% or lower risk of a 5% mortality
   b) For open decks, a crosswind during the voyage of only 5 knots must be sufficient to achieve a 2% or lower risk of a 5% mortality

2) For the discharge component of the voyage, the heat stress risk for both open decks and closed decks is assessed against a port-specific wet-bulb temperature distribution. The port-specific distribution for the majority of Middle Eastern ports is developed from land based data as described in the W.LIV.0267 report and may be higher or lower the worst case voyage distribution, depending on the port and time of year.
   a) For closed decks, the heat stress risk is assessed in the same way as for the sailing component of the voyage, i.e. there must be sufficient PAT to achieve a 2% or less risk of a 5% mortality when assessing against the port-specific wet-bulb temperature distribution.
   b) For open decks, the crosswind at port is assumed to be zero. For this reason, the heat stress risk assessment considers only the effects of natural convection and mechanical ventilation. That is, there must be sufficient PAT to achieve a 2% or lower risk of 5% mortality when assessing against the port-specific wet-bulb temperature distribution.

The heat stress risk for both the sailing and the discharge components of the voyage must be satisfied for all stocking lines.

2.3.1 Revision of Weather Data

The revised methodology incorporates two sources of wet-bulb temperature distributions for the discharge component of the voyage:

1. One is derived from land based data and used for seven of the ten ports. Treatment of the land based data is described in more detail in the W.LIV.0267 report.
2. The other is derived from the VOS data points in close proximity to a particular port. This approach is used for the remaining three ports (Adabiya, Dhahran, Muscat). The data analysis methodology used is discussed in section 3.4. Only the T_{WB} distributions used for the discharge component of the voyage for these three ports are based on the revised data analysis approach as discussed in the report.

The wet-bulb temperature distributions used for the sailing component of the voyage remain based on the analysis of oceanic zones as discussed in section 2.3 of the LIVE.116 report and used in version 2.3 of the software.

Revised data analysis has been undertaken for the sailing component of the voyage. The results of the revised data analysis are not used in the current implementation for the sailing component of the voyage and are not documented in this version of the report.

3 Updated Weather Analysis

3.1 Introduction

The weather data used for previous heat stress risk estimates are separate wet-bulb temperature distributions for each month and each of four different voyage types (northern and southern Australia to the Red Sea and the Gulf). Normal distributions were fitted to all 48 distributions and the 98th percentile (2% risk) wet-bulb temperature for a particular arrival day and port was interpolated from the appropriate normal distributions. The weather data analysis therefore supported a risk estimate that:

- Considered the wet-bulb temperature over the voyage, but not the port-specific conditions.
- Was previously the same for all ports in the Red Sea and similarly treated all ports in the Gulf identically.
- Considered data from 1991 to 2002.

Full details on the analysis of weather data for previous versions are available in the LIVE.116 report.

In order to support a port-specific risk estimate for heat stress on live export voyages, analysis of port-specific weather data was necessary. The outcome of the port-specific data analysis process is a port-specific T_{WB} distribution for each month developed from land based data in the immediate vicinity of the port. Refer to the W.LIV.0267 report for details. Port specific T_{WB} distributions are based on VOS data as described in sections 3.3 and 3.4 in cases where no land based wet bulb temperature data were available.

The data analysis process for ports where suitable land based data was not available is discussed in more detail in section 3.2. The analysis behind the development of the port-specific T_{WB} distributions for the arrival port risk is provided in section 3.3. Weather considerations for the departure ports remain unchanged, with the acclimatisation factors based on the same acclimatisation zones and wet-bulb temperature data as in previous versions of HotStuff.

3.2 Data Source and Quality

The weather data analysis undertaken for previous versions of HotStuff (v2.3 and earlier) was based on the Voluntary Observing Ships (VOS) dataset obtained from the National Climatic Data Centre (a US government body) for the period 1991-2002 (11.6yrs). This is still the best data source available for oceanic wet-bulb temperature data and the more recent data for 2002-2007 (5.4yrs) has been added, giving a total of 17 years of data for assessing arrival port and voyage weather for live export ships (NB. This data is not used in assessing departure port weather conditions in the development of acclimatisation temperatures). The data originate from a wide variety of voluntary sources including naval vessels, merchant vessels and fixed and drifting buoys. Since 2002, the number of voluntary ships contributing data has declined significantly (roughly half of the fleet), resulting in only a 22% increase in the number of observations in the dataset from the addition of the 2002-2007 data. The most recent (2002-2007) dataset covers the entire globe, while the original (1991-2002) dataset covered the middle Eastern region only. The accuracy of wet-bulb distributions for arrival port and journey rely on the accuracy of wet-bulb temperature, time (year, month, day and hour) and location (latitude and longitude) measurements taken by the

VOS fleet. Records missing any of these measurements, and duplicate records were removed in a ‘pre cleaning’ phase before the primary data cleaning process described below.

3.2.1 Cleaning of Data

Inaccuracies in recorded wet-bulb temperatures can occur from both measurement and reporting. The most likely measurement error in wet-bulb temperature is that the wet-bulb itself becomes dry or does not have air freely circulating around it, causing ‘over-estimated’ wet-bulb temperatures. In the LIVE.116 study, comparison of the VOS data with adjacent, reliable shore data indicated that the VOS probability distributions were approximately 1°C higher in the region of interest, due to inaccuracies. To overcome this problem, a 1°C downward correction to the VOS data has been adopted. This is consistent with the approach taken in the previous study and is applied to all wet-bulb distributions.

To identify and remove inaccuracies from the data, it was useful to plot the wet-bulb temperature by voyage distance for a particular month. Figure 3-1 shows a plot of wet-bulb temperature vs. voyage distance (in degrees, 1°=59.4 nautical miles (M)) along the voyage from the south of Australia to the Red Sea during the month of January. Ports and latitudes of interest are also marked. The crosses represent observations which were deemed inaccurate due to several criteria discussed below, and were therefore removed.

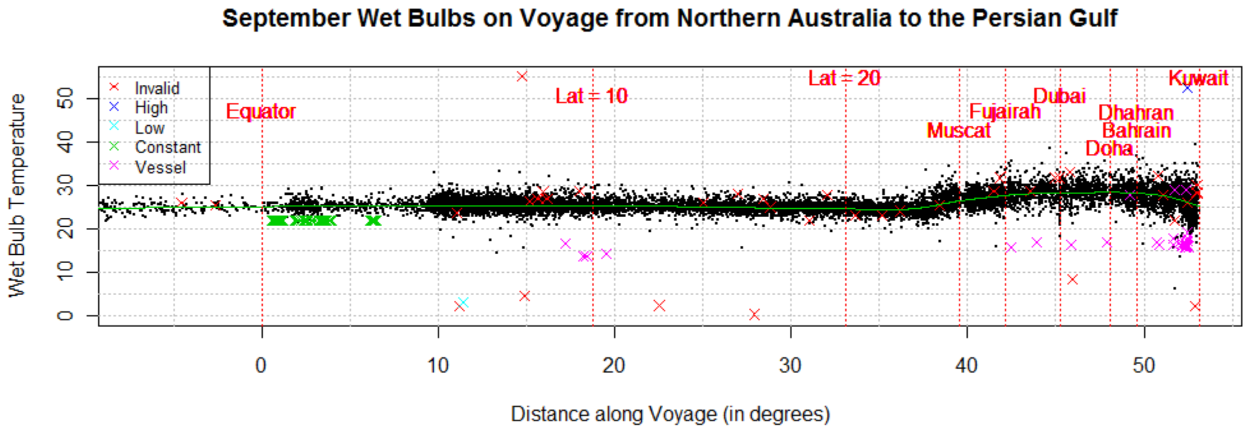

Figure 3-1: Wet-bulb temperature profile plotted by voyage distance

As dry bulb temperatures were also available for the majority of observations, it was often possible to remove observations whose wet-bulb temperature was invalid, given the dry bulb temperature recording. The maximum and minimum possible wet-bulb temperatures corresponding to a relative humidity of 100%, and 0% respectively at the recorded dry bulb temperature were calculated and used to identify where data records contained invalid wet-bulb temperatures. Figure 3-1 shows that this criterion typically removed most temperatures which were much hotter or colder than all other observations from that month and location. Some of these observations did have wet-bulb temperatures which were similar to other temperatures for that month and location; but given that the invalid data records represent a small proportion of all data records, they were removed to be conservative. Only 0.27% of observations were removed using this criterion.

The most unlikely high and low observations persisting after the above humidity criteria were considered on a case by case basis using the following criteria:

- It was assumed that observations with a wet-bulb temperature above 40°C and a dry bulb temperature above 50°C were most likely recorded in Fahrenheit, and therefore discarded (rather than "corrected").
- It was also assumed that unusually cold observations with wet and dry bulb temperatures below 5°C (with most readings within ±20° of the equator) were most likely due to a decimal point being forgotten and were therefore discarded.
- Wet-bulb temperatures below 1°C were also removed when they were unusual for the month and location in question and the corresponding dry bulb temperature was unavailable for the above humidity criteria.

Only 0.02% of wet-bulb observations were removed because they were too hot or cold.

Occasionally a line of constant observations was noticeable. It was found that several "vessels" had their entire wet-bulb readings fixed on one particular value - 0.28% of observations were removed for this reason. One further vessel was removed because although its wet-bulb measurements varied, they were all far below other observations in the same area and time period. It was considered that this vessel should be removed, with a resulting 0.04% reduction in the size of the dataset. After removing observations using all of the above criteria, 513,511 observations were available for calculating wet-bulb distributions.

3.3 Port Weather Data for the Discharge Component of the Voyage

For seven of the ten ports currently included in the risk assessment software, land based data is used to develop the T_{WB} distributions for calculation of the risk of heat stress during discharge. Refer to the LIVE.0267 report for more details on the source of the land based data.

Port	Data source for discharge component	Data source for sailing component
Adabiya	VOS dataset (defined radius from port)	VOS dataset (oceanic zone)
Aqaba	**Land based**	VOS dataset (oceanic zone)
Jeddah	**Land based**	VOS dataset (oceanic zone)
Kuwait	**Land based**	VOS dataset (oceanic zone)
Bahrain	**Land based**	VOS dataset (oceanic zone)
Dhahran	VOS dataset (defined radius from port)	VOS dataset (oceanic zone)
Doha	**Land based**	VOS dataset (oceanic zone)
Dubai	**Land based**	VOS dataset (oceanic zone)
Fujairah	**Land based**	VOS dataset (oceanic zone)
Muscat	VOS dataset (defined radius from port)	VOS dataset (oceanic zone)

Table 1: Data source for Port T_{WB} data

For the remaining three ports, there was no appropriate land based data available. The most appropriate interim measure is considered to be use of the VOS data as described in the next section for the discharge component of the voyage.

3.4 VOS Data Analysis for the Discharge Component of the Voyage

For the ports where land based data is currently unavailable (Adabiya, Dhahran, Muscat), wet-bulb distributions for each port of arrival have been developed by extracting all observations within a specified distance (radius) of a port from VOS data. These T_{WB} are then compared with the worst case T_{WB} distributions along the voyage route to identify the existing T_{WB} distributed to be used for the sailing component of the voyages.

Degrees latitude/longitude has been used as the unit for measuring distance of observations from each port to simplify the data extraction process. As the distance from the equator increases, the distance on the ground for one degree of longitude decreases. The distance on the ground for one degree of latitude remains the same at 60.0 nautical miles (M). For this reason, the region of included data for ports in the north of the Gulf and the Red Sea will be slightly elongated in the north-south direction. The largest elongation of 1°E=51.76M vs. 1°N = 60.0M for the northernmost port of Adabiya will have a negligible effect on the wet-bulb distributions in the region considered in this study and associated risk estimates.

Wet-bulb distributions for each port of arrival in a particular month are obtained from all observations within a specified radius. The wet-bulb distributions were found to stabilise once the radius was expanded to include at least 500 observations in each month. The radius within which observations for each port were considered was kept as small as possible to maximise the relevance of the readings to the weather at the port, while maintaining a sufficient number of readings to generate the required distributions. As the number of observations available in the VOS dataset determines the radius used, a larger radius was needed for ports with fewer readings such as those at the northern tip of the Red Sea (3° radius for Adabiya, 2.4° radius for Aqaba) and the northern tip of the Gulf (2° radius for Kuwait) while a smaller radius was sufficient for other ports, such as Muscat (radius 1°). Table 2 provides the radius around the port used to capture sufficient temperature data points for the development of a port-specific T_{WB} distribution. Note that VOS based data is only used for Adabiya, Dhahran and Muscat in the current version of the software.

Port	Radius
Adabiya	3.0°
Aqaba	2.4°
Jeddah	1.2°
Kuwait	2.0°
Bahrain	1.5°
Dhahran	1.7°
Doha	1.7°
Dubai	1.7°
Fujairah	1.3°
Muscat	1.0°

Table 2: Port region required for sufficient T_{WB} data

Figure 3-2 shows the number of observations for each month of the year at each port with increasing distance from the port. The radius used to determine the data points for each port was keep as small as possible while maintaining the number of points for each month used to develop a T_{WB} distribution to approximately 500.

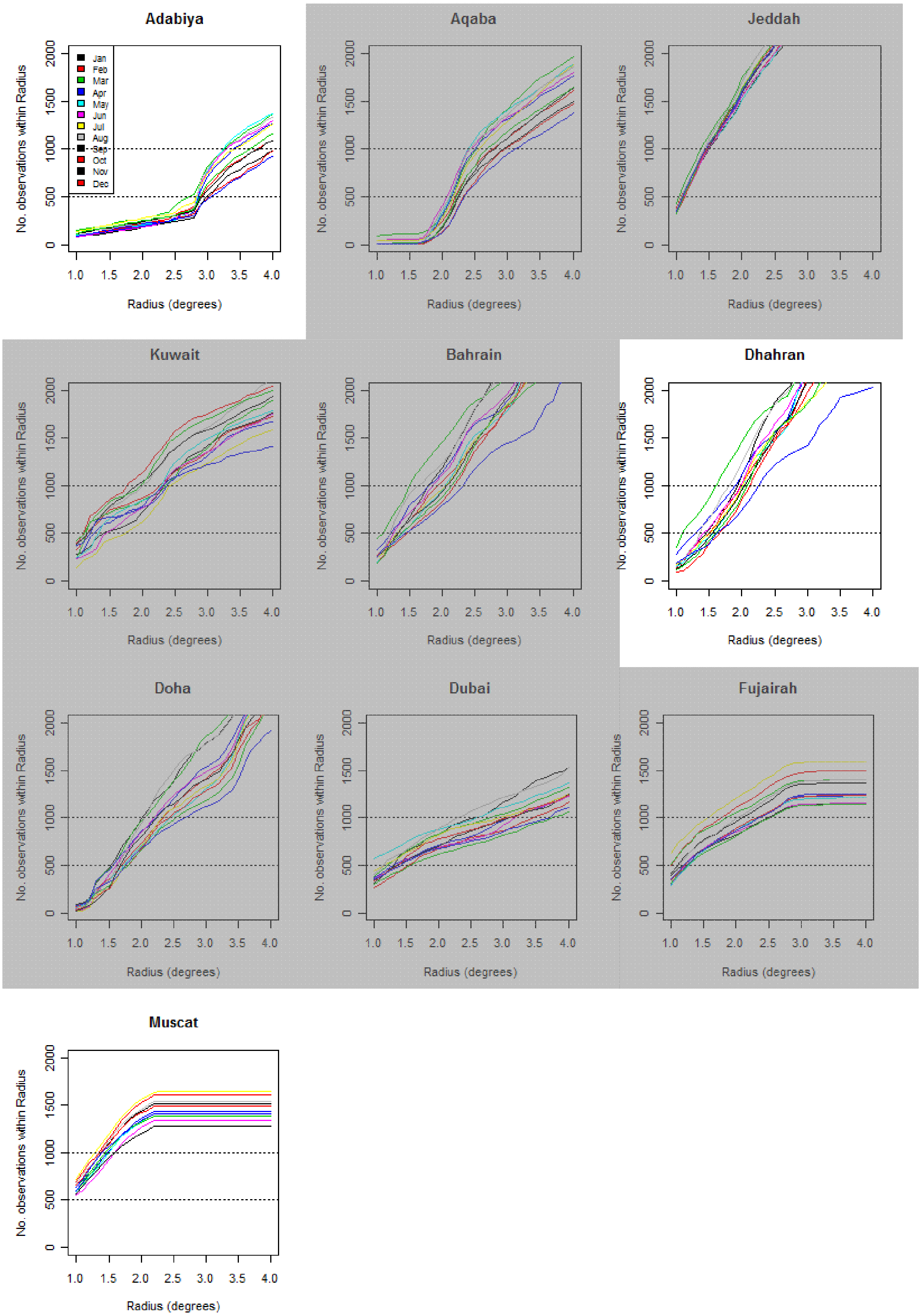

Figure 3-2: Number of VOS observations with increasing distance from each port

3.4.1 VOS Wet-bulb Distributions for Arrival Ports

Figure 3-3 and Figure 3-4 provide key aspects of the wet-bulb distributions for ports in the Red Sea and Persian Gulf, respectively. Each line shows the change in the wet-bulb distribution for a particular arrival port over the entire year. Dashed lines show the variation in the median wet-bulb temperature, while solid lines show the 98th percentile. The 98th percentile gives an indication of the wet-bulb temperatures that influence the port-specific heat stress risk estimates. Only the VOS wet bulb temperature data for Adibiya shown in Figure 3-3 and Dhahran and Muscat shown in Figure 3-4 is used in risk estimation during discharge. Wet bulb temperatures for other ports are taken from land based data as discussed in the W.LIV.0267 report.

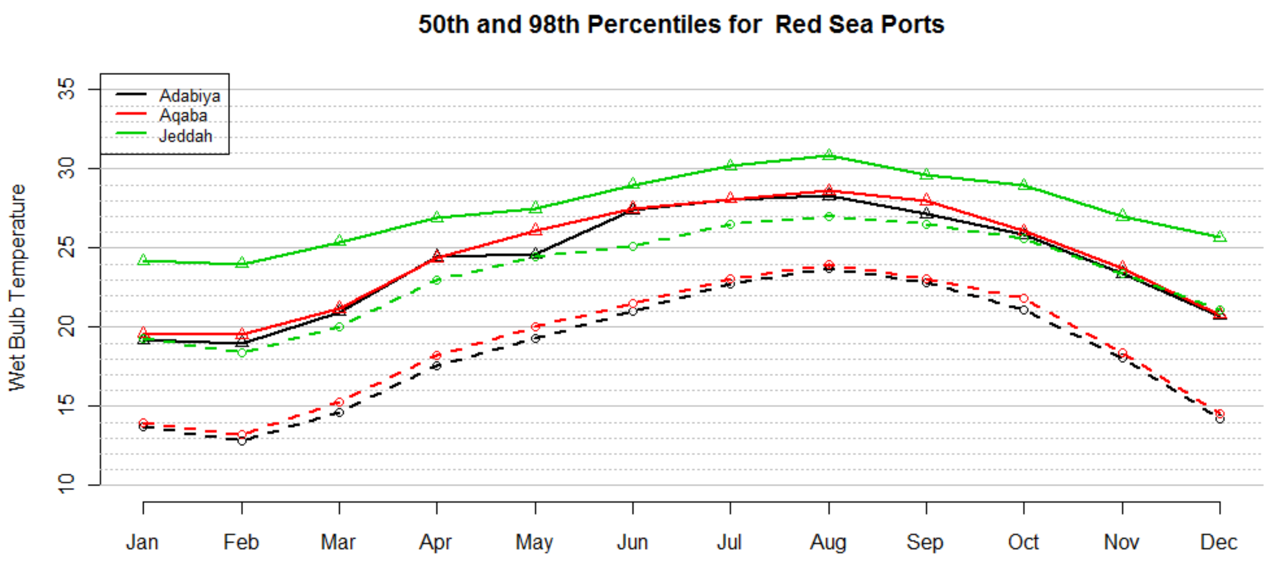

Figure 3-3: Annual port-specific wet-bulb temperature distributions for the Red Sea region.

In the Red Sea, Jeddah experiences the highest wet-bulb temperatures all year round while the northernmost ports of Adabiya and Aqaba are at least 1.5°C to 2°C cooler during the northern summer and up to 4°C cooler during the northern winter. All Red Sea ports reach their maximum wet-bulb temperatures in August. At this time, there is a 2% chance of the wet-bulb temperature exceeding 30.8°C in Jeddah and 28.3°C in Adabiya and Aqaba.

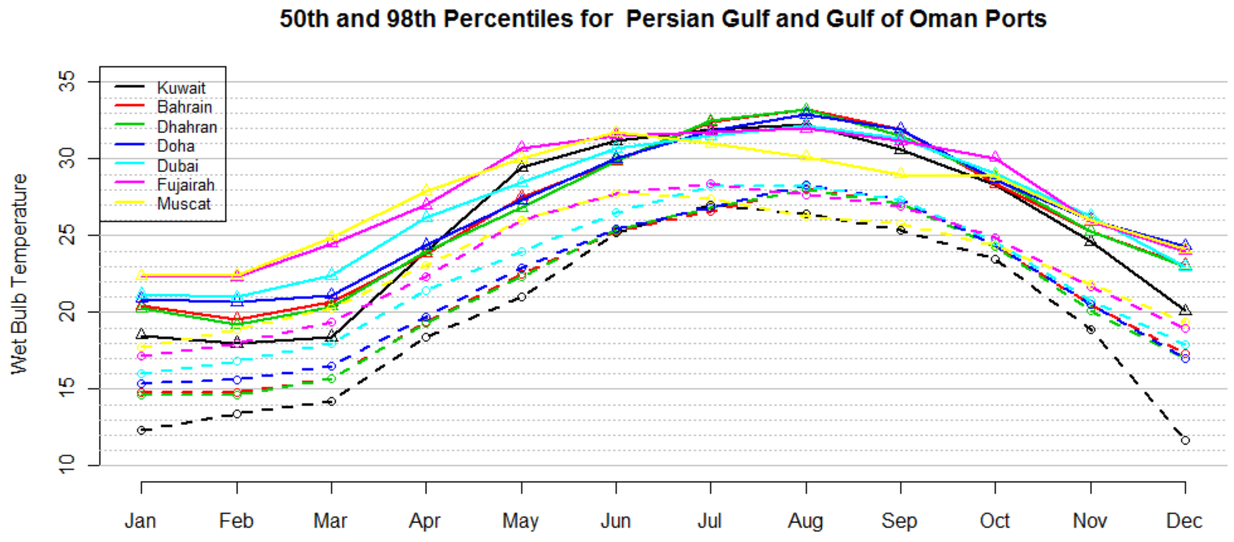

Figure 3-4: Annual port-specific wet-bulb temperature distributions for the Persian Gulf region

All ports in the Persian Gulf (Kuwait, Bahrain, Dhahran, Doha and Dubai) have more than a 2% chance of wet-bulb temperatures exceeding 30°C between June and September, peaking at over 32°C in August for some ports. Note that while the 50th percentile temperature for Muscat is higher than the corresponding temperature for Kuwait all year round, the 98th percentile temperature is significantly higher for Kuwait from July through to late September. Wet-bulb temperatures in Muscat peak earlier than in any ports in the northern Gulf, with the 98th percentile reaching a maximum of 31.5°C in June. In Fujairah, which is just north of Muscat, there is more than a 2% chance of wet-bulb temperatures exceeding 30°C for the entire period from May through until October.

4 HotStuff Software Implementation

This section outlines the changes to the HotStuff software completed to support changes to the methodology outlined in section 2.3. The software has been rewritten in a newer development environment and hosts a number of new features and improvements, which are described below. For step-by-step instructions on how to use the HotStuff software, refer to the software operating instructions, which are available via the help menu and included in Appendix 4.

4.1 Summary of Key Additions and Changes in HotStuff 3.0

HotStuff 3.0 incorporates a number of important changes implemented to support the revised methodology, ease of use, understanding of the outputs, security of the data and maintenance of the software. The changes can be categorised into the following types:

- Addition of software functionality necessary to support the changes in methodology to incorporate the risk of heat stress on open decks at the port of discharge as outlined in section 2.3. These software changes are also described in section 4.2.
- Addition of functionality to improve the efficacy of the software and promote improved understanding of the outcomes from the heat stress risk assessment methodology. This is described in section 4.3.
- Fixing of the outstanding issues with HotStuff 2.3 (refer to section 4.4).
- Conversion of the software used to develop HotStuff from Visual Basic 6 to Visual Basic.Net. While the conversion does not have any immediate implications for software functionality, the conversion allows ongoing software support and opens up a number of opportunities such as web-enabling the software.

4.2 Additional Software Functionality for the Support of Methodology Changes

While much of the process of using the HotStuff software to create a stocking plan with entry by entry heat stress risk estimates remains the same, there are a number of small changes to support a port-specific risk estimate for discharge.

The key changes required for adding a stocking entry to a voyage are:

- On development of a voyage, all of the discharge ports need to be specified in the order of arrival.
- The discharge port must be specified for each stocking entry.
- Both a voyage risk and a discharge port risk are calculated and displayed in the stocking entry table.

4.2.1 Specification of Discharge Ports in Order of Arrival

Each stocking line is assessed for heat stress risk at each port of discharge where the stocking line is present on the ship. The stocking line is assessed at each port up to the port of discharge for that stocking line. Information required to complete the calculations includes the port of discharge for each stocking line and the order of discharge ports for the voyage. When configuring a voyage, rather than just selecting the first port of discharge, as in the prior versions, the user develops and orders a list of discharge ports. The ordered list of discharge ports is used to populate the options for associating a stocking line with a particular port. It is also used to determine, for each stocking line, if the weather at one or more ports need to be considered when calculating the risk of heat stress in port.

4.2.2 Voyage and Discharge Port Risk

Voyage and discharge risk should be considered independently. The higher of the two risks is the determining risk for the stocking line.

For closed decks, since the ventilation method remains constant and the voyage T_{WB} distribution is higher than the T_{WB} distribution at the point of discharge in most cases, the voyage risk is generally higher than the discharge risk.

For open decks, the voyage T_{WB} distribution is higher than the T_{WB} distribution at the point of discharge in most cases, but the mechanical ventilation used at the port is generally less effective than the crosswinds able to be generated during sailing. Depending on the difference between the voyage T_{WB} distribution and the discharge T_{WB} distribution, either the sailing risk or the discharge risk may be the determining risk.

4.3 Additional Functionality in HotStuff 3.0

While the core methodology and configuration of the HotStuff software remain the same, a significant number of changes have been made to improve the software and incorporate useful features. Supplementary key changes and additions include:

- Addition of a “fill all stocking lines to risk” parameter
- Development of risk profiles for a particular voyage configuration over the full year
- The ability to change the limiting stocking density tables by which the loading is done, and hence the entries on which the risk calculations are based

4.3.1 Fill All Stocking Lines to Risk Function

HotStuff 3.0 allows the number of livestock for each stocking line for the whole voyage to be adjusted such that the limiting risk is below 2% (or 2% with less than 5 knots crosswind).

4.3.2 Development of Risk Profiles

HotStuff 3.0 enables the development of a risk profile for each stocking line over the whole year for a particular voyage configuration (vessel, stocking arrangement and port arrival list). The risk profile provides an indication of the level of destocking that may be required at different times during the year, showing when it is practical to carry a particular line on a particular deck and also to which ports. Information on how to generate a risk profile using the HotStuff software is given in Appendix 3.

4.3.3 Changing Base Stocking Density Tables

In cases where the base stocking density tables are changed from the default Australian Standards for the Export of Livestock (ASEL) tables, such as when blanket destocking requirements are introduced for temporary periods, prior versions of HotStuff have been difficult to use. HotStuff continues to set the stocking density at default levels unless destocking is required to reduce heat stress. When wholesale destocking is mandated, the appropriate destocking level has previously required manual calculation for each stocking line entry.

HotStuff now allows the use of either the default ASEL tables for the whole year (which is the way the ASEL tables are intended to be used in HotStuff) or the May – Oct tables for the northern summer. Additional proportional wholesale destocking can also be applied to the chosen table. Changing the base tables does not affect the way that the heat stress risk estimates are calculated.

At those times when blanket destocking requirements are introduced, this feature can also be used to assess the risk that the live export fleet is exposed to under the wholesale destocking measure. This can be achieved by setting the stocking density tables as defined in the wholesale measure and running the risk profile for a range of voyage types. If there is a remaining risk, it will be evident in the risk profile produced. Figure 4-1 through to Figure 4-3 show a comparison between the default and the May – Oct / Nov – Apr stocking tables for cattle and sheep as well as an example of a 10% blanket destocking measure in terms of the resulting area per head of livestock. HotStuff 3.0 can be used to evaluate the remnant risk of blanket destocking measures for particular voyage configurations.

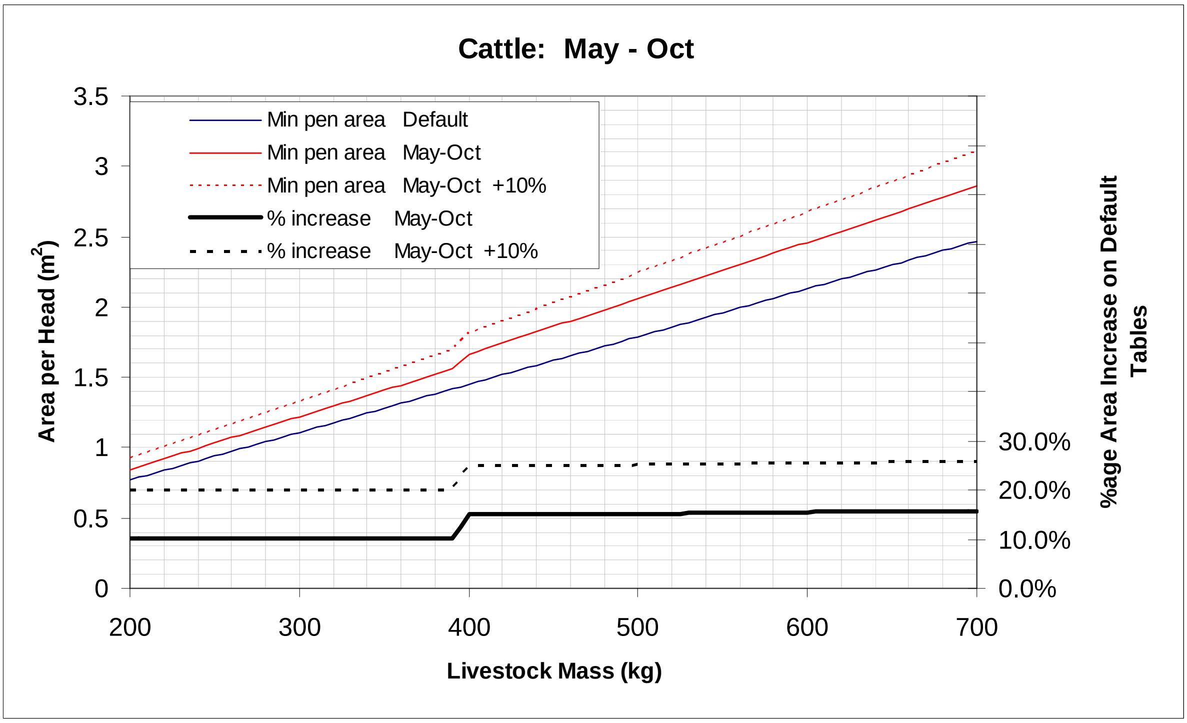

Figure 4-1: Default and May - Oct ALES tables for cattle

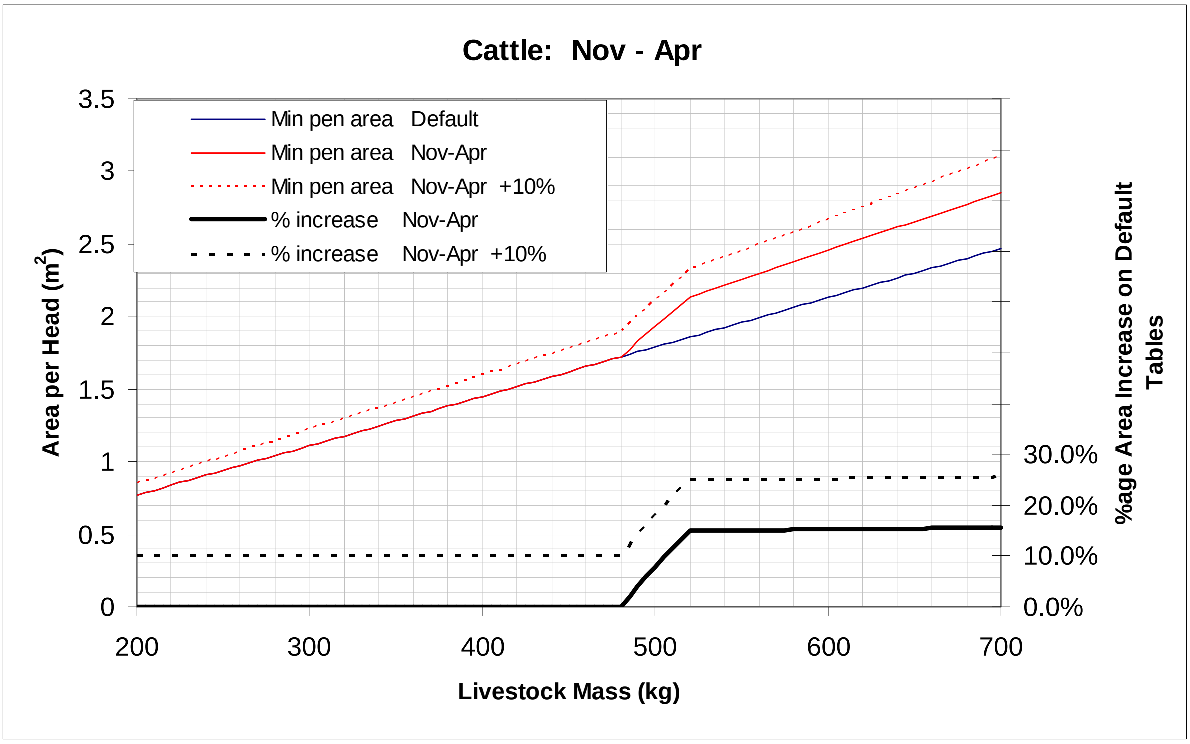

Figure 4-2: Default and Nov - Apr ALES tables for cattle

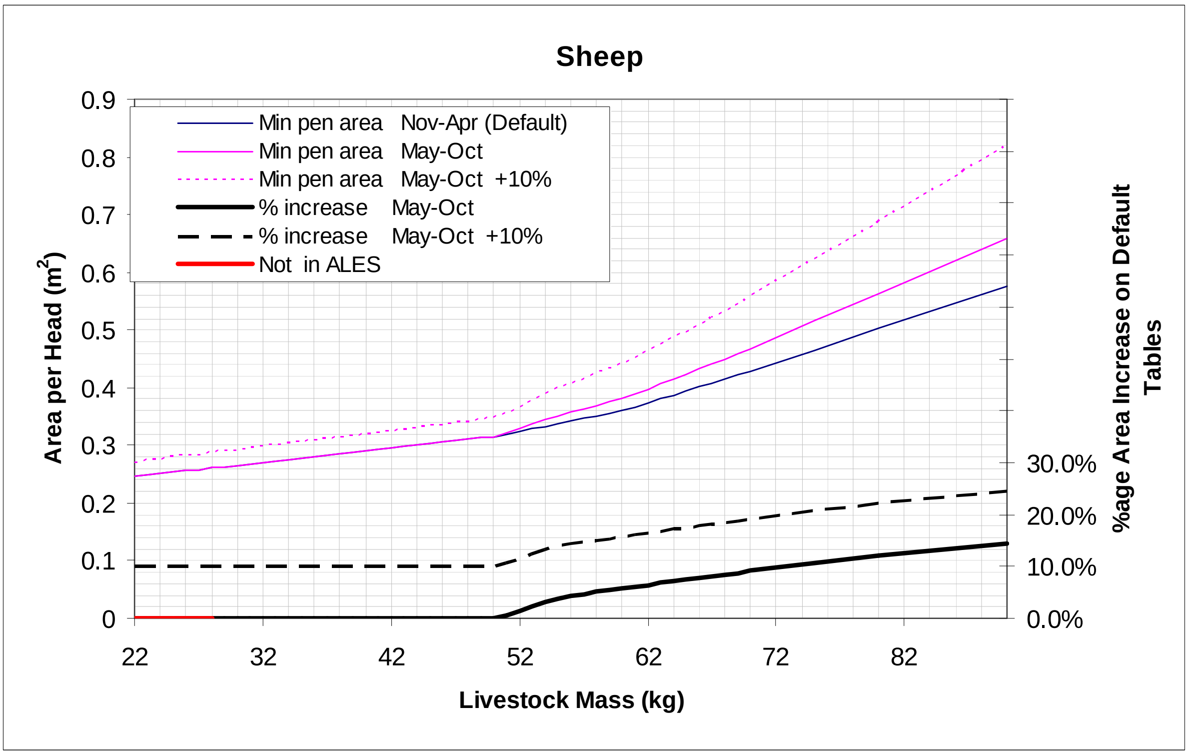

Figure 4-3: Default and May - Oct ALES tables for sheep

HotStuff 3.0 also includes interpolation for date of departure, to reduce the impact that using monthly inputs has on the calculated stocking density when a voyage date is moved by one day to the next month.

4.4 Other Improvements in HotStuff Version 3.0

Other improvements in HotStuff 3.0 include:

- An incorrect usage of the deck index used in open deck risk calculations in version 2.3 has been identified and fixed. The correction affects the assessment of the influence of re-ingestion on open decks.
- Problems with the generation of reports have been address by using Crystal Report™ functionality in the place of superseded data report features. Problems in inconsistency with units have been rectified.
- The database is now secure. While it was possible to detect database changes with the prior versions of HotStuff, it is now not possible to access the backend database to make manual changes without an access password.
- Interpolation problems are fixed.
- Visualisation of stocking levels for each entry has been added. There is now colour coding to indicate which stocking lines are overstocked or have been destocked to reduced heat stress risk.

5 Conclusions

The methodology for estimating the risk of heat stress in livestock on voyages to the Middle East has been revised to include specific consideration to the risk of heat stress on open decks during discharge. The revised methodology has been incorporated in HotStuff software version 3.0.

In addition to revising the methodology, a number of features have been added, to improve the ease of use, understanding of the outputs, security of the data, and maintenance of the software.

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OVERVIEW

The voyage heat stress risk assessment program, HS, is designed to calculate the expected mortality rate, risk of 5% mortality for closed decks, and required crosswind for open decks, for livestock being transported by ship from Australian to Middle Eastern ports. The program takes account of the following:

- The type of livestock
- The breed
- The weight
- The condition
- The coat length
- The acclimatisation zone
- The ship ventilation and deck dimensions
- The quantity of a particular line of livestock on a particular deck
- The pen area
- The departure and destination port
- The departure month and arrival date

Risk indices are assigned to the various individual lines of livestock to enable adjustments to be made to reduce the mortality rate for a particular voyage.

1 DATA ENTRY

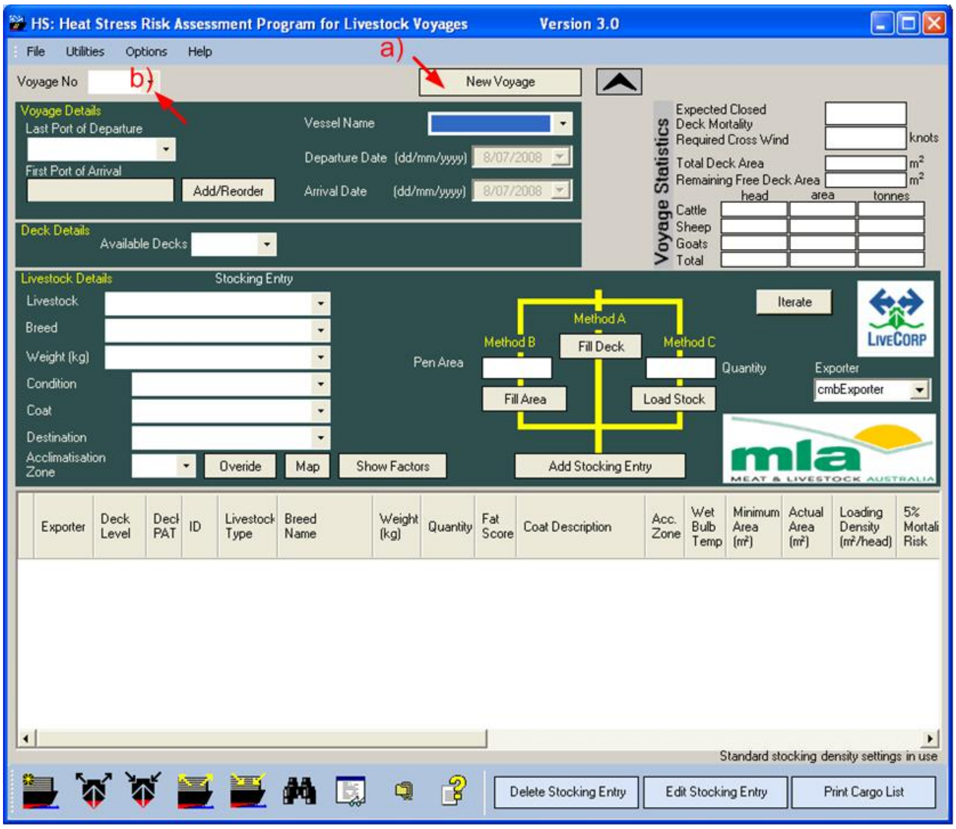
Three types of data are required by the software:

- Data relating to the livestock characteristics, ship and deck ventilation data and statistical weather information. These data are contained within the software. LiveCorp must be contacted to make changes to these data.
- Voyage data including ship, departure port and date, destination port and arrival date.
- Stocking line data including deck number, livestock breed, type and weight, acclimatisation factors, fat score and coat type.

Before voyage data can be entered, the required vessels must be imported into the HS database. Section 6.1 provides an explanation of the procedure for importing vessel data into the database.

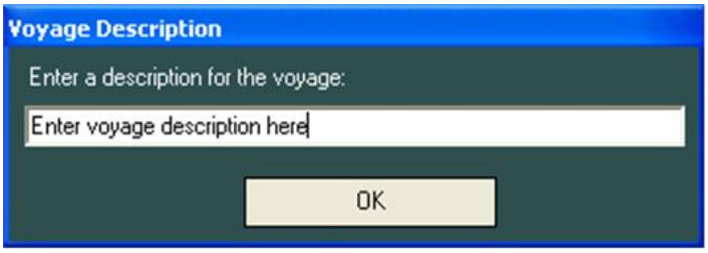
1.1 Voyage Data Entry

Voyage data can be entered in two ways. A new voyage may be entered by selecting a) *New Voyage* or an existing voyage may have its data modified by selecting the dropdown list box indicated at b).

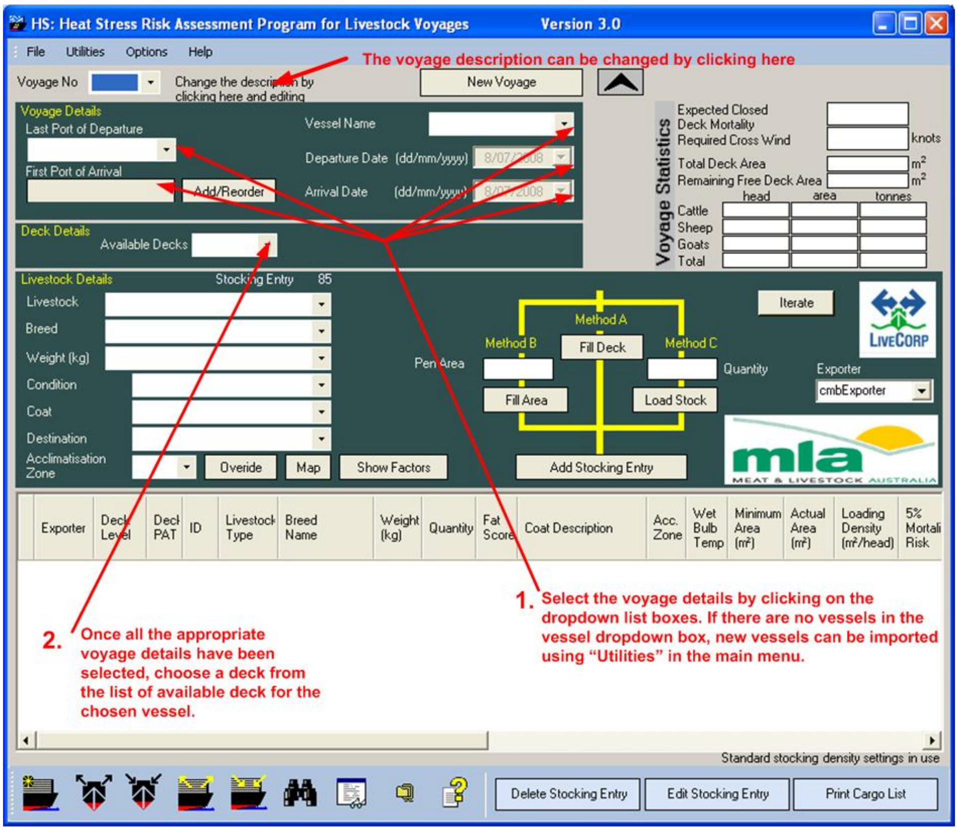


1.2 Entering a New Voyage

To enter a new voyage, click the *New Voyage* button. After entering the voyage description in the voyage description box, enter the vessel name, departure port, departure month, destination port and arrival date into the input form. The arrival date is entered either manually or by using the calendar.



The description of a voyage can be changed by clicking on the voyage description label on the input form. It is important to develop a consistent method of labelling voyages so that they are easy to identify at a later date. The voyage description field may contain any alphanumeric characters, so it may be appropriate to develop a descriptive short hand code for the field. In particular, the sequential voyage number for a specific vessel would be useful. The HS voyage number is a sequential number for indexing within the program and does not relate to the shipper's numbering scheme.



The first thing to do when entering a new voyage is to enter the voyage details. To enter voyage details, choose one of the items from each of the “Vessel”, “Departure Port”, “Departure Month” and “Arrival Port” list boxes. Choose an arrival date from the arrival date calendar. If the vessel dropdown box is empty it will be necessary to import vessel details into the database before a voyage can be entered. See section 6.1 for details on how to import vessel data. Once the voyage data has been selected, it is necessary to specify a deck before the first stocking entry can be added.

1.3 Editing Voyage Data

The departure port, departure month, destination port and arrival date can be altered if required. The vessel cannot be changed once a new voyage is created and the vessel name has been entered. To delete a voyage, click the *Delete Voyage* button.

1.4 Vessel, Livestock and Weather Data

These data are contained within the software and can only be modified by LiveCorp. The vessel data is imported by using *Import Data* on the *Utilities* menu.

1.5 Entering Stocking Lines

Stocking lines are created by entering the data in the *Livestock Details* area:

- The deck number. Note that the unassigned pen area (m^2) and pen air turnover (m/hr) are displayed adjacent to the deck number, once it is selected.
- Livestock type
- Breed
- Weight
- Condition
- Coat type
- Acclimatisation zone. This may be entered by zone by choosing one of the zones listed in the drop down box, or may be over-ridden by clicking the *Override* button which enables a wet bulb temperature to be entered directly into the software. When using the zone option, a map displaying the acclimatisation zones can be displayed by clicking the *Map* button.
- Quantity
- Pen area (m^2)

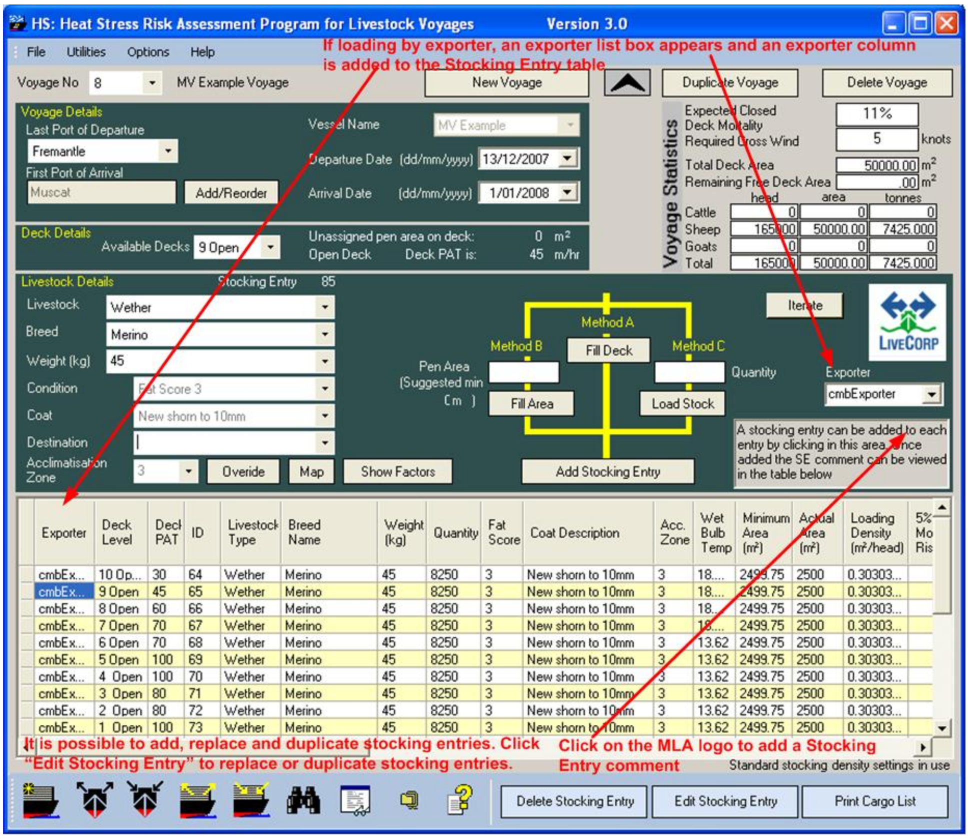
There are a number of different methods for entering the pen area and quantity:

- Enter both quantity and pen area numbers manually
- Use the “fill deck” button. This button fills the remaining area on the current deck with the chosen livestock to the ALES tables for northern winter. The method does not reference risk calculation when determining the quantity of livestock assigned to the remaining area on the deck.
- Enter required pen area and use the “fill to risk” button. The fill to risk button fills the specified area with as many of the chosen livestock as possible with the following constraints:
  1. The 5% mortality risk for the stocking entry must be less than or equal to 2%
  2. The pen area for each animal must be greater than the minimum in the ALES tables for the northern winter

- Enter required quantity and use the "load to risk" button. The "load to risk" button loads the specified livestock into the minimum pen area possible with the same constraints as for the "fill to risk" feature.

It is possible to specify an exporter for the stocking entry, see the next section for a description on how to do this. It is also possible to add a comment to the stocking entry to include details not provided for elsewhere in the table or to assist in identification of individual stocking entries. To add comment into a stocking entry, click on the live export logo and enter the comment in the text box that appears.

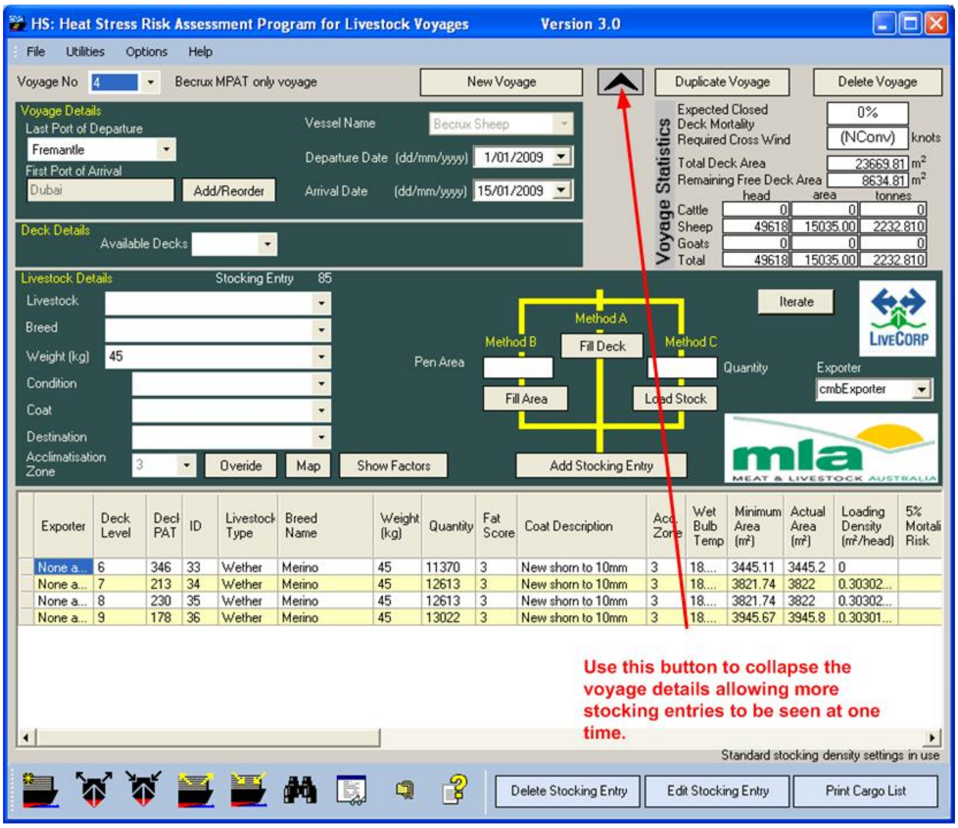
Once the data are entered, they are saved into the database by clicking the *Add Stocking Entry* button. The data are then displayed in the *Stocking Entries* grid at the bottom of the screen. Individual mortality rate estimates or required crosswinds are displayed for each stocking entry line in the grid. The average expected mortality for the voyage and the maximum required crosswind are displayed in the area at the upper right of the screen.



1.5.1 Entering Stocking Lines by Exporter

If stocking entries are from a number of different exporters, then it is possible to load by exporter. To load by exporter, select Options->Load by Exporter. Selecting this option should do two things:

- Add an exporter list box to the right hand side of the livestock details frame. This box enables the choice of an associated exporter when adding a stocking entry. New exporters can be added to the list by selecting "-> add new exporter", which should be the last entry in the list.
- Add an extra "Exporter" column to the left hand side of the data table. It is possible to order the rows of the data table by exporter in the same way as the other columns in the table. See section 7.1 for details on how to change the order of the rows in the data table.



1.5.2 Mortality Risk Calculations

The calculation for mortality risk and required cross wind takes voyage, deck and livestock details into account. The table below gives a brief explanation of the effect of the voyage, deck and livestock details on risk calculations:

Voyage Details

Last Port of Departure	The last port of departure and first port of arrival determine the route for the vessel. Together with the arrival date, the departure and arrival ports are used to determine the weather statistics used for the risk calculations.
First Port of Arrival	
Arrival date	
Departure month	Used to determine the acclimatisation zone. The choice of zone can be overridden by the user.

Deck Details

Deck	The deck chosen determines the mechanical PAT on the deck, the deck width and the deck height as well as whether a closed deck or open deck calculation is to be performed. The mechanical PAT directly effects the temperature rise

	above ambient on the deck and therefore the mortality risk at a given temperature. The width and height of the deck effects the required cross wind for an open deck.
Livestock Details	
Livestock Breed	The livestock type and breed determine the base beta curve for the stocking entry. The beta curve dictates the estimated percentage of livestock that will die at a given temperature.
Weight Condition Coat Acclimatisation Zone/ Wet Bulb Temperature	The weight, condition, coat and acclimatisation temperature all determine corresponding adjustment factors. The product of the adjustment factors is used to shift the base beta curve to the left or the right (increasing and decreasing respectively the estimated percentage of livestock that will die at a given temperature). The adjustment factors can be viewed by clicking on the appropriate button.
Pen Area Quantity	The pen area and quantity determine the loading density for the stocking entry. The loading density directly effects the temperature rise above ambient on the deck in conjunction with the deck PAT and therefore the mortality risk at a given temperature.

It is possible to vary the estimated mortality risk by changing any of the above variables. Given that many of the characteristics of a stocking entry are determined before loading, generally the only parameters that may be changed are the loading deck, pen area allocated to the stocking entry and quantity of livestock that make up the stocking entry.

A common method of reducing the mortality risk for a given stocking entry is to increase the pen area allocated to that stocking entry. Generally, the reason for increasing the pen area is because the stocking entry is very close to or above the mortality limit. Increasing the pen area for the stocking entry will have a marginal effect initially, but if moderate destocking is not effective then the 5% mortality temperature for the livestock is too close to the 2% ambient temperature and more temperature resistant livestock may be necessary to cope will the conditions.

As the 2% ambient temperature approaches the 5% mortality temperature for a given animal, the animal requires more and more space on a given deck until an infinite deck spce is required when the temperatures are equal (Not Possible on the chosen deck). Of course, it is possible to choose livestock and conditions such that each animal requires a large area. The livestock in this case are obviously not suitable for the conditions.

1.5.3 Required Cross Wind Calculations

The calculation to determine the required crosswind is more complicated and takes a number of factors into account. The required crosswind is always calculated such that the risk of a 5% mortality is 2%. The first important point in understanding the crosswind calculations is that the effects of crosswinds and mechanical PAT are mutually exclusive. At some point the mechanical ventilation will no longer be sufficient and a crosswind will be necessary to ventilate the open deck instead.

As the ambient wet bulb temperature increases and the difference between the ambient temperature and the temperature at which livestock start to die decreases, ventilation requirements are increased. When ventilation requirements are low, the mechanical ventilation on the vessel may be sufficient. As ventilation requirements are increased, at some point the mechanical ventilation on the vessel will no longer be sufficient and a crosswind is necessary. If the mechanical ventilation of an open deck is poor, then the crosswind required at the point where the mechanical ventilation is no longer sufficient will be low (eg. 2 knots). On the other hand, if the mechanical ventilation of an open deck is good, then the crosswind required at the point where the mechanical ventilation is no longer sufficient will be much higher (eg. 10 knots).

If the ventilation requirements are very high, this is because the ambient temperature is very close to the temperature at which there is a 2% risk of a 5% mortaility. It is possible in this scenario that the addition of one animal, for example, will take the required crosswind from “mechanical PAT sufficient” to “inf” (or no amount of crosswind is sufficient). The reason for this is that the addition of one animal effects the loading density and therefore the temperature rise on the deck. If the increase in temperature rise on the deck puts the (ambient temperature + temperature rise on the deck) above the 5% mortaility temperature then no amount of ventilation will be sufficient.

1.6 Editing and Deleting Stocking Entries

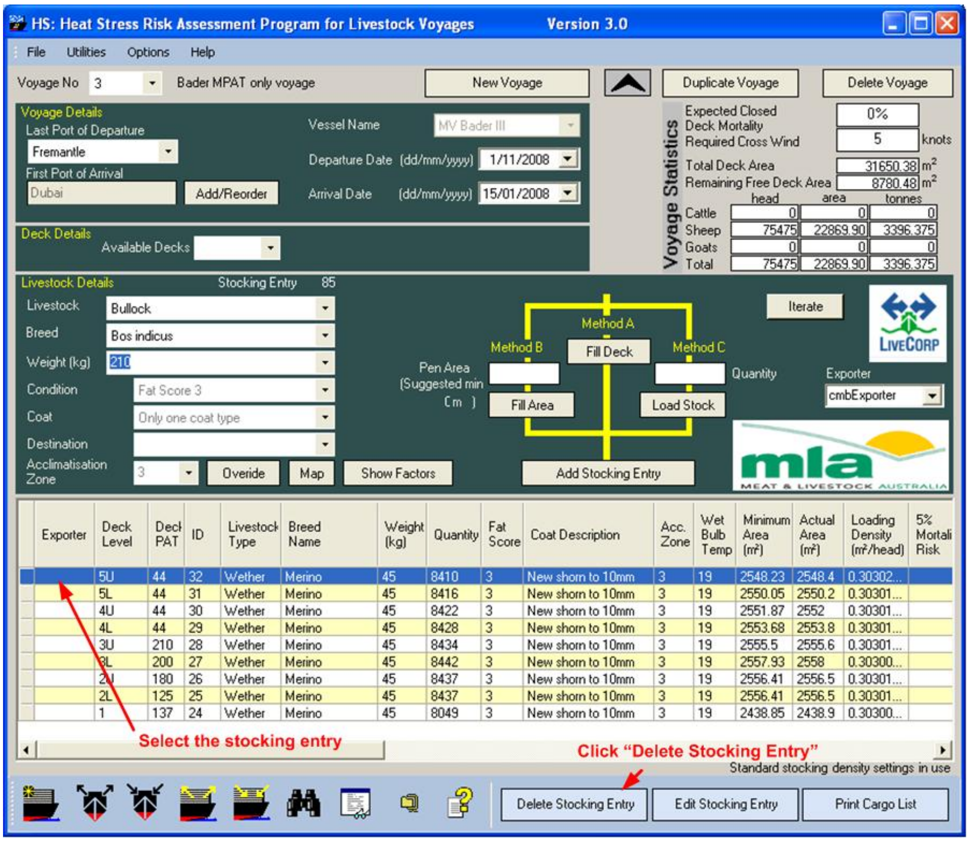
Stocking entries can be edited or deleted.

1.6.1 Editing Stocking Entries

Individual stocking entries can be edited by selecting the stocking entry in the stocking entries grid and clicking the *Edit Stocking Entry* button. Data for that stocking entry may then be re-entered or modified in the *Livestock Details* area.

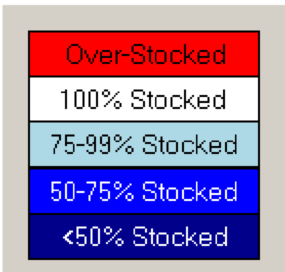
1.6.2 Deleting Stocking Entries

Stocking entries can be deleted by selecting the stocking entry in the stocking entries grid and clicking the *Delete Stocking Entry* button.



1.6.3 Highlighting for Stocking Density Identification

HS 3.0 incorporates a stocking entry table highlighting feature to enable easy identification of overstocked and understocked stocking entries. Any stocking entries that are currently overstocked relative to the stocking density requirements of the appropriate ALES tables are automatically highlighted in red. Similarly, any stocking items that have been destocked from the maximum allowable stocking density specified in the ALES tables is automatically highlighted in blue. The shade of blue indicates the approximate level to which the line has been destocked.

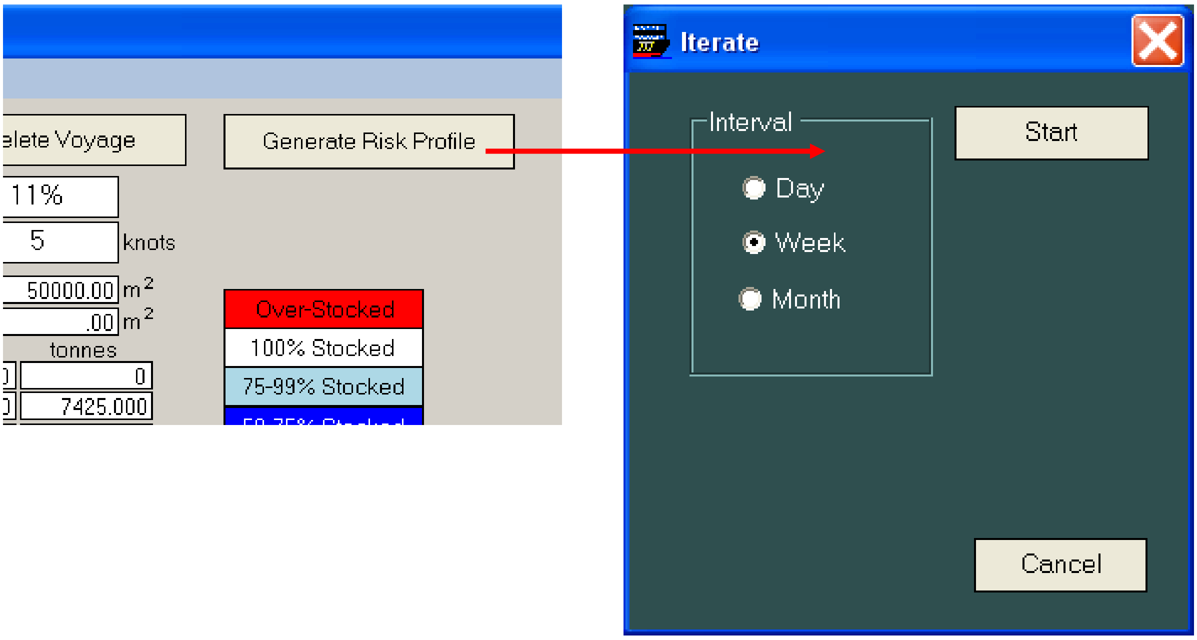


Deck Level	Deck PAT	ID	Livestock Type	Breed Name	Weight (kg)	Quantity	Fat Score	Coat Description
Main Deck	35	1	Wether	Merino	45	4300	3	New shorn to 10r
Deck No 1 UT	34	2	Wether	Merino	45	9000	3	New shorn to 10r
Deck No 2 LT	28	3	Wether	Merino	45	5167	3	New shorn to 10r
Deck No 2 UT	28	4	Wether	Merino	45	5167	3	New shorn to 10r
Deck No 3 LT	29	5	Wether	Merino	45	4370	3	New shorn to 10r
Deck No 3 UT	29	6	Wether	Merino	45	4359	3	New shorn to 10r
Deck No 4 LT	64	7	Wether	Merino	45	9339	3	New shorn to 10r
Deck No 4 UT	64	8	Wether	Merino	45	10000	3	New shorn to 10r
Deck No 5 LT	61	9	Wether	Merino	45	10000	3	New shorn to 10r
Deck No 5 UT	61	10	Wether	Merino	45	9333	3	New shorn to 10r
Deck No 6 LT	91	11	Wether	Merino	45	9333	3	New shorn to 10r
Deck No 6 UT	92	12	Wether	Merino	45	9330	3	New shorn to 10r
Deck No 7 LT	74	13	Wether	Merino	45	9326	3	New shorn to 10r
Deck No 7 UT	75	14	Wether	Merino	45	9313	3	New shorn to 10r
Main Deck	35	15	Bull	Bos taurus - beef	280	695	3	Summer Coat

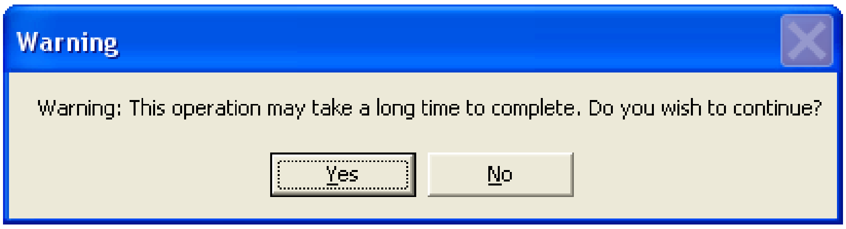
2 GENERATING RISK PROFILES

One of the significant new features in HS 3.0 is the ability to generate heat stress risk profiles over a whole year for a particular voyage type and stocking configuration. The risk profile provides an indication of how the heat stress risk estimate will change with different sailing dates and provides an improved picture of the generated risk estimate.

The risk profile generation feature uses the same methodology for generating the risk estimate, but provides a facility for repeating the risk estimate calculation over the year and presenting the results in an understandable format. HS 3.0 uses Excel to display the results of the risk profile generation process allowing subsequent manipulation of the results by the user if required. Clicking the "Generate Risk Profile" button on the main input screen opens in the iteration dialog box.

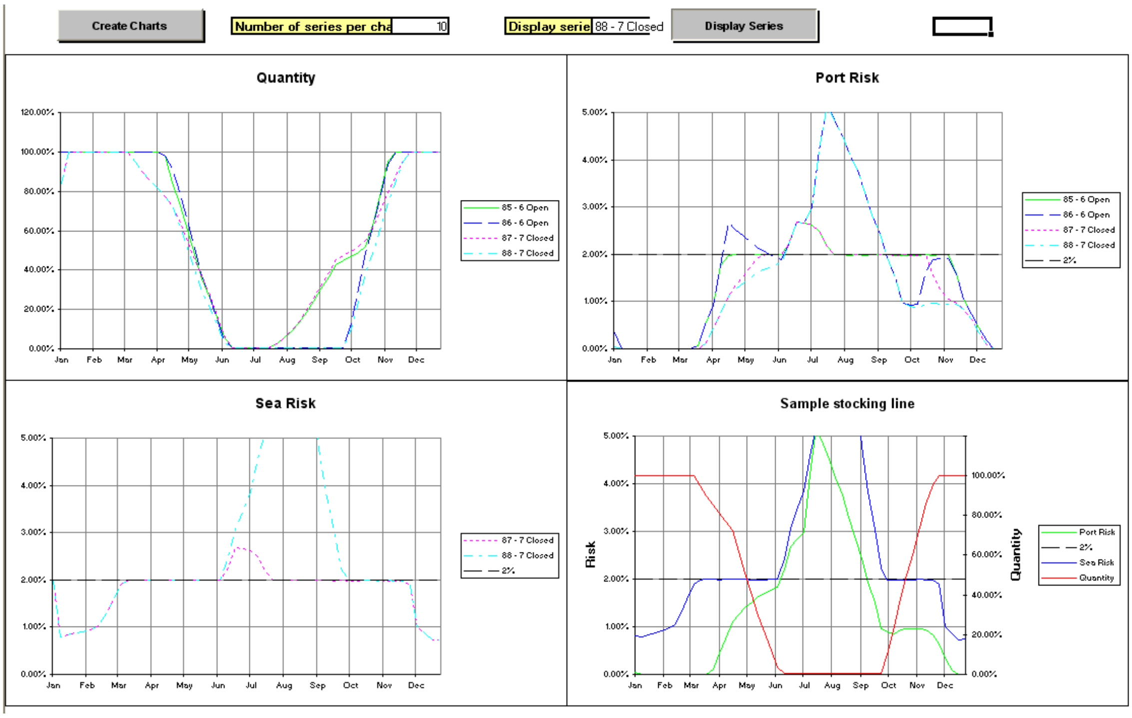


The iteration dialog box allows the selection of the time interval between each iteration. In most cases a weekly interval between risk calculation iterations is recommended since it provides satisfactory profile resolution without excessive runtime (~5 minutes). Monthly time intervals result in a significantly faster run time (~1 minute), but at the expense of risk profile resolution (risk estimates may change significantly within a month in some cases). A daily time interval calculation will take approximately 1 hour. Calculation time is also dependant on the number of stocking entries. A dialog box will warn of a long estimated completion time.



At any time, it is possible to stop the risk profile generation process by clicking the stop button

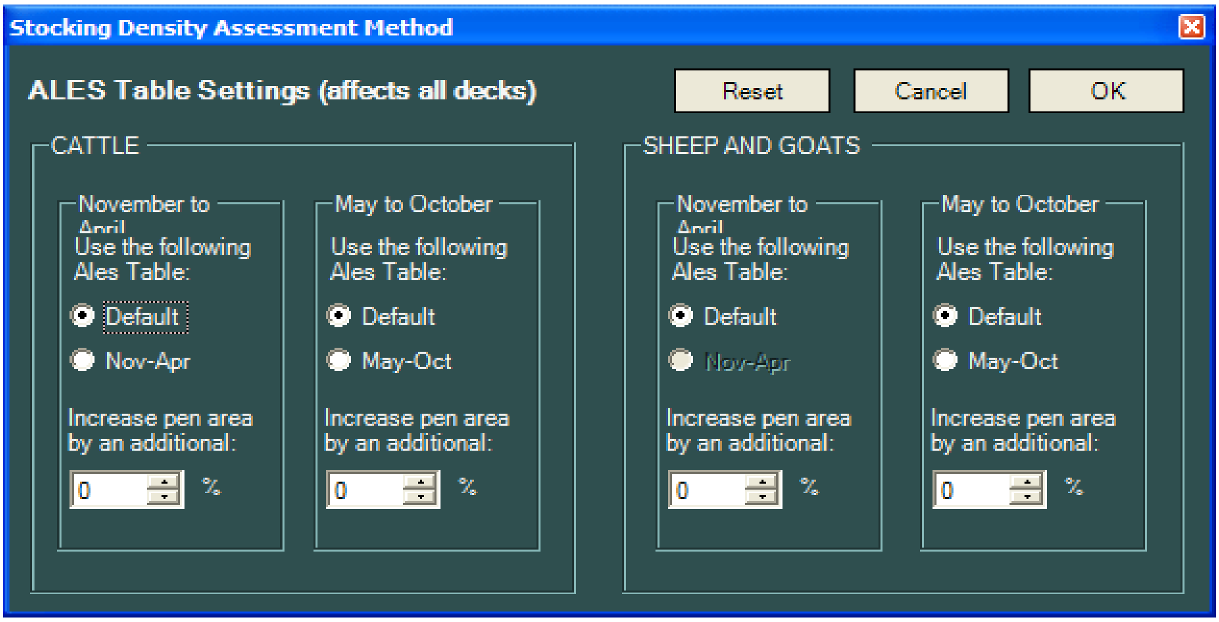
At the completion of the risk profile generation process HS 3.0 will use an excel macro to display the results written to the spreadsheet in graphical format. An example of the output produced is shown below.



3 ALTERING STOCKING DENSITY DEFAULT SETTINGS

HS 3.0 provides the facility to alter the base stocking density requirements that dictate the maximum stocking density before consideration for heat stress risk calculations. This facility allows the software to handle blanket destocking requirements and change the base stocking density table for different livestock types and times of year.

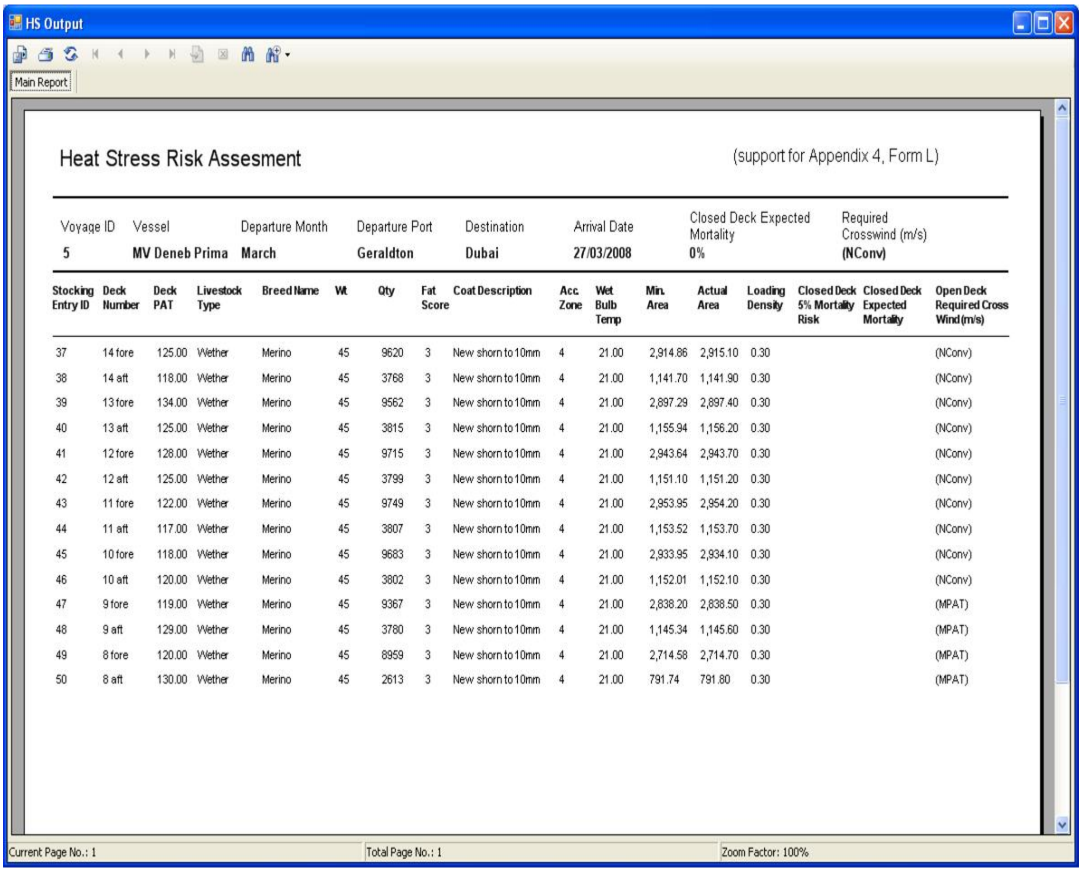
It is also possible to increase the pen area per head of livestock calculated with the “fill area” or “load stock” calculation buttons. This provides a convenient way to destock in advance reducing the manual destocking requirement.



Any change from the default settings will prompt the display of a warning label below the stocking entry table. The warning label will remain while the ALES table settings remain modified.

4 PRINTING REPORTS

Reports for a voyage can be printed by selecting the voyage number in the *Voyage No.* drop down box and clicking the *Print Cargo List* button. The cargo list is ordered in the same way as the data grid (by selecting data grid from options in the main menu). The printout is produced in a similar format to the Appendix 4 Form L.

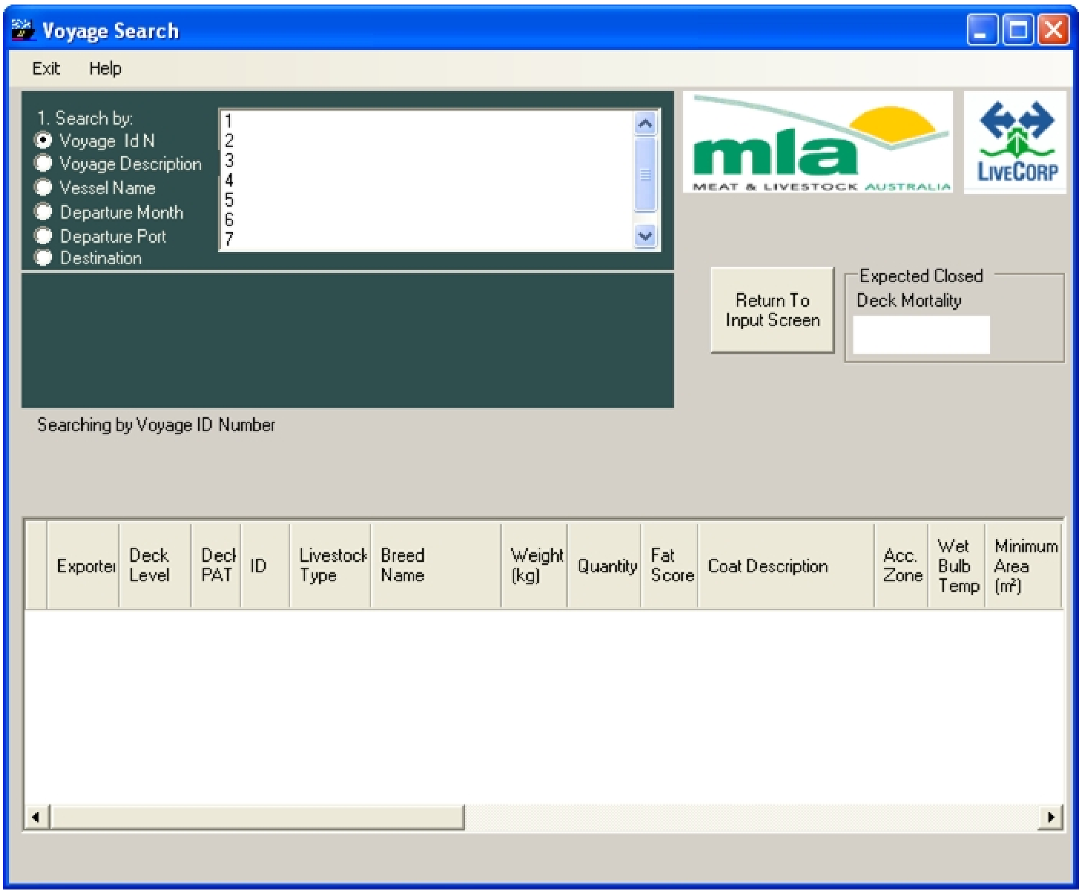


Heat Stress Risk Assesment (support for Appendix 4, Form L)

Voyage ID	Vessel	Departure Month	Departure Port	Destination	Arrival Date	Closed Deck Expected Mortality	Required Crosswind (m/s)
5	MV Deneb Prima	March	Geraldton	Dubai	27/03/2008	0%	(NConv)

Stocking Entry ID	Deck Number	Deck PAT	Livestock Type	Breed Name	Wt	Qty	Fat Score	Coat Description	Acc. Zone	Wet Bulb Temp	Min. Area	Actual Area	Loading Density	Closed Deck 5% Mortality Risk	Closed Deck Expected Mortality	Open Deck Required Cross Wind (m/s)
37	14 fore	125.00	Wether	Merino	45	9620	3	New shorn to 10mm	4	21.00	2,914.86	2,915.10	0.30			(NConv)
38	14 aft	118.00	Wether	Merino	45	3768	3	New shorn to 10mm	4	21.00	1,141.70	1,141.90	0.30			(NConv)
39	13 fore	134.00	Wether	Merino	45	9562	3	New shorn to 10mm	4	21.00	2,897.29	2,897.40	0.30			(NConv)
40	13 aft	125.00	Wether	Merino	45	3815	3	New shorn to 10mm	4	21.00	1,155.94	1,156.20	0.30			(NConv)
41	12 fore	128.00	Wether	Merino	45	9715	3	New shorn to 10mm	4	21.00	2,943.64	2,943.70	0.30			(NConv)
42	12 aft	125.00	Wether	Merino	45	3799	3	New shorn to 10mm	4	21.00	1,151.10	1,151.20	0.30			(NConv)
43	11 fore	122.00	Wether	Merino	45	9749	3	New shorn to 10mm	4	21.00	2,953.95	2,954.20	0.30			(NConv)
44	11 aft	117.00	Wether	Merino	45	3807	3	New shorn to 10mm	4	21.00	1,153.52	1,153.70	0.30			(NConv)
45	10 fore	118.00	Wether	Merino	45	9683	3	New shorn to 10mm	4	21.00	2,933.95	2,934.10	0.30			(NConv)
46	10 aft	120.00	Wether	Merino	45	3802	3	New shorn to 10mm	4	21.00	1,152.01	1,152.10	0.30			(NConv)
47	9 fore	119.00	Wether	Merino	45	9367	3	New shorn to 10mm	4	21.00	2,838.20	2,838.50	0.30			(MPAT)
48	9 aft	129.00	Wether	Merino	45	3780	3	New shorn to 10mm	4	21.00	1,145.34	1,145.60	0.30			(MPAT)
49	8 fore	120.00	Wether	Merino	45	8959	3	New shorn to 10mm	4	21.00	2,714.58	2,714.70	0.30			(MPAT)
50	8 aft	130.00	Wether	Merino	45	2613	3	New shorn to 10mm	4	21.00	791.74	791.80	0.30			(MPAT)

5 SEARCHING



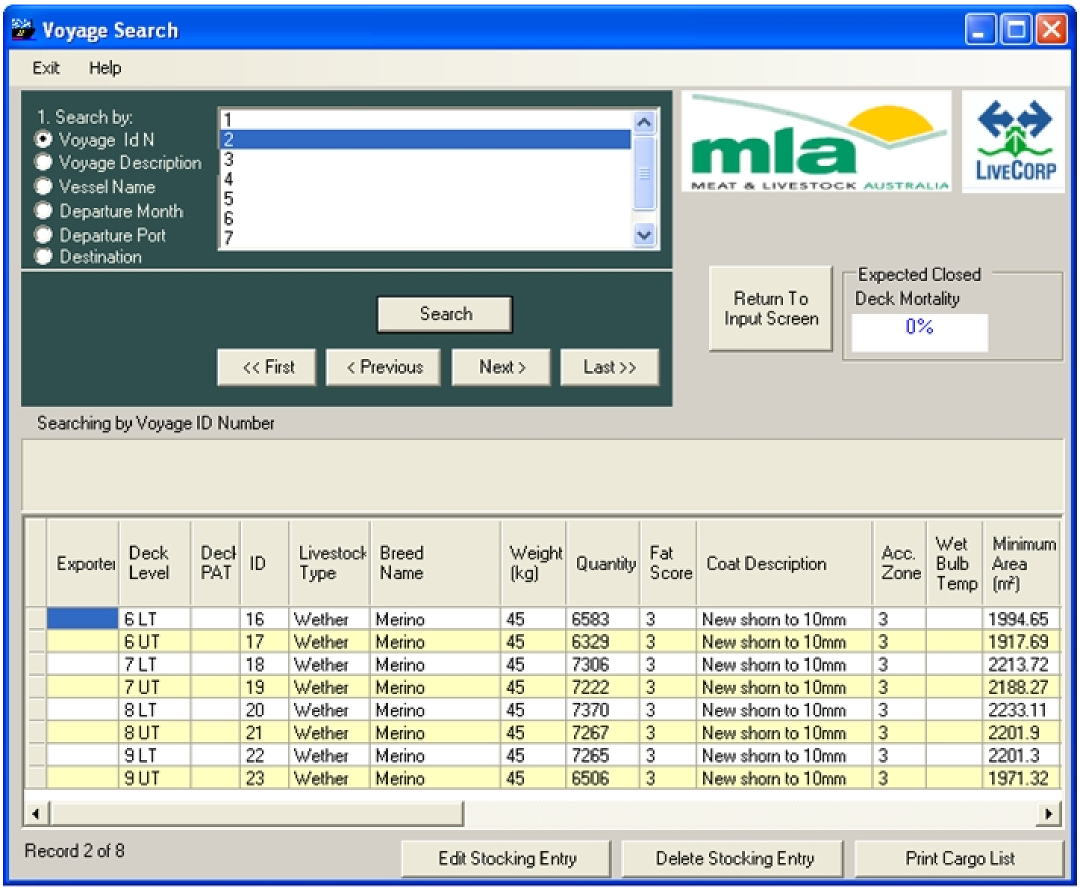
The search screen is activated by entering the File menu and clicking Find (or by using the Ctrl+F accelerator key or the appropriate toolbar button).

Searches can be conducted by the following indices:

- Voyage Id No.
- Voyage Description
- Vessel name.
- Departure month.
- Departure port.
- Destination.

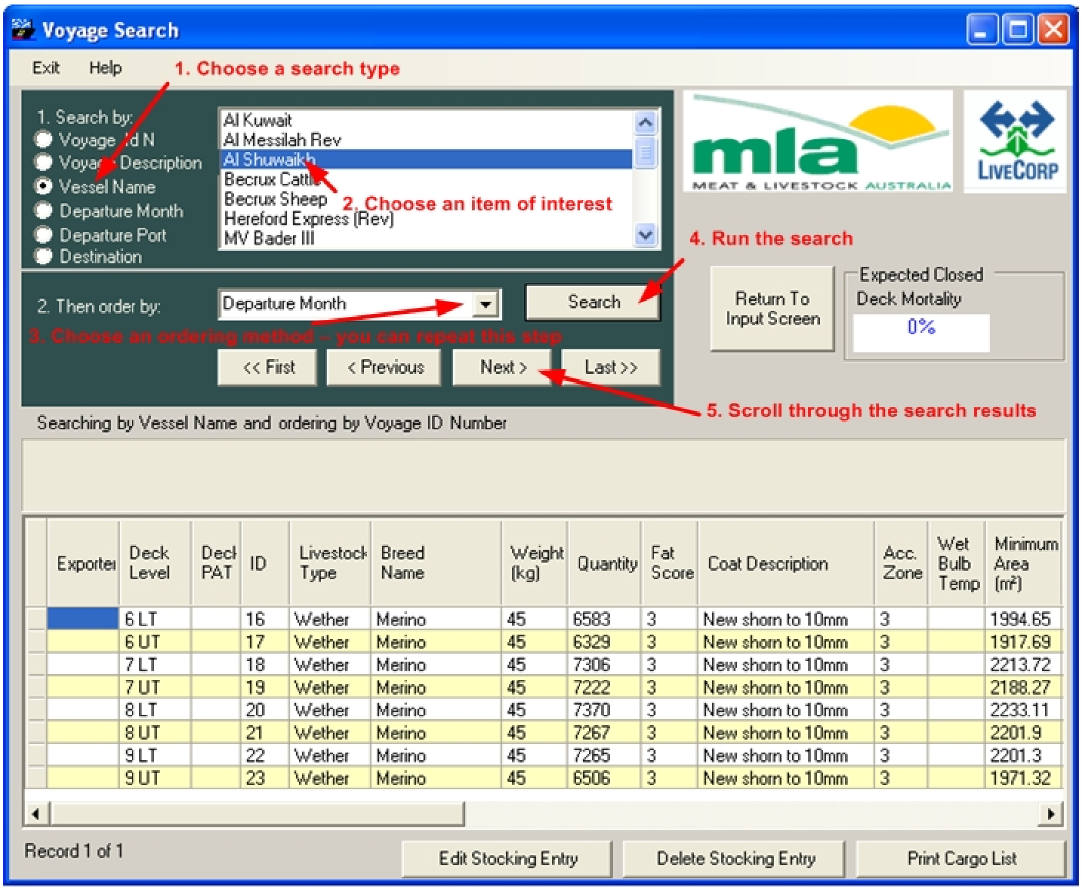
5.1 Searching by Voyage Id No or Voyage Description

Select the Voyage Id No. or Voyage Descriptions search by clicking the appropriate option button. A list of Voyage Id No's is displayed in the adjacent list box. Select the required Voyage Id No and click the *Search* button. The voyage details are displayed as shown.



Other voyages meeting the search criteria can be displayed using the “First, Previous, Next and Last” buttons.

5.2 Searching by Vessel, Departure Month, Departure or Destination Port



These criteria are searched by selecting the appropriate option button and selecting the required entity from the list, which is displayed adjacent to the option buttons. The selection is then ordered by selecting the search order criteria from the drop down box. The search criteria are displayed below the criteria selected.

The required data is displayed by clicking the *Search* button. The edit, delete and print functions operate as described in Section 1.6.

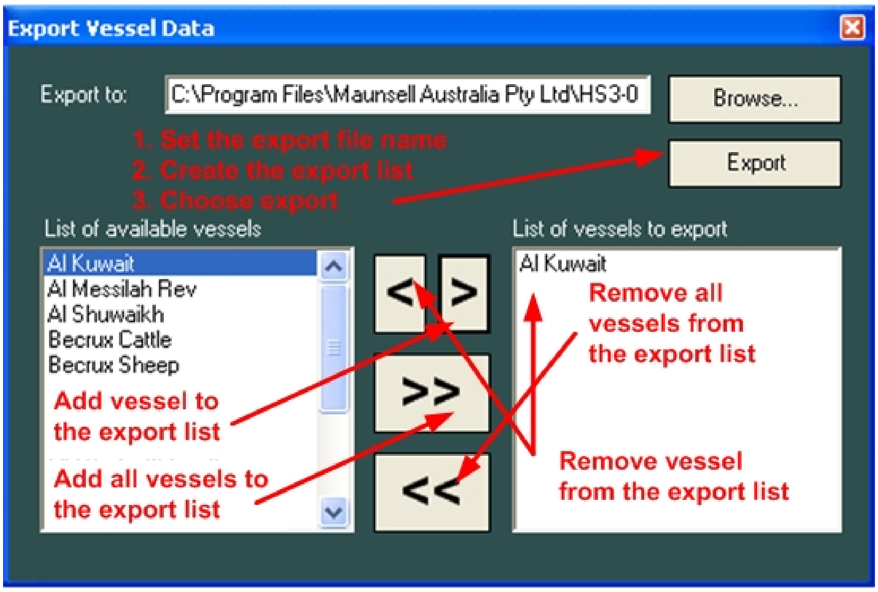
6 UTILITIES

6.1 Import Vessel Data

New vessel data may be imported into the software by going to the *Utilities* menu and then clicking on *Import Vessel Data (or by using the F5 accelerator key or the icon on the toolbar)*. The path from which the file is imported from is entered manually or selected by clicking the *Browse* button. Once the path is entered the import operation is completed by clicking the *Import* button. This should only need to be done once, on installation of vessels relevant to the user. The import vessel database facility supports only type 2.0 vessel databases. Type 1.0 databases do not contain sufficient information for open deck calculations.

6.2 Export Vessel Data

Once imported, vessel data may be exported as a vessel database file. The exported vessel database file may contain vessel and deck information about one or many vessels. A default file path given in the 'Export to' text box may be changed to export to the desired file folder. Vessels are added to the list of vessels to export by choosing the *single arrow button* for one vessel at a time or the *double arrow button* for all vessels. Similarly, single vessels can be removed from the list of vessels to export by choosing the *single arrow button* and all vessels can be removed from the list by selecting the *double arrow button*. Once the desired export list has been created the export file is created by clicking the *Export* button.

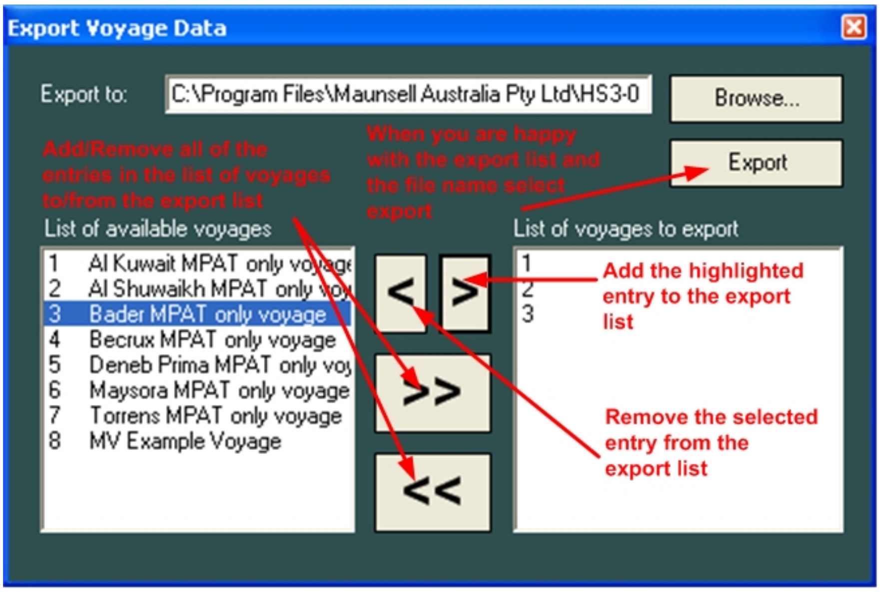


6.3 Import Voyage Data

Existing voyage data may be imported into the software by going to the *Utilities* menu and then clicking on *Import Voyage Data (or by using the F7 accelerator key or the icon on the toolbar)*. The path from which the file is imported from is entered manually or selected by clicking the *Browse* button. Once the path is entered the import operation is completed by clicking the *Import* button. The import voyage database facility supports importing from both type 1.0 (Livestock_3 databases) and type 2.0 (HS) databases. In addition to this, voyages may also be imported from voyage databases created with HS.

6.4 Export Voyage Data

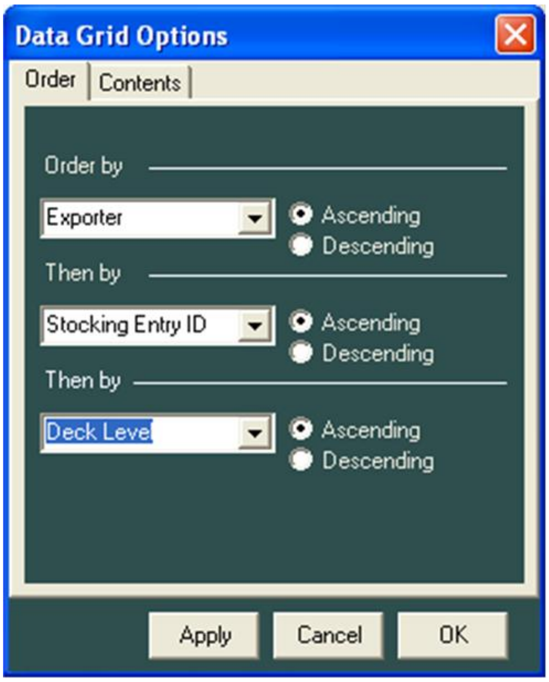
Voyage data may be exported by going to the *Utilities* menu and then clicking on *Import Vessel Data (or by using the F5 accelerator key or the icon on the toolbar)*. The exported vessel database file may contain vessel and deck information about one or many vessels. A default file path given in the 'Export to' text box may be changed to export to the desired file folder. Vessels are added to the list of vessels to export by choosing the *single arrow button* for one vessel at a time or the *double arrow button* for all vessels. Similarly, single vessels can be removed from the list of vessels to export by choosing the *single arrow button* and all vessels can be removed from the list by selecting the *double arrow button*. Once the desire export list has been created the export file is created by clicking the *Export* button.



7 OTHER OPTIONS

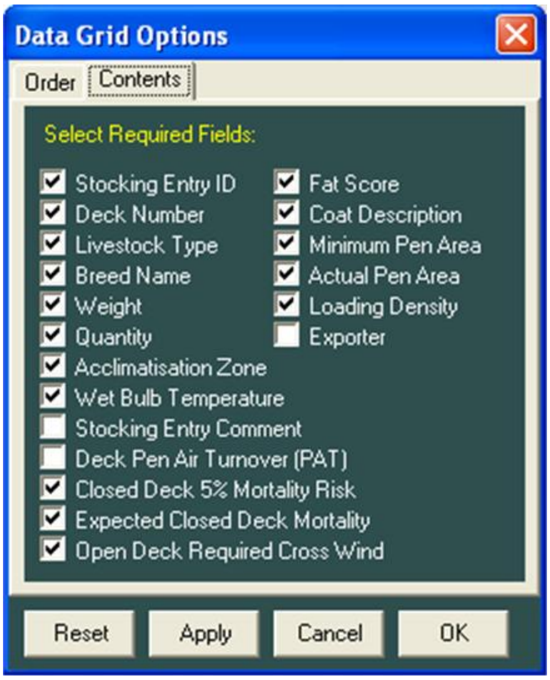
7.1 Data grid order

The data grid on the input form may be reordered by selecting Datagrid from Options in the main menu. Select the parameter by which the list is to be ordered and whether the parameter is to be listed in ascending or descending order. Selecting 'Apply' reorders the datagrid without closing the data grid order box. Selecting 'OK' reorders the datagrid and closes the data grid order box. The ordering sequence generated by the data grid order box is also used for the cargo report.

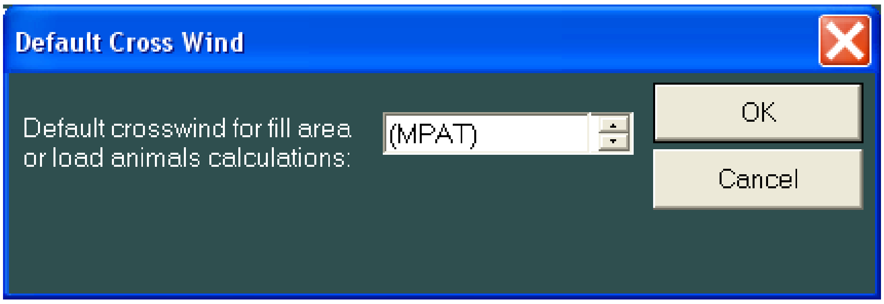


7.2 Data grid contents

The data grid contents tab in the data grid options box enables the columns shown in the data grid to be determined. Each of the columns can be selected or deselected depending on user requirements. All of the check boxes can be reset to their default values by clicking the reset button.



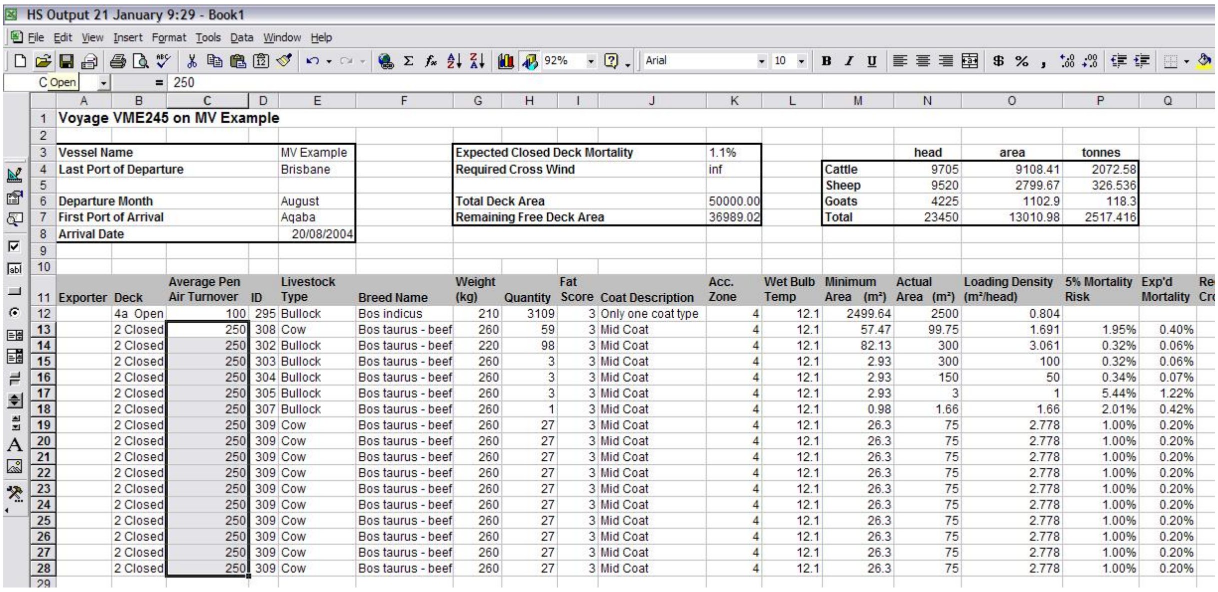
7.3 Setting the Crosswind Default Value



7.4 Export data table to Excel

At any time, all of the data in the data grid can be exported to an excel spreadsheet. The full table for the current voyage is exported in the order specified in the data grid order box. Some of the statistics are exported to the spreadsheet, but more analysis can be performed on the data, as required, by further developing the spreadsheet after the export.

The export process also sets the printer settings for the spreadsheet. If your default printer is unable to print A3 pages then you may need to set the printer settings manually.



HS Output 21 January 9:29 - Book1

Voyage VME245 on MV Example

Vessel Name	MV Example
Last Port of Departure	Brisbane
Departure Month	August
First Port of Arrival	Aqaba
Arrival Date	20/08/2004

Expected Closed Deck Mortality	1.1%
Required Cross Wind	inf
Total Deck Area	50000.00
Remaining Free Deck Area	36989.02

	head	area	tonnes
Cattle	9705	9108.41	2072.58
Sheep	9520	2799.67	326.536
Goats	4225	1102.9	118.3
Total	23450	13010.98	2517.416

Exporter	Deck	Average Pen Air Turnover	ID	Livestock Type	Breed Name	Weight (kg)	Quantity	Fat Score	Coat Description	Acc. Zone	Wet Bulb Temp	Minimum Area (m²)	Actual Area (m²)	Loading Density (m²/head)	5% Mortality Risk	Exp'd Mortality	Re Cr
	4a Open	100	295	Bullock	Bos indicus	210	3109	3	Only one coat type	4	12.1	2499.64	2500	0.804			
	2 Closed	250	308	Cow	Bos taurus - beef	260	59	3	Mid Coat	4	12.1	57.47	99.75	1.691	1.95%	0.40%	
	2 Closed	250	302	Bullock	Bos taurus - beef	220	98	3	Mid Coat	4	12.1	82.13	300	3.061	0.32%	0.06%	
	2 Closed	250	303	Bullock	Bos taurus - beef	260	3	3	Mid Coat	4	12.1	2.93	300	100	0.32%	0.06%	
	2 Closed	250	304	Bullock	Bos taurus - beef	260	3	3	Mid Coat	4	12.1	2.93	150	50	0.34%	0.07%	
	2 Closed	250	305	Bullock	Bos taurus - beef	260	3	3	Mid Coat	4	12.1	2.93	3	1	5.44%	1.22%	
	2 Closed	250	307	Bullock	Bos taurus - beef	260	1	3	Mid Coat	4	12.1	0.98	1.66	1.66	2.01%	0.42%	
	2 Closed	250	309	Cow	Bos taurus - beef	260	27	3	Mid Coat	4	12.1	26.3	75	2.778	1.00%	0.20%	
	2 Closed	250	309	Cow	Bos taurus - beef	260	27	3	Mid Coat	4	12.1	26.3	75	2.778	1.00%	0.20%	
	2 Closed	250	309	Cow	Bos taurus - beef	260	27	3	Mid Coat	4	12.1	26.3	75	2.778	1.00%	0.20%	
	2 Closed	250	309	Cow	Bos taurus - beef	260	27	3	Mid Coat	4	12.1	26.3	75	2.778	1.00%	0.20%	
	2 Closed	250	309	Cow	Bos taurus - beef	260	27	3	Mid Coat	4	12.1	26.3	75	2.778	1.00%	0.20%	
	2 Closed	250	309	Cow	Bos taurus - beef	260	27	3	Mid Coat	4	12.1	26.3	75	2.778	1.00%	0.20%	
	2 Closed	250	309	Cow	Bos taurus - beef	260	27	3	Mid Coat	4	12.1	26.3	75	2.778	1.00%	0.20%	
	2 Closed	250	309	Cow	Bos taurus - beef	260	27	3	Mid Coat	4	12.1	26.3	75	2.778	1.00%	0.20%	
	2 Closed	250	309	Cow	Bos taurus - beef	260	27	3	Mid Coat	4	12.1	26.3	75	2.778	1.00%	0.20%	
	2 Closed	250	309	Cow	Bos taurus - beef	260	27	3	Mid Coat	4	12.1	26.3	75	2.778	1.00%	0.20%	

8 Accelerator Keys

Function	Accelerator Key
New Voyage	Ctrl+N
Find Voyage	Ctrl+F
Print Voyage Risk Profile report	Ctrl+P
Import Vessel Data	F3
Export Vessel Data	F4
Import Voyage Data	F5
Export Voyage Data	F6
Delete Exporter	F8
Export to Excel	F9
Compact Database	F11
Help: Contents	F1
Help: About HS 2.3	F2
Data Grid options	Ctrl+D
Turn Tool Tip Help on/off	Ctrl+T
Load by Exporter	Ctrl+E
Set Cross Wind Default	Ctrl+S