Final report

Correlation vs causation - does hydatid disease in cattle decrease carcase weight?

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Prepared by: Victoria Brookes, Cara Wilson, Tamsin Barnes, David Jenkins

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Abstract

This project was undertaken to determine whether reduced carcase weight in cattle at processing is caused by presence of hydatid cysts.

Data were provided from 3,364,737 cattle processed between 2 January 2019 to 26 July 2022 at five processors (Beenleigh, Biloela, and Rockhampton in Queensland, Wagga Wagga in New South Wales, and Naracoorte in South Australia). Following removal of duplicates, cattle that had remained on the same PIC region from birth to processing were selected, leaving a subset of 1,648,049 cattle for descriptive and statistical analysis.

Choropleth maps showed that the distribution of hydatid disease was highly spatially dependent, with high prevalence focussed on the Brisbane region and extending from northern New South Wales and mid-north Queensland and inland to regional Queensland. Maps also indicated that cattle were, on average, lighter from northern regions, more likely to be female, and older (by dentition). Cattle with fluke detected at processing were generally from southern regions, and cattle with comorbidities were identified from across the source regions (perhaps fewer than expected from the Rockhampton processor catchment).

Statistical analyses using linear mixed-effect regression models were guided by directed acyclic graphs and included covariates to eliminate confounding, selection and information bias. The average effect of hydatid cysts on carcase weight (measured by hot standard carcase weight) was a reduction of between 0-2.5kg across all years and cohorts of cattle by age (dentition). This small effect is biologically plausible. However, although selection bias is unlikely, confounding and information bias cannot be ruled out; therefore, although estimates are consistent across age and year cohorts, findings are not definitive.

Such a small reduction in carcase weight would be a very small percentage of liveweight for most cattle and difficult to observe. Whilst this weight difference might be valuable at population level, it is debatable whether it would be sufficient for producers to be motivated to undertake greater control measures against hydatid infection in their cattle. A cost-benefit analysis (CBA) would need to be conducted to determine the value of a vaccine or implementation of other control strategies to producers and processors.

Further collection of cross-sectional observational data is extremely unlikely to further determine whether the effect of hydatid disease on carcase weight is accurate. Given the current findings, we recommend that if a CBA indicates an economically viable impact of vaccination, a field-trial on farms of the vaccine be conducted, in which the vaccine is randomised to cattle within farms and between farms. Randomisation of the intervention would determine if the currently estimated effect were causal. However, it should be noted that the study would be logistically difficult because multiple doses of vaccine are required (ideally, administration should be blinded), a large number of cattle would be required to detect small differences in weight, and the cattle would need to be followed to processing with accurate records from birth.

A vaccine trial would be more feasible than an experimental design in which cattle were randomly exposed to *Echinococcus* because it would determine impacts in organ condemnation and downgrading, as well as weight. In addition, an experimental design is likely to be logistically infeasible; the number of cattle recruited would need to be extremely large to detect such small difference in weight and cattle would have to be kept for several years with no incursions by infected canids.

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1. Background

Echinococcus granulosus is a tapeworm that causes the parasitic zoonosis hydatid disease. Despite there being several species of *Echinococcus* globally, only *Echinococcus granulosus* sensu stricto has been reported in Australia. Canid species harbour the adult tapeworm (definitive hosts). In Australia, these are domestic dogs, dingoes, and their hybrids. The intermediate hosts in which the larval stage of the parasite develop within fluid-filled (hydatid) cysts in the viscera (offal) are herbivorous or omnivorous. In Australia they are predominantly macropods, sheep, and cattle (Baldock, Arthur & Lawrence, 1985; Jenkins & Morris, 2003).

Although cattle are considered accidental hosts and infection is generally subclinical, hydatid cysts are regularly found in the viscera at processing (Baldock, Arthur & Lawrence, 1985; Wilson et al., 2019c). Hydatid cysts are primarily reported in the liver and lungs of cattle (Banks et al., 2006; Wilson et al., 2019c), but are also reported in the heart, kidney, spleen (Wilson et al., 2019c) and occasionally the brain and skeletal muscle (Baldock, Arthur & Lawrence, 1985; Moazeni et al., 2015).

The true prevalence of hydatid cysts in cattle in the Australian beef industry has recently been reported to be as high as 33%, accounting for sensitivity and specificity of meat inspection (Wilson et al., 2019c). Earlier prevalence estimates of hydatid disease in cattle which were largely based on processor data are between 14—16%, but the sensitivity and specificity of meat inspection was not accounted for (Baldock, Arthur & Lawrence, 1985; Banks et al., 2006; Roberts, 1982). Wilson et al. (2019b) suggested that if comorbidities were reported at processing, this might improve the sensitivity of routine meat inspection because hydatid cysts would be reported even if other conditions (for example, fluke) were more noticeable and therefore, more likely to be recorded.

In cattle, the prevalence of hydatid cysts at processing has been reported to be higher in older animals and those that are grass-fed (Banks et al., 2006; Pullar & Marshall, 1958; Roberts, 1982; Wilson et al., 2019c). Reported prevalence in cattle less than one year old is low (<3%) (Gemmell & Brydon, 1960; Wilson et al., 2019c), but for those that are older than four years, prevalence of up to 39.5% has been reported (Banks et al., 2006; Pullar & Marshall, 1958). A recent study by Wilson et al. (2019c) accounted for the low sensitivity of routine meat inspection and reported that the true prevalence in eight-tooth animals could be as high as 85.6%. An apparent association between sex and hydatid cysts (more frequently detected in female cattle at processing) has been reported (Baldock, Arthur & Lawrence, 1985; Banks et al., 2006; Wilson et al., 2019a). However, a recent study by Wilson et al. (2019c) indicated that the effect of sex was likely to be an artefact of the cross-sectional nature of processor data, and due to male cattle being processed at a younger age than female cattle who subsequently have a longer exposure period.

The prevalence of hydatid cysts at processing has also been shown to vary with geographic origin (Wilson et al 2019). In a study in which data were acquired from a northern New South Wales processor, Wilson et al. (2019c), reported hydatid cysts at processing in almost all regions in which cattle were sourced, but, consistent with other studies, regions where prevalence was higher included those located in the Great Dividing Range and along the northern coast of New South Wales (Baldock, Arthur & Lawrence, 1985; Banks et al., 2006; Gemmell & Brydon, 1960; Wilson et al., 2019c). This spatial variation in prevalence of infection has been attributed to the distribution of wild dogs, macropods and climatic conditions (Banks et al., 2006; Gemmell & Brydon, 1960).

Parasitic diseases can lead to major economic losses in livestock industries due to condemnation and downgrading of affected carcass parts, lost productivity and reduced market access (Bisset, 1994; Chick, 1979; Torgerson & Dowling, 2001; Wilson et al., 2020). Globally, annual economic losses from hydatid disease in livestock as high as $2,190,132,464 (95% CI, $1,572,373,055–$2,951,409,989) have been estimated, due to liver condemnation, decreased carcase weight,

decreased fecundity, reduced milk production and decreased hide value (Budke, Deplazes & Torgerson, 2006). The detection of hydatid cysts and subsequent downgrading or condemnation of affected organs at processing has recently been reported to have financial impacts on the Australian beef industry (Wilson et al., 2020). The estimated direct loss to a single processor resulting from the condemnation and downgrading of such organs was estimated to be AUD 6.70 per infected animal at an apparent prevalence of 8.9% cattle with hydatid cysts (Wilson et al., 2020). As can be expected, at a population level, losses resulting from hydatid disease found in viscera are highest in grass-fed, eight-tooth, female cattle. However, at an individual level, losses from infected cattle were greatest in eight-tooth, grain-fed cattle because the livers from these cattle are typically larger and more valuable than those from grass-fed cattle (Wilson et al., 2020). It should be noted that the direct losses estimated in studies such as Wilson et al. (2020) can be estimated with a reasonable degree of accuracy because they only relate to the organs deemed unfit for human consumption by the meat inspector regardless of their true prevalence of disease.

Indirect losses, such as potentially reduced carcass weight, are more difficult to measure due to inaccurate reporting of hydatid disease at processing and other causes of reduced carcase weight such as concurrent disease (comorbidities; Wilson et al. (2020)) and management decisions (for example, feed system and cattle breed), particularly those that are related to the geographic and climatic conditions of the farm which also influence exposure to *Echinococcus* larvae. A number of studies have estimated indirect losses (Benner et al., 2010; Harandi, Budke & Rostami, 2012; Sariozkan & Yalcin, 2009), and one of the first studies to suggest a potential impact on weight resulting from hydatid disease was Polydorou (1981) but did not specify the species studied. Several studies have reported economic losses associated with reduced productivity (Haftu & Kebede, 2014; Moro et al., 2011; Torgerson, Carmona & Bonifacino, 2000), but have not measured losses resulting from infection with hydatid cysts such as carcase weight, directly.

Understanding the impact that hydatid disease has on the productivity of cattle is important for prevention and control. While the losses incurred due to condemnation and downgrading of viscera are important at an industry level, they are not incurred by the producer because producers are not paid for the offal. Prevention and control of hydatid disease and costs associated with this occur at the producer level. Therefore, incentive to adopt control strategies, such as deworming of domestic dogs, on-farm wild dog control, and potentially, the vaccination of cattle against infection with hydatid cysts needs to have benefit for the producer. It is speculated that if hydatid disease reduces the carcase weight of cattle, producers will have more incentive to prevent disease in their cattle.

2. Objectives

The primary objective of this study was to estimate the effect of the presence of hydatid cysts on the carcase weight of cattle processed at several processors in eastern Australia to determine the relevance of this disease to beef producers. These processors were selected because they report comorbidities in the viscera. A secondary objective was to describe the occurrence and spatial distribution of hydatid disease in cattle reported by routine meat inspection at processing.

The primary objective has been achieved as completely as possible with the dataset provided. It is not possible to eliminate all confounding, but the estimated effects are biologically plausible. The secondary objective has been completed.

3. Methodology

Data were provided from 3,364,737 cattle processed between 2 January 2019 to 26 July 2022 at five processors (Beenleigh, Biloela, and Rockhampton in Queensland, Wagga Wagga in New South Wales, and Naracoorte in South Australia).

Extensive data preparation was conducted. Conditions other than fluke (recorded in a separate column) that were identified at processing and could have influenced carcase weight (co-morbidities) were identified from the 'assessments codes' column in the raw data and re-categorised. These included arthritis, bruising, and other carcass defects such as cancer, anaemia, antibiotic treatment, fracture, myositis (see Appendix A for full list of comorbidities included in 'other comorbidities'). Cattle were removed from the dataset if they were vealers (zero-tooth and <150kg), or if they had a hot standard carcase weight (HSCW) <50kg.

Hydatid disease was categorised to a single binary variable according to whether hydatid cysts were detected in any organ. Age was classified according to dentition with zero-, two-, four-, six-, and eight-tooth cattle of approximate ages <18 months, 18—30 months, 24—36 months, 30—42 months, and ≥42months, respectively.

Descriptive statistical analyses of cattle characteristics, disease, and carcase weight (outcome of interest; measured by hot standard carcase weight [HSCW]) were conducted, focusing on the cattle that had remained in the same Property Identification Code (PIC) region for their lifetime.

Choropleth maps of characteristics of the cattle at processing from each PIC region were produced. These included: the number of cattle, proportion of cattle in which hydatid cysts were detected (the exposure variable of interest), proportion of cattle detected with fluke, proportion of cattle detected with comorbidities, proportion of grain-fed cattle, distribution of sex, dentition, and carcase weight (outcome of interest). Choropleth maps were also used to display the mode frequency of processor for cattle in each PIC region, and the mean distance travelled to processors from the centroid of each PIC region.

A directed acyclic graph (DAG; Figure 1) of variables that influence both the identification of hydatid disease at processing and HSCW was developed to guide investigation of the relationship between the presence of hydatid cysts and HSCW. This relationship was investigated using linear, mixed effects regression models with adjustments for confounding pathways. Covariates included the presence of fluke and comorbidities, sex and whether the animal was grainfed, and PIC region was included as a random effect.

The dataset represents the proportion of cattle with conditions (for example, hydatid cysts and fluke) in cattle at processing and not the incidence of these conditions. To account for confounding pathways that could influence the incidence of hydatid disease in cattle (as well as carcase weight), and the effects of hydatid disease, it is important to not only account for temporal associations (for example, a management decision that could influence the incidence of hydatid disease must come before the exposure), but also ensure that analyses are conducted within cohorts that are comparable regarding exposure and outcome incidences (experiences) throughout the chain of events, including having a similar duration of disease. Therefore, analyses were conducted on subgroups of cattle of the same age (dentition) and year of processing so that the population in each stratum could be considered stable regarding the number of cattle in subgroups of exposure experiences (including covariates) and subsequent hydatid disease incidence and duration. Year of processing was stratified in addition to age group to reduce the influence of longer-term changes to population stability associated with climate trends. Lastly, hydatid disease is highly unlikely to cause death in cattle; therefore, hydatid disease would be unlikely to appear to increase the weight of cattle who had hydatid disease at processing – these cattle are not 'hydatid disease survivors.' Additionally, hydatid

disease (the exposure) could not be influenced by experiencing the outcome (weight change); therefore, reverse causality of weight on hydatid was not possible.

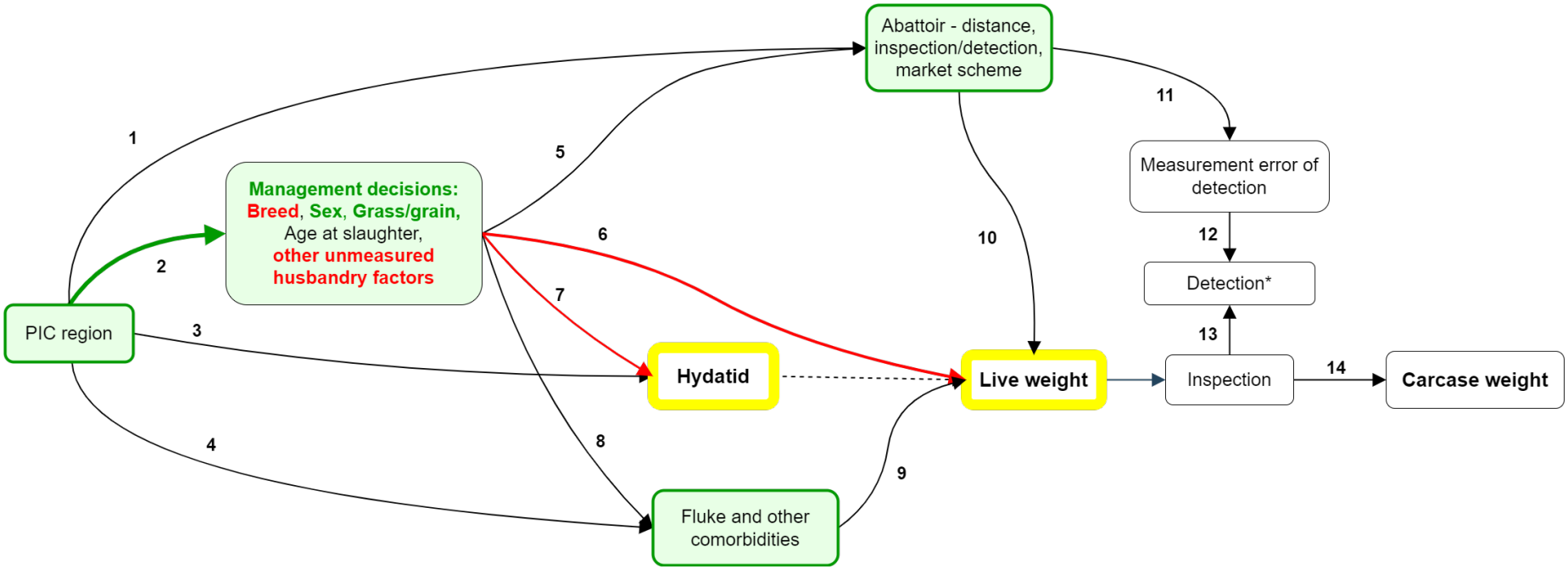

Figure 1 Directed acyclic graph for the investigation of the causal effect of hydatid disease on carcase weight (measured as hot standard carcase weight) of cattle.

Confounding pathways from 'Hydatid' into 'Live Weight' and 'Carcase weight' are controlled via measured variables 'Abattoir' (Path 10) and 'Fluke and other comorbidities' (Path 9). The variable 'PIC region' is controlled as a surrogate confounder to eliminate some confounding due to the pathway between 'Hydatid' and 'Live weight' via 'Management decisions.' Whilst some of the variables in the 'Management decisions' group can be controlled (sex, and whether grass- or grain-fed), others are unmeasured, such as breed and proximity to wild dog habitat; however, there is likely a strong association between these unmeasured confounders and PIC region. Dependent measurement and misclassification errors that could cause information bias are also blocked via 'Abattoir'. Overall, inclusion of variables in green as covariables in the regression equations isolate the causal effect of Hydatid on Carcase weight. However, it is possible that remaining confounding could occur from Hydatid to Live Weight via Paths 7 and 6.

4. Results

4.1 Processors

Following removal of duplicates, cattle that had remained on the same PIC region from birth to processing were selected, leaving a subset of 1,648,049 cattle for the analysis. Most of these cattle were processed in the three Queensland processors (n = 1,195,472, 72.5%; Figure 2), of which Rockhampton processor processed most (n = 523,772). Naracoorte in South Australia processed the fewest (n = 160,661).

Figure 3 shows the geographic extent from where cattle were sourced (most from eastern regional and mid to mid-north coast Queensland). The median number of cattle processed from each PIC region was 1,268 (range 1—218,627). The median number of farms in each PIC was 49 (range 1—861), and the median number of cattle processed from each farm was 1,268 (range 1—218,627).

The annual number of cattle processed at all the processors in the study decreased from 607,939 in 2019 to 196,263 in 2022 (Figure 4).

The source distribution and distances travelled to processors by cattle were similarly geographically broad for each processor (Figure 5 and Figure 6). Overall, median distance travelled was 242km (95% range 32—1389km). The distribution of all cattle for each processor is included in Appendix B.

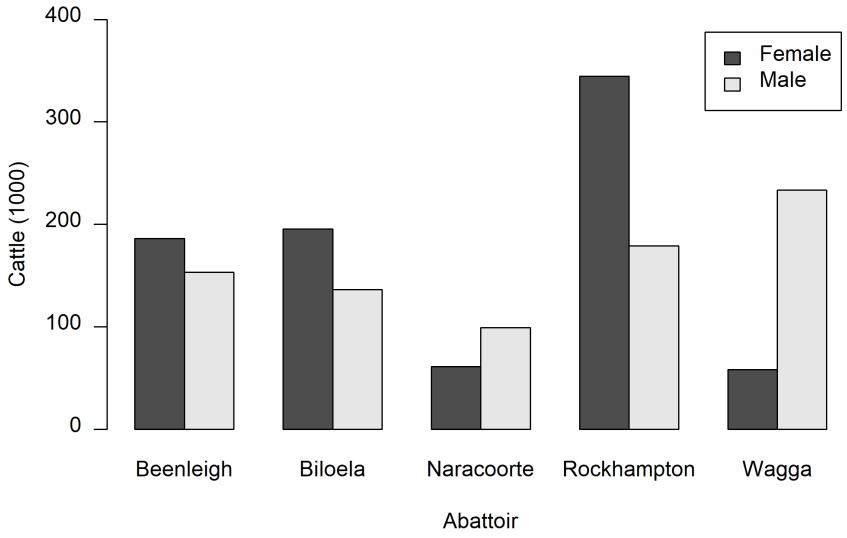

Figure 1 Number of cattle which had remained on the same property identification code (PIC) region for their lifetime, processed at each processor and stratified by sex, in a study of the effect of hydatid disease on carcase weight at five processors in eastern Australia, 2019-2022.

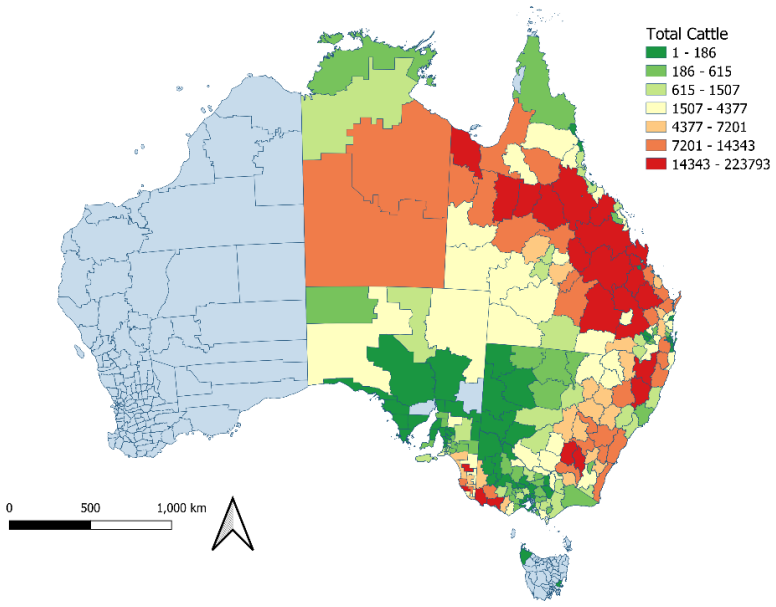

Figure 2 Number of cattle which had remained on the same property identification code (PIC) region for their lifetime processed from each PIC region, in a study of the effect of hydatid disease on carcase weight at five processors in eastern Australia, 2019-2022.

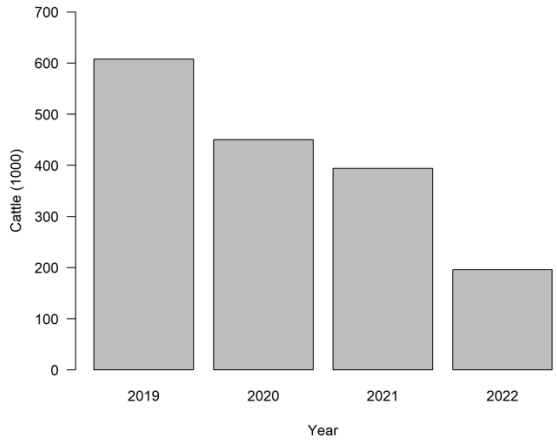

Figure 3 Annual number of cattle processed which had remained on the same property identification code region for their lifetime in a study of the effect of hydatid disease on carcase weight at 5 processors in eastern Australia, 2019-2022.

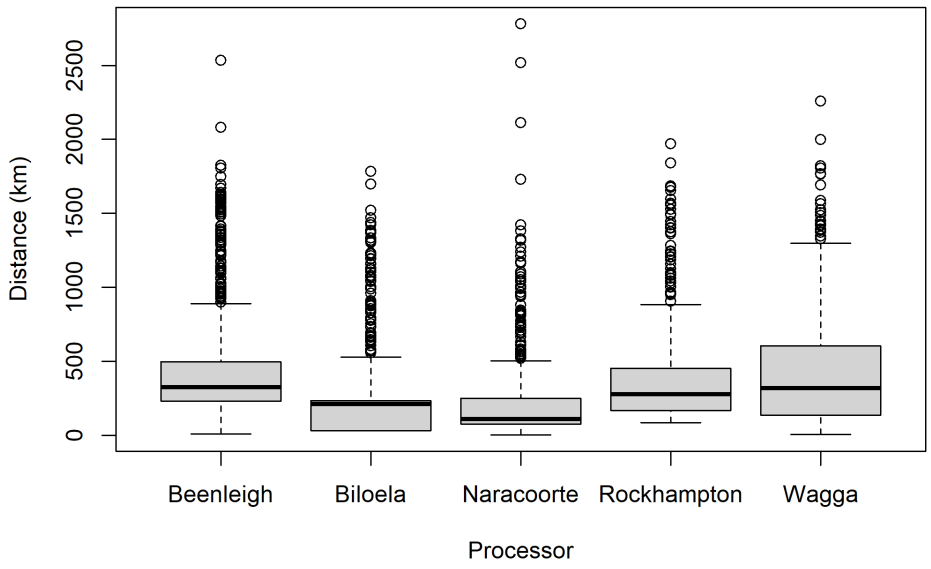

Figure 4 Distance travelled to processor by cattle which had remained on the same property identification code region for their lifetime in a study of the effect of hydatid disease on carcase weight at 5 processors in eastern Australia, 2019-2022.

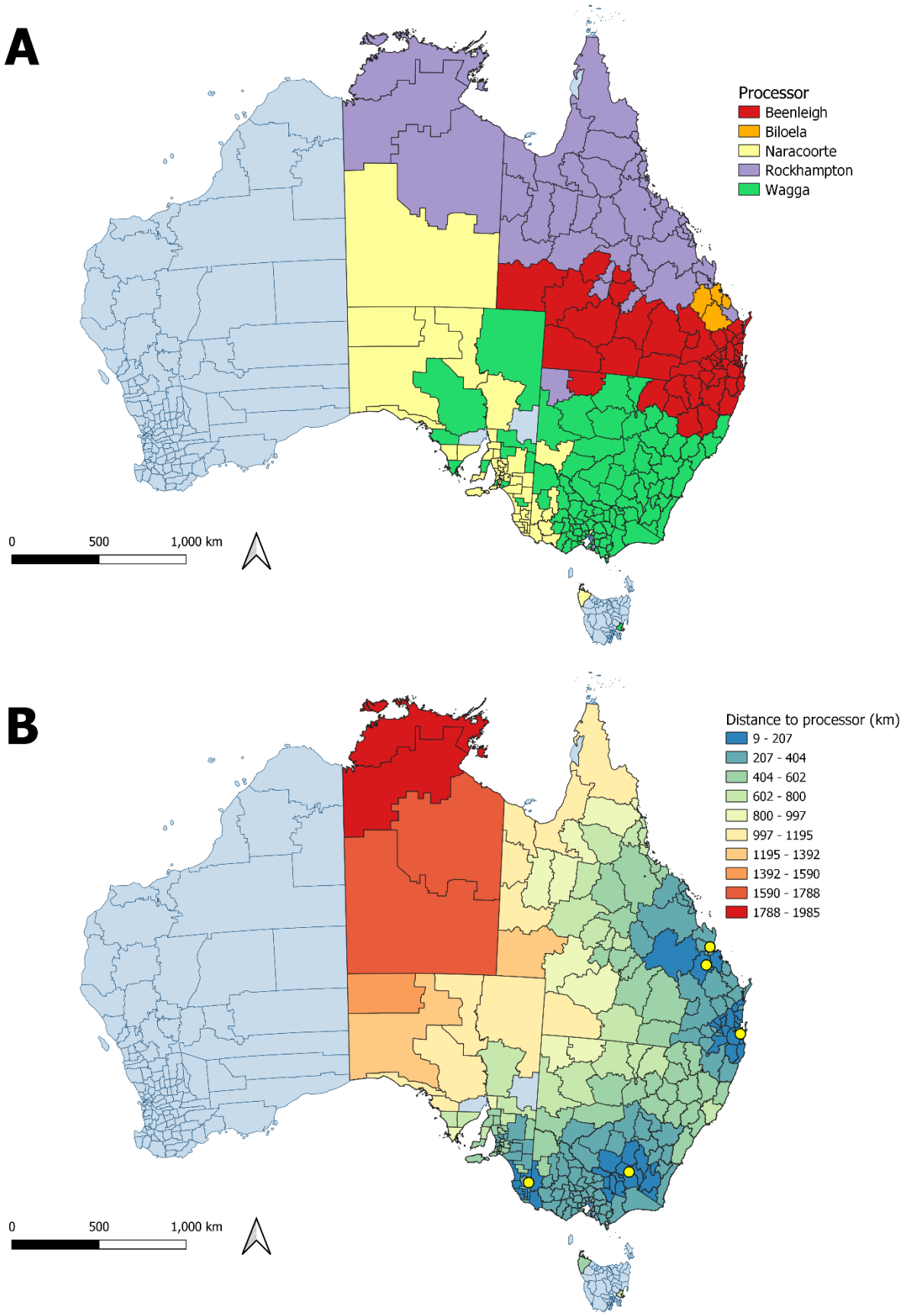
A
Processor
Beenleigh
Biloela
Naracoorte
Rockhampton
Wagga
0
500
1,000 km
B
Distance to processor (km)
9 - 207
207 - 404
404 - 602
602 - 800
800 - 997
997 - 1195
1195 - 1392
1392 - 1590
1590 - 1788
1788 - 1985
0
500
1,000 km

Figure 5 A) Most frequent processor for cattle by PIC region, and B) mean distance travelled to processor by cattle which had remained on the same property identification code region for their lifetime in a study of the effect of hydatid disease on carcase weight at 5 processors in eastern Australia, 2019-2022.

4.2 Cattle characteristics

In Queensland abattoirs, most cattle processed were female (n = 726,215, 60.7%; Figure 2). In contrast, most cattle processed in the New South Wales (Wagga Wagga) and South Australia (Naracoorte) processors were male (n = 332,675, 73.5%). Figure 7 shows the distribution of the proportion of cattle by sex according to PIC source.

By dentition, the largest group of cattle were eight-tooth females (n = 479,011), and the smallest was eight-tooth males (n = 60,757; Figure 8). Figure 9 shows that older cattle were more likely to have been sourced from northern PICs.

The proportion of cattle that had been grain-fed also varied by region, with grain-fed cattle commonly being from southern PICs (Figure 10).

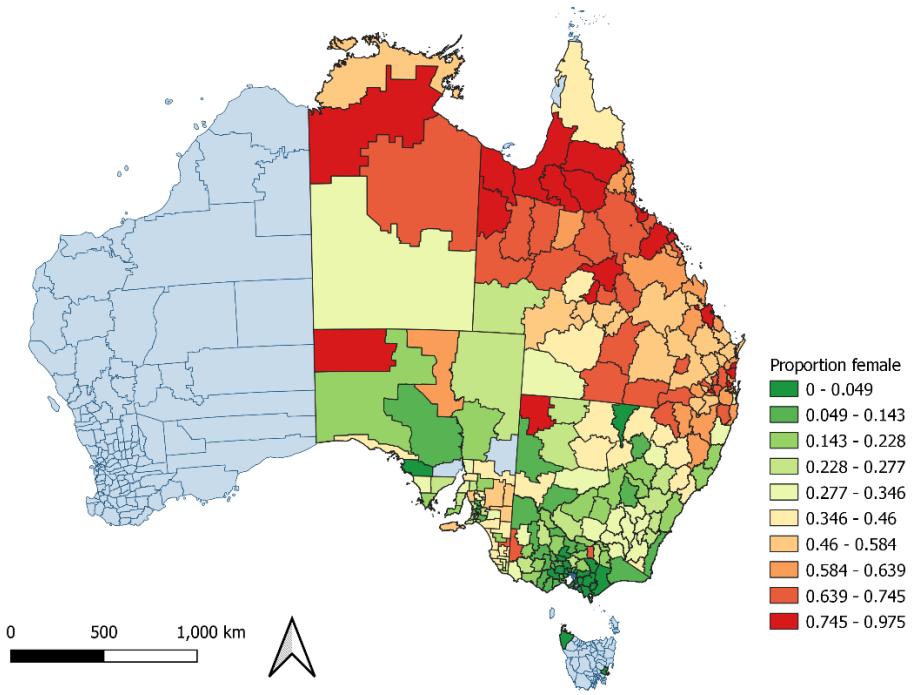

Figure 6 Proportion of sex of cattle which had remained on the same property identification code (PIC) region for their lifetime processed from each PIC region, in a study of the effect of hydatid disease on carcase weight at five processors in eastern Australia.

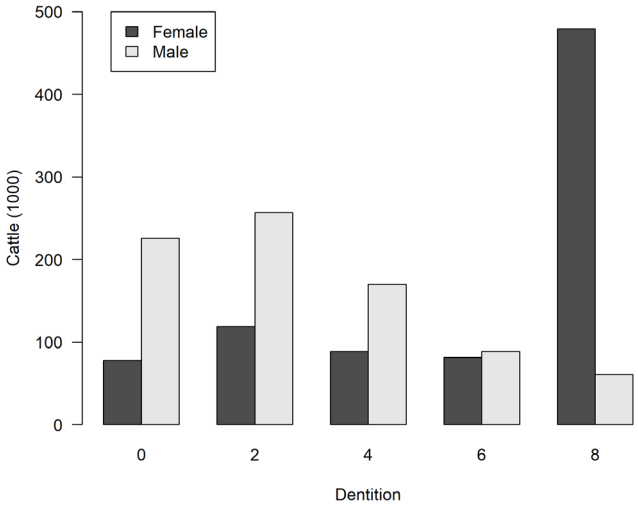

Figure 7 Number of cattle which had remained on the same property identification code region for their lifetime by dentition and sex, in a study of the effect of hydatid disease on carcase weight at five processors in eastern Australia, 2019-2022.

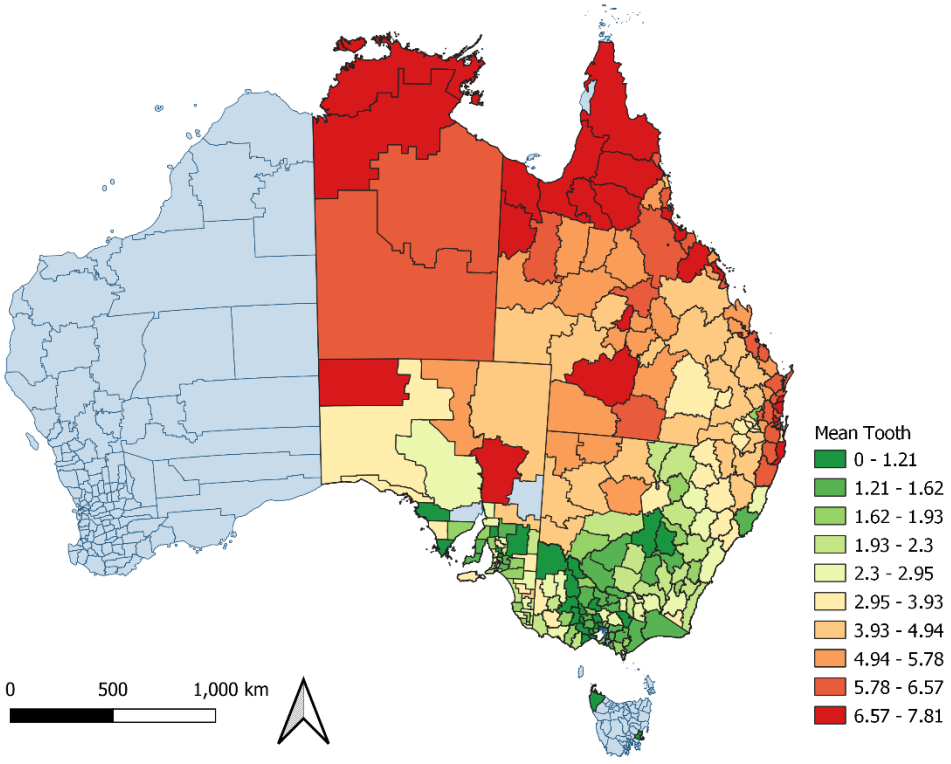

Figure 8 Age of cattle by number of dentition (1—8 teeth) which had remained on the same property identification code (PIC) region for their lifetime, processed from each PIC region, in a study of the effect of hydatid disease on carcase weight at five processors in eastern Australia, 2019-2022.

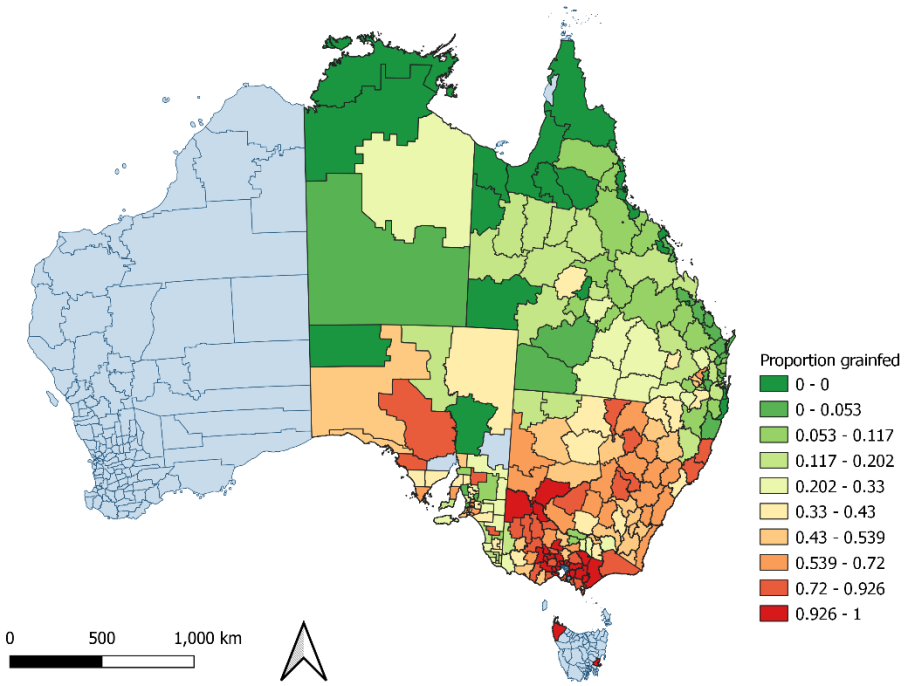

Figure 9 Proportion of grain-fed cattle which had remained on the same property identification code (PIC) region for their lifetime, processed from each PIC region, in a study of the effect of hydatid disease on carcase weight at five processors in eastern Australia, 2019-2022.

4.3 Disease detection

The distribution of the proportion of cattle with comorbidities detected at processing varied throughout the source region (Figure 11). In contrast, the proportion of cattle with hydatid cysts (any location) and liver fluke demonstrated a strong spatial pattern (Figure 12 and Figure 13). Carcases with hydatid cysts were more commonly detected in cattle from northern NSW and southeast and coastal Queensland, and carcases with liver fluke were more commonly detected in New South Wales and Victoria, especially southwest coastal regions.

Of particular interest was the high proportion of cattle with hydatid cysts detected in the Brisbane region (Figure 14). Although fewer cattle were processed from this region, the proportion of cattle in which hydatid cysts were detected was consistently high (0.33—0.70).

The proportion of all cattle with hydatid cysts detected in any organ was 17.2% (n = 283,073). Of these, 94% of cattle had cysts detected in the liver (44% in liver and lung), and 6% had cysts detected in the lung only (Figure 15). A negligible number of cattle had cysts detected in the spleen (n = 44), and heart (n = 29), and of these, most also had hydatid detected in the liver (n = 67; 92%).

The proportion of cattle detected with hydatid cysts increased with age (Figure 16). Hydatid cysts were also more commonly detected in cattle that had not been grain-fed, and in female cattle (Figure 15). Female cattle were less commonly grain-fed (Figure 17) and a higher proportion of them were older (eight-tooth) cattle (Figure 8).

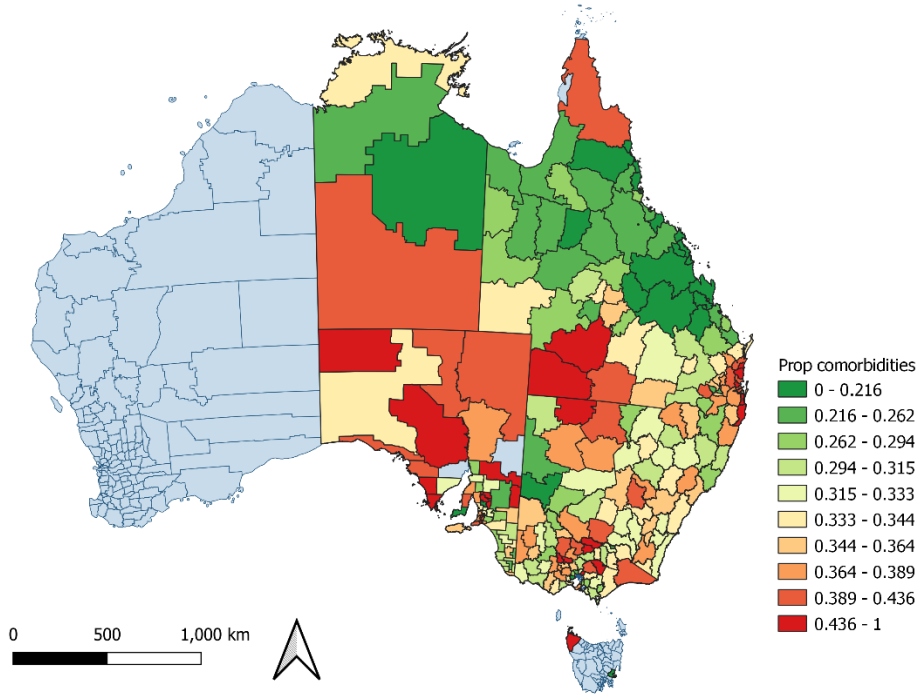

Figure 10 Proportion of cattle which had remained on the same property identification code (PIC) region for their lifetime, with comorbidities (disease conditions other than hydatid cysts or liver fluke) detected at processing from each PIC region, in a study of the effect of hydatid disease on carcase weight at five processors in eastern Australia, 2019-2022.

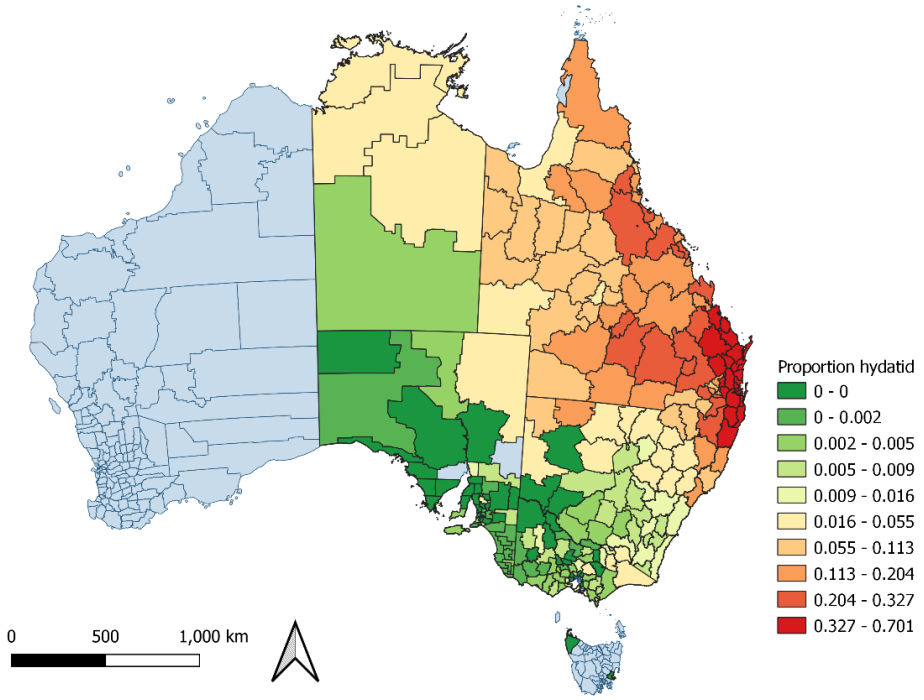

Figure 11 Proportion of cattle which had remained on the same property identification code (PIC) region for their lifetime, with hydatid cysts detected at processing from each PIC region, in a study of the effect of hydatid disease on carcase weight at five processors in eastern Australia, 2019-2022.

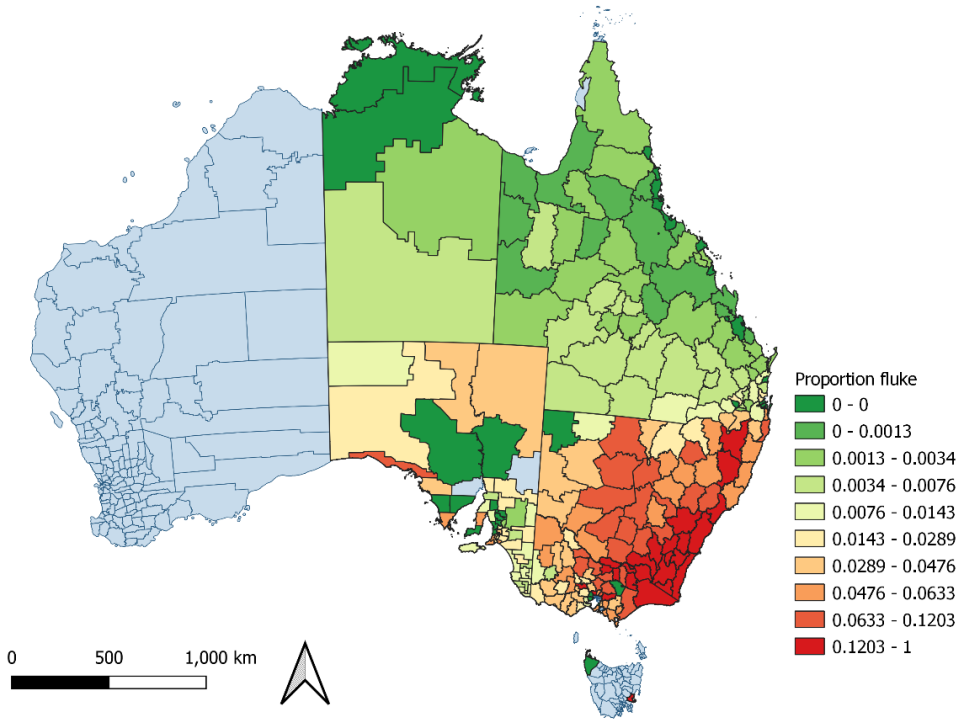

Figure 12 Proportion of cattle which had remained on the same property identification code (PIC) region for their lifetime, with liver fluke detected at slaughter from each PIC region, in a study of the effect of hydatid disease on carcase weight at five processors in eastern Australia, 2019-2022.

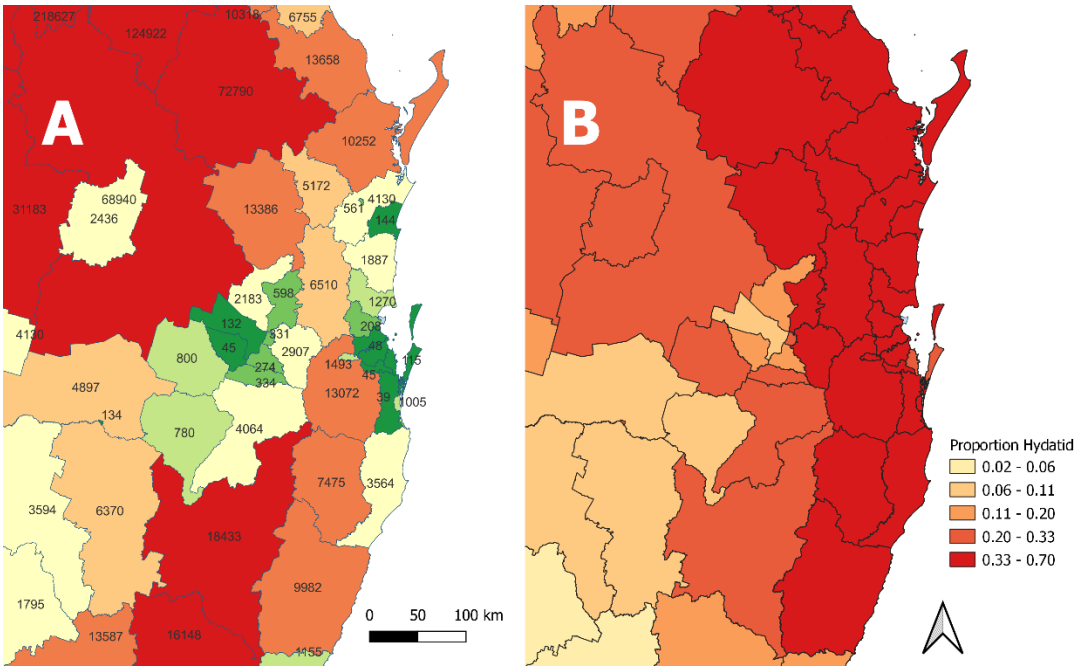

Figure 13 Number of cattle processed (A) and proportion detected with hydatid cysts (B) which had remained on the same property identification code (PIC) region in the Brisbane region for their lifetime, by PIC region, in a study of the effect of hydatid disease on carcase weight at five processors in eastern Australia, 2019-2022.

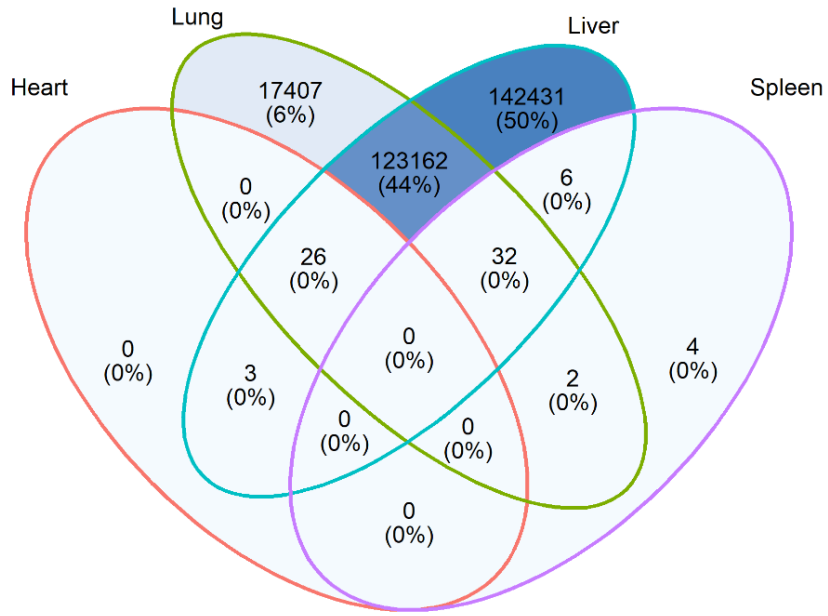

Figure 14 Venn diagram of the numbers and proportions of cattle which had remained on the same property identification code (PIC) region for their lifetime, in which hydatid cysts were detected the liver, lungs, spleen and heart, in a study of the effect of hydatid disease on carcase weight at five processors in eastern Australia, 2019-2022.

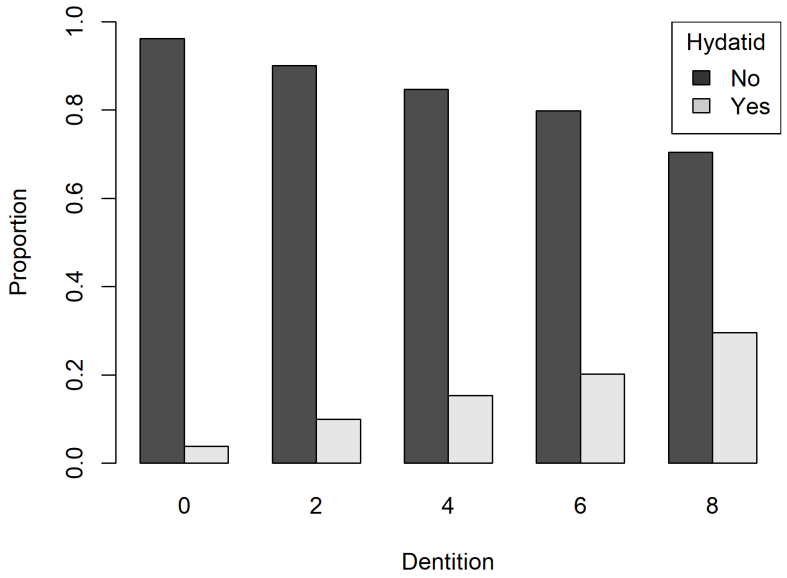

Figure 15 Barplot of the proportion of cattle which had remained on the same property identification code (PIC) region for their lifetime, in which hydatid cysts were detected in any organ stratified by age, in a study of the effect of hydatid disease on carcase weight at five processors in eastern Australia, 2019-2022.

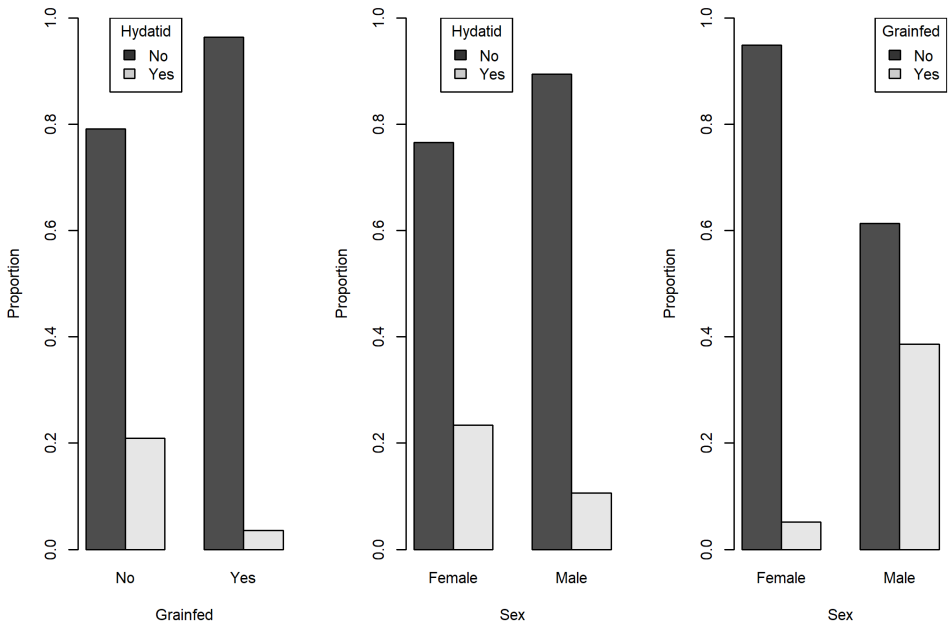

Figure 16 Barplots of the proportion of cattle which had remained on the same property identification code (PIC) region for their lifetime, in which hydatid cysts were detected in any organ stratified by sex and whether they were grain-fed, in a study of the effect of hydatid disease on carcase weight at five processors in eastern Australia, 2019-2022.

4.4 Carcase weight

Hot standard carcase weight (HSCW) was similar between all age groups (Figure 18). Female cattle were generally lighter, with mean HSCW 261.29kg (95% range 182.4—363.6kg, n = 846,117 cattle). Male cattle had a mean HSCW of 330.19kg (95% range 235.8—433.4kg, n = 801,932cattle).

Carcases from cattle that were not grain-fed were also lighter than grain-fed cattle (Figure 19). Mean HSCW in grain-fed cattle was 340.4kg (95% range 245.8—439.4kg; n = 353,211 cattle), and mean HSCW in non-grain-fed cattle was 282.4kg (95% range 188—379.9kg, n = 1,294,828).

Carcase weight was generally lower in carcases in which hydatid cysts were detected (Figure 20). Mean HSCW in cattle in which hydatid cysts were detected was 283kg (95% range 189.2—404kg; n = 283,073 cattle), and mean HSCW in cattle in which hydatid cysts were not detected was 297.3kg (95% range 192—417.5kg, n = 1,364,976).

Figure 19 shows a timeseries of several variables and the monthly proportion of carcases detected with hydatid. There is a strong temporal pattern between the proportion of female cattle, cattle that were not grain-fed, the mean age of cattle and the mean carcase weight of cattle that were processed each month, and the proportion of cattle in which hydatid cysts were detected.

These findings are consistent with the strong spatial pattern of the mean weight of cattle processed increasing from northern to southern PICs (Figure 14), where cattle in the northern PICs are more likely to be female, older, and not grain-fed. This is also the region in which hydatid cysts are more commonly detected in processed cattle. The following section investigates the possibility that lower carcase weight loss can be attributed to the presence of hydatid cysts.

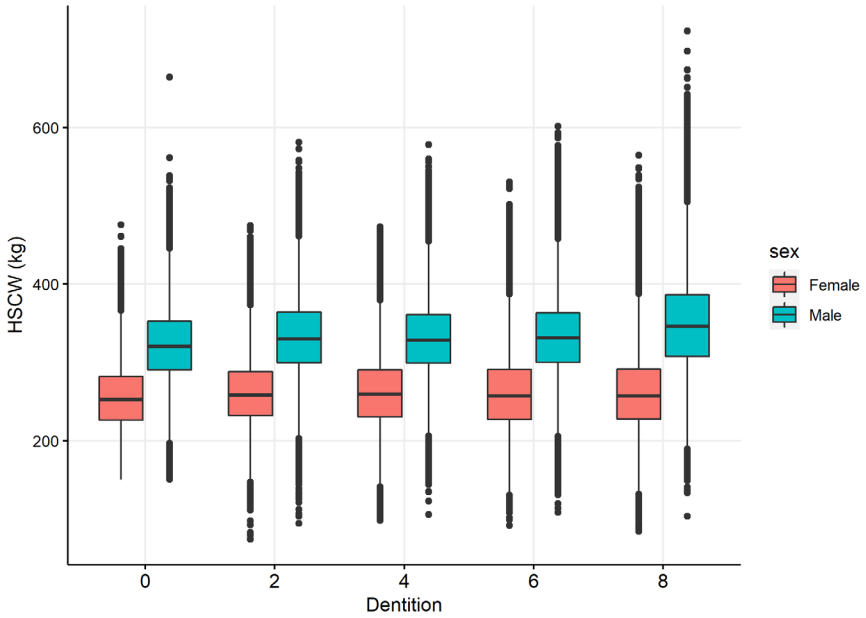

Figure 17 Carcase weight (HSCW = hot standard carcase weight) of cattle which had remained on the same property identification code (PIC) region for their lifetime, stratified by sex, in a study of the effect of hydatid disease on carcase weight at five processors in eastern Australia, 2019-2022.

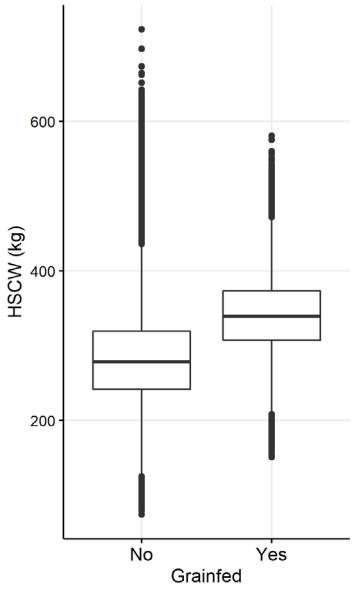

Figure 18 Carcase weight (HSCW = hot standard carcase weight) of cattle which had remained on the same property identification code (PIC) region for their lifetime, stratified by whether they were grain-fed, in a study of the effect of hydatid disease on carcase weight at 5 processors in eastern Australia, 2019-2022.

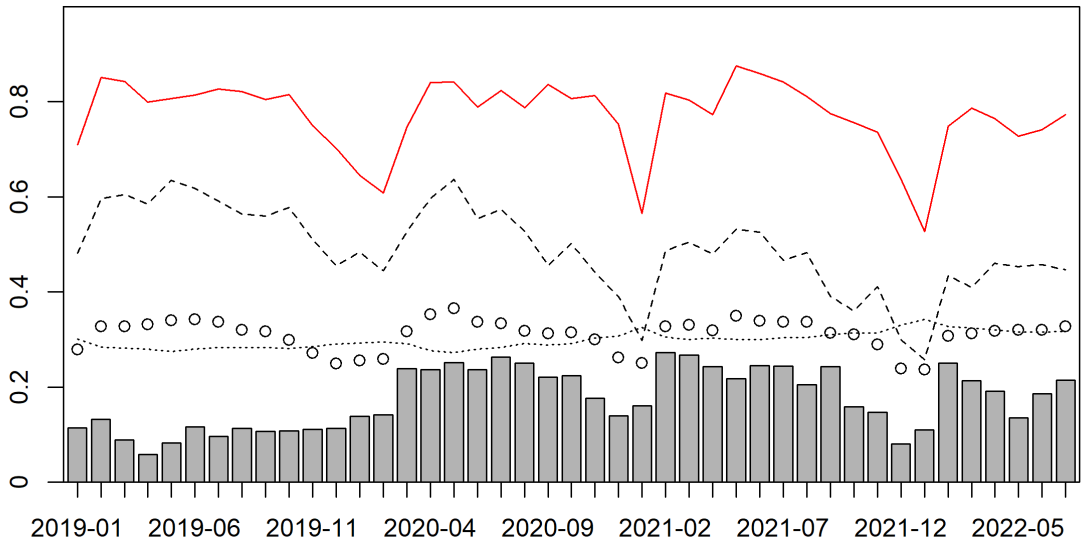

Figure 19 Timeseries of monthly mean proportion of cattle in which hydatid cysts were detected, were not grain-fed, were female, carcase weight (/1000), and age by dentition (/10), in a study of the effect of hydatid disease on carcase weight at five processors in eastern Australia, 2019-2022. Red line = proportion not grain-fed, dashed line = proportion of female cattle, circles = mean age by dentition/10, dotted line = mean carcase weight/1000, grey bars = proportion of cattle in which hydatid cysts were detected.

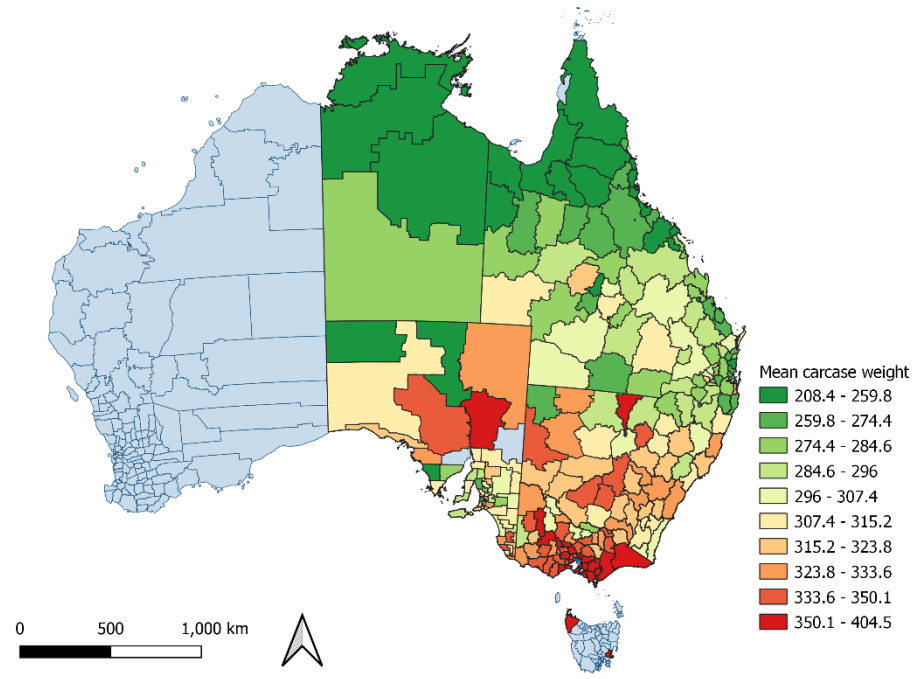

Figure 20 Mean hot standard carcase weight of cattle which had remained on the same property identification code (PIC) region for their lifetime, from each PIC region in a study of the effect of hydatid disease on carcase weight at five processors in eastern Australia, 2019-2022.

4.5 Statistical analysis

Table 1 shows a series of preliminary models in the statistical analysis of the effect of hydatid cysts on carcase weight to explore the effect of clustering of weight by location. The null model (A) indicates that the outcome of carcase weight (measured by hot standard carcase weight) is moderately clustered by PIC region, because the ICC (intraclass correlation coefficient; ICC) is high relative to the full model (D), at 0.31 and 0.18, respectively.

The univariable model (B; presence of hydatid cysts only) with no random effects indicates that without adjustment for confounding pathways, the effect on weight appears to be quite large (carcases in which hydatid cysts were detected are on average 14.25kg; standard error, se 0.12kg). However, much of this is accounted for by PIC region, because the effect reduces to 6.71kg (se 0.12) once PIC region is included as a random effect (model C).

The effect on carcase weight further reduces to 4.46kg (se 0.1kg) in the full model in which potentially confounding pathways are accounted for by inclusion of covariates (sex, presence of comorbidities, presence of fluke, abattoir, grain-fed or not). In this model the ICC is also lower, indicating less clustering by PIC region once covariates are included. The size of the effect of hydatid cysts on carcase weight should not be interpreted as a causal effect in the full model (D), because this is the full dataset, and the incidence and duration of exposures (including hydatid cysts) are unlikely to be stable throughout age cohorts and years of processing

Tables 2-5 are stratified by age and year to estimate the apparent effect of hydatid cysts on carcase weight by age and annual cohort. All models in Tables 2—5 include covariates (sex, presence of comorbidities, presence of fluke, abattoir, grain-fed or not, distance to processor) to adjust for confounding pathways, and a random effect of PIC region.

The range of point estimates of the apparent effect of hydatid cysts on weight and their 95% confidence intervals are shown in Figure 20. The point estimates of the total effect of the presence of hydatid cysts range from -5.45 kg (s.e. 0.63 kg) – 0.32kg (s.e. 0.58kg), in six-tooth cattle in 2019 and two-tooth cattle in 2022, respectively. Most estimated point effects are between -2.5—0kg. Clustering by region is still apparent, with ICC ranging from 0.25—0.45.

Table 1 Preliminary models in linear mixed-effects regression analyses of cattle which had remained on the same property identification code (PIC) region for their lifetime, in a study of cattle processed at five processors in eastern and southern Australia in 2019. Clustering by origin was accounted for in all models.

	Hot standard carcase weight (kg)							
	(A) Null Model		**(B) Univariable (no random effect)**		**(C) Univariable (random effect)**		**(D) Full Model**	
Predictors	Estimate	se	Estimate	se	Estimate	se	Estimate	se
Intercept	303.26	2.51	297.26	0.05	304.13	2.47	-18146.12	66.72
Hydatid			**-14.25**	0.12	**-6.71**	0.12	**-4.46**	0.10
Covariates: sex, age (dentition), year, presence of comorbidities, presence of fluke, abattoir, grain-fed (yes/no), distance to processor.								
Random Effects								
σ^2	2949.25				2943.87		1793.78	
τ_{00}	1308.18 $_{PIC\_REGION}$				1267.57 $_{PIC\_REGION}$		392.85 $_{PIC\_REGION}$	
ICC	0.31				0.30		0.18	
N	211 $_{PIC\_REGION}$				211 $_{PIC\_REGION}$		211 $_{PIC\_REGION}$	
Observations	1648048		1648049		1648048		1648048	
Marginal R^2 / Conditional R^2	0.000 / 0.307		0.008 / 0.008		0.002 / 0.302		0.380 / 0.491	

Table 2 Estimated effect of the presence of hydatid cysts (detected at slaughter) on hot standard carcase weight (HSCW; kg) in linear mixed-effects regression analyses of cattle stratified by age (dentition) and which had remained on the same property identification code (PIC) region for their lifetime, in a study of cattle processed at five processors in eastern and southern Australia in 2019. Clustering by origin was accounted for in all models.

2019	**Hot standard carcase weight (kg)**							
	Two-tooth		**Four-tooth**		**Six-tooth**		**Eight-tooth**	
Predictors	Estimate	se	Estimate	se	Estimate	se	Estimate	se
Intercept	260.66	1.86	261.09	2.17	262.65	2.59	263.35	2.22
Hydatid	**-2.32**	0.47	**-2.17**	0.52	**-5.47**	0.63	**-3.58**	0.29
Covariates: sex, presence of comorbidities, presence of fluke, abattoir, grain-fed (yes/no) , distance to processor.								
Random Effects (PIC region)								
σ^2	1511.36		1599.41		1846.68		1865.31	
τ_{00}	564.05 $_{PIC\_REGION}$		692.37 $_{PIC\_REGION}$		836.33 $_{PIC\_REGION}$		717.85 $_{PIC\_REGION}$	
ICC	0.27		0.30		0.31		0.28	
N	192 $_{PIC\_REGION}$		186 $_{PIC\_REGION}$		181 $_{PIC\_REGION}$		177 $_{PIC\_REGION}$	
Observations	136104		82465		54716		210412	
Marginal R^2 / Conditional R^2	0.441 / 0.593		0.413 / 0.590		0.344 / 0.548		0.197 / 0.420	

Table 3 Estimated effect of the presence of hydatid cysts (detected at slaughter) on hot standard carcase weight (HSCW; kg) in linear mixed-effects regression analyses of cattle stratified by age (dentition) and which had remained on the same property identification code (PIC) region for their lifetime, in a study of cattle processed at five processors in eastern and southern Australia in 2019. Clustering by origin was accounted for in all models.

2020	**Hot standard carcase weight (kg)**							
	Two-tooth		**Four-tooth**		**Six-tooth**		**Eight-tooth**	
Predictors	Estimate	se	Estimate	se	Estimate	se	Estimate	se
Intercept	252.35	2.00	256.66	2.15	257.26	2.51	267.40	2.28
Hydatid	**-2.24**	0.41	**-2.34**	0.42	**-2.02**	0.50	**-0.66**	0.25
Covariates: sex, presence of comorbidities, presence of fluke, abattoir, grain-fed (yes/no) , distance to processor.								
Random Effects (PIC region)								
σ^2	1466.96		1465.71		1648.56		1781.93	
τ_{00}	532.51 $_{PIC\_REGION}$		488.15 $_{PIC\_REGION}$		545.03 $_{PIC\_REGION}$		673.86 $_{PIC\_REGION}$	
ICC	0.27		0.25		0.25		0.27	
N	195 $_{PIC\_REGION}$		190 $_{PIC\_REGION}$		185 $_{PIC\_REGION}$		178 $_{PIC\_REGION}$	
Observations	100291		72918		44686		148695	
Marginal R^2 / Conditional R^2	0.465 / 0.607		0.475 / 0.606		0.383 / 0.537		0.231 / 0.442	

Table 4 Estimated effect of the presence of hydatid cysts (detected at slaughter) on hot standard carcase weight (HSCW; kg) in linear mixed-effects regression analyses of cattle stratified by age (dentition).

2021	**Hot standard carcase weight (kg)**							
	Two-tooth		**Four-tooth**		**Six-tooth**		**Eight-tooth**	
Predictors	Estimate	se	Estimate	se	Estimate	se	Estimate	se
Intercept	274.24	2.63	276.61	2.40	281.72	2.33	290.14	2.54
Hydatid	**-1.60**	0.41	**-2.14**	0.39	**-0.37**	0.49	**-1.87**	0.31
Covariates: sex, presence of comorbidities, presence of fluke, abattoir, grain-fed (yes/no) , distance to processor.								
Random Effects (PIC region)								
σ^2	1438.35		1462.47		1687.88		1968.01	
τ_{00}	1194.99 $_{PIC\_REGION}$		868.42 $_{PIC\_REGION}$		563.41 $_{PIC\_REGION}$		872.82 $_{PIC\_REGION}$	
ICC	0.45		0.37		0.25		0.31	
N	195 $_{PIC\_REGION}$		194 $_{PIC\_REGION}$		185 $_{PIC\_REGION}$		182 $_{PIC\_REGION}$	
Observations	90536		72722		47555		121309	
Marginal R^2 / Conditional R^2	0.278 / 0.606		0.301 / 0.562		0.322 / 0.491		0.251 / 0.481	

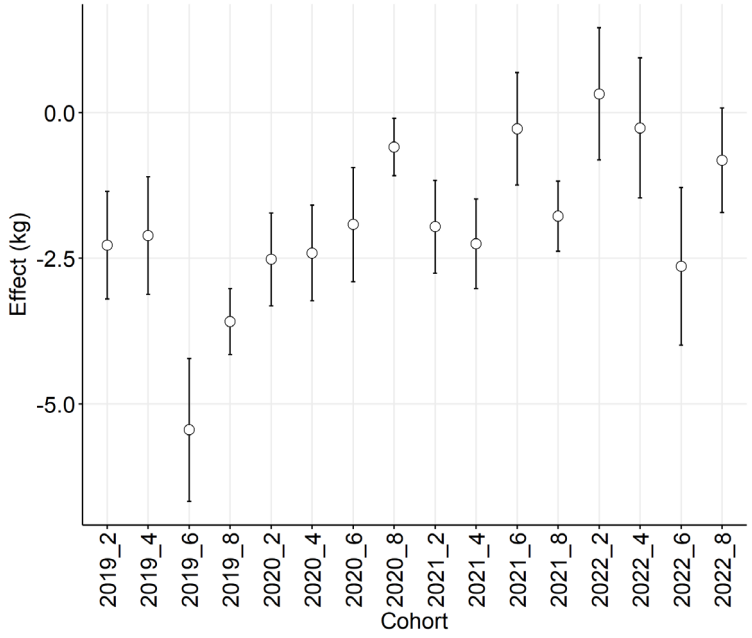

Figure 21 Estimated point effects and 95% confidence intervals of the effect of the presence of hydatid cysts (detected at processing) on hot standard carcase weight (HSCW; kg) in linear mixed-effects regression analyses of cattle stratified by age (dentition) and which had remained on the same property identification code (PIC) region for their lifetime. Models are listed by year (2019-2022) and age (dentition; 2-8 tooth). Clustering by PIC of origin was accounted for in all models.

Table 5 Estimated effect of the presence of hydatid cysts (detected at slaughter) on hot standard carcase weight (HSCW; kg) in linear mixed-effects regression analyses of cattle stratified by age (dentition) and which had remained on the same property identification code (PIC) region for their lifetime, in a study of cattle processed at five processors in eastern and southern Australia in 2021. Clustering by origin was accounted for in all models.

2022	**Hot standard carcase weight (kg)**							
	Two-tooth		**Four-tooth**		**Six-tooth**		**Eight-tooth**	
Predictors	Estimate	se	Estimate	se	Estimate	se	Estimate	se
Intercept	271.60	2.23	277.41	2.42	283.58	2.79	294.32	3.05
Hydatid	**0.44**	0.58	**-0.25**	0.61	**-2.75**	0.69	**-0.89**	0.46
Covariates: sex, presence of comorbidities, presence of fluke, abattoir, grain-fed (yes/no), distance to processor.								
Random Effects (PIC region)								
σ^2	1402.06		1508.70		1669.21		1975.37	
τ_{00}	706.18 $_{PIC\_REGION}$		667.27 $_{PIC\_REGION}$		665.02 $_{PIC\_REGION}$		1003.60 $_{PIC\_REGION}$	
ICC	0.33		0.31		0.28		0.34	
N	180 $_{PIC\_REGION}$		168 $_{PIC\_REGION}$		160 $_{PIC\_REGION}$		167 $_{PIC\_REGION}$	
Observations	48806		30892		23180		59352	
Marginal R^2 / Conditional R^2	0.362 / 0.576		0.326 / 0.533		0.316 / 0.511		0.241 / 0.497	

5. Conclusion

The number of cattle in this dataset and the recording of comorbidities including fluke as well as hydatid cysts during processing, provided opportunity to investigate the effect of hydatid disease on carcase weight in more detail than has occurred previously. In this study, in cattle in which hydatid cysts were detected, carcase weight was lighter by approximately 0—3kg by age cohort and year of processing (2019 and 2022). Whilst this effect was consistent across age groups throughout the study years and is biologically plausible, it could be due to residual confounding, selection bias, or information bias. These are discussed below.

Another new finding from this study is the high apparent prevalence of hydatid cysts at processing focused on the Brisbane region and extending along coastal northern New South Wales and most of the Queensland coastline, and into regional Queensland. This has not been demonstrated previously due to the location of previous studies (including the source areas if processor-based) and fewer cattle processed from the Brisbane region. This distribution is consistent with the distribution of wild dogs and dingoes along the Great Dividing Range in a climate conducive to survival of *Echinococcus* larvae on pasture.

5.1 Confounding – could other variables account for the estimated effect of hydatid cysts on carcase weight?

The highest proportion of cattle in which hydatid cysts were detected were from northern PICs, focussed on the Brisbane region and extending coastally and inland, especially into regional Queensland. There was a similar north-south spatial pattern with other variables that could influence weight. For example, descriptive analyses demonstrated that female cattle and cattle that had not been grain-fed were also more likely to have originated from northern regions, and that these cattle were expected to be significantly lighter than male cattle or cattle which had been grain-fed. These variables – and others that could contribute to an apparent spatial effect on carcase weight (liver fluke, distance travelled to abattoir) – were included in the statistical models as potential confounders and reduced the observed effect of detected hydatid cysts on carcase weight.

Residual confounding of the estimate of hydatid cysts on carcase weight is possible. In the directed acyclic graph, a link exists between the presence of hydatid disease and liveweight via the management variable. This variable incorporates decisions such as the types of cattle kept, the system in which cattle are kept, and where cattle will be processed. These decisions are part of farm management that is related to the location (e.g. climate, topography, and vegetation) and are generally made prior to the lifespan of each batch of beef cattle.

Many management practices that are associated with location are broadly controlled by the inclusion of PIC location as a random variable, and this is supported by the grouping of carcase weight within PICs (observed as the relatively high intra-class correlation coefficients [ICC] of the models by year and age group). However, the effect of all management variables might not be fully accounted for by the inclusion of PIC region as a random effect – or other variables related to management such as sex and whether an animal was grainfed as fixed effects – and could contribute to the apparent observed effect of hydatid cysts on weight. For example, breed of cattle is often associated with geographic locality (Banks et al., 2006). *Bos indicus* breeds of cattle are more prevalent in northern Australia and could be lighter by age than *Bos taurus* breeds in the south. Smaller cattle breeds could also be from areas where they are more likely to become infected with hydatid cysts, such as marginal grazing areas with hosts such as wild dogs and macropods. Local climate variables within PICs related to topography, as well as soil and vegetation type, influence both exposure to hydatid and feed quality and availability and therefore, might also influence carcase weight. 'Management' could also include practices that were not accounted for such as proximity to unimproved land on which wild dogs could roam, types of fencing, and the presence of dogs on the property. Therefore, the link from hydatid disease to liveweight via 'management' could not be completely blocked and remains a possible source of confounding.

5.2 Selection bias – could differences between the study population and the source population account for the estimated effect of hydatid cysts on carcase weight

The source population in this study are cattle that remained in the same PIC for their lifetime. The study population is not a random selection of cattle from this population because it is a convenience sample of cattle from selected processors at which multiple defects (hydatid cysts,

fluke, and other comorbidities) could be recorded. It also does not include cattle that were processed for meat or died on farm (for example, injury, flooding, illness, old age).

The death of cattle on farm could be considered as 'loss to follow up' in this population. Given the insidious nature of hydatid disease (inapparent clinical signs), we consider it extremely rare that cattle would die of conditions associated with hydatid disease on farm and that this population would be negligibly small. The cattle that are processed on farm ('home slaughter') are also a very small population relative to this dataset, and unlikely to influence the estimated effect measure of hydatid cysts on carcase weight because the reasons for on-farm processing are generally a lifestyle choice and not related to disease or weight. Therefore, we consider these mechanisms of selection bias to be insignificant. However, the selection of processors in the study could induce selection bias via a 'Berkson bias' mechanism which is worth considering. For example, if processors are more likely to have attracted producers from regions which are systematically more (or less) likely to have cattle with hydatid cysts (for example, northern regions generally go to Beenleigh, Rockhampton and Biloela, and southern regions in which hydatid disease is less prevalent generally go to Naracoorte and Wagga Wagga), and these processors also target cattle of particular weights, an apparent statistical association would be created between hydatid disease and carcase weight. Overall, we believe this is unlikely due to the diverse geographic range on the processors in this study and their large source regions. In addition, the estimated effect of hydatid disease on carcase weight that was observed across the age and year cohorts in this study was consistent (selection bias is more commonly associated with unpredictable effect changes which could be unstable across cohorts). This pathway of selection bias (Figure 23) was also partially blocked by variables associated with 'management decision' that were included to control confounding.

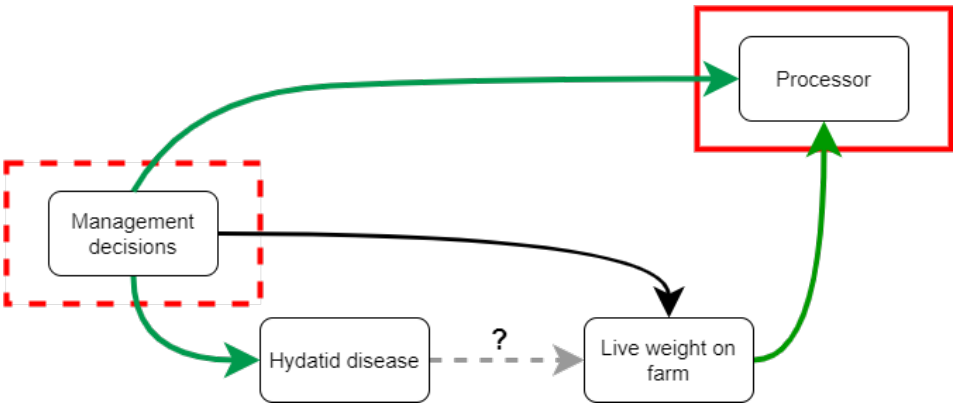

Figure 22 Directed acyclic graph of a mechanism for selection bias between hydatid disease and liveweight on farm. Management decisions influence hydatid disease and a producer's choice of processor, and live weight on farm inherently influences where an animal is processed. The variable, 'Processor', is inherently controlled red box), because the dataset is from selected processors. The variable 'management decisions' is partially controlled by variables such as PIC region (an ancestor variable), and whether cattle are grainfed, sex, and age (dentition; stratified).

5.3 Information bias – could measurement error or misclassification account for the estimated effect of hydatid cysts on carcase weight

It is known that the sensitivity and specificity of hydatid cyst detection at processing can be low (Wilson et al., 2019b) and this is likely to vary between meat inspectors and abattoirs. In the current study, this potential information bias was accounted for by including processors in the analyses; however, this will not account for differences within processors (variation between inspectors) or regional differences. Whilst the variation between inspectors could be considered minimal (they are all trained on the same pathways), regional differences could be marked due to the spatial variation in relative frequency of other diseases. For example, hydatid cysts might be more readily detected in cattle from northern PICs because fluke (another condition found in the liver) is less likely in this region and does not provide a competing diagnosis. If there is a higher probability of hydatid detection in northern PICs where cattle are inherently lighter, this effect could be incorrectly attributed to hydatid cysts rather than changes in detection probability. Processors in which multiple morbidities can be recorded were selected for this study, but it is likely that recording is still influenced by processing line speed and the most obvious or expected conditions could be recorded first, followed by other conditions as time allows. Enøe et al. (2003) reported that more time to inspect organs at meat inspection could improve sensitivity. It appears that cattle that were processed at Rockhampton were less likely to have comorbidities recorded. The effect of this is difficult to determine; cattle which had comorbidities that affected weight could be lighter but have been classified as cattle without defects at meat inspection, thus potentially reducing (biasing towards the null) any effect of hydatid on weight. Overall however, cattle came from a range of northern and southern regions to each processor which is likely to have reduced the influence of measurement error and misclassification effects.

In addition, dentition was used as a proxy for age in this study. Throughout all ages, this is a broad representation of actual age. To determine subtle effects (for example, a producer keeping cattle for a few extra weeks to reach a target weight because they were slower to gain weight due to hydatid disease) would ideally require knowledge of days since infection with hydatid to determine if weight gain is slowed by infection with hydatid. Even with accurate age data, an assumption that cattle are exposed uniformly would still have to be made, and cattle will be exposed at different times depending on their herd circumstances (therefore, duration of time with hydatid will vary). The effect becomes more marked as cattle reach eight-teeth and they can be any age over 3.5 years. Cattle that are 3.5 years old are more likely to be in better body condition than those that are 10 years old. Older cattle are also more likely to have detectable hydatid cysts due to the longer exposure time to *Echinococcus* larvae in the environment and the longer time for cysts to develop in their viscera.

5.4 Population stability

This analysis uses cross-sectional data with prevalent, not incident, exposures and outcomes. Analysis depends on measurement of effects in a stable cohort so that the incidence and duration of hydatid disease and other exposure histories would be stable across comparison groups and inclusion of covariates to account for confounding that would have occurred prior to hydatid disease. Whilst the analysis was stratified by age and year of processing, it is possible that cattle moved within the PIC regions and had mixed exposure histories (for example, were grainfed for varying periods of time). It is also impossible to determine the onset of hydatid

infection in affected cattle and measure duration of infection accurately (as already discussed above). This could vary within the age and year cohorts in this analysis and lead to biased effect estimates.

5.5 Plausibility of the estimated effect of hydatid cysts on carcase weight, and impact

The small reduction in carcase weight due to the presence of hydatid cysts that was estimated in this study is a biologically plausible effect. Although selection bias is unlikely, confounding and information bias cannot be ruled out. However, the estimated effects in the current study are also consistent between years and age cohorts which suggests findings are robust.

It has been assumed that infections in older cattle will have a greater effect on weight, if there is any effect at all, due to the longer exposure period and duration over which cysts have developed. However, it is also possible that earlier, active infections in younger cattle stimulate a greater immune response (and thus, reduce weight) than infections in older cattle in which the immune response is more mature and cysts are already walled off. The level of infection was not differentiated in cattle in the current study and although Wilson et al. (2019a) reported that cattle typically have light infections (few and small cysts), it is the heavier infections that are more likely to be reported by the meat inspector (Wilson et al., 2019b) regardless of age group.

Ultimately, such a small reduction in carcase weight would be a very small percentage of liveweight for most cattle and difficult to observe. Whilst this weight difference might be valuable at population level, it is debatable whether it would be sufficient for producers to be motivated to undertake greater control measures against hydatid infection in their cattle. A cost-benefit analysis (CBA) would need to be conducted to determine the value of a vaccine or implementation of other control strategies to producers and processors.

6. Future research and recommendations

Further collection of cross-sectional observational data is extremely unlikely to further determine whether the effect of hydatid disease on carcase weight is accurate. Given the current findings, we recommend that if a CBA indicates an economically viable impact of vaccination, a field-trial on farms of the vaccine be conducted, in which the vaccine is randomised to cattle within farms and between farms. Randomisation of the intervention would determine if the currently estimated effect were causal. However, it should be noted that the study would be logistically difficult because multiple doses of vaccine are required (ideally, administration should be blinded), a large number of cattle would be required to detect small differences in weight, and the cattle would need to be followed to processing with accurate records from birth.

A vaccine trial would be more feasible than an experimental design in which cattle were randomly exposed to *Echinococcus* because it would determine impacts in organ condemnation and downgrading, as well as weight. In addition, an experimental design is likely to be logistically infeasible; the number of cattle recruited would need to be extremely large to detect such small difference in weight and cattle would have to be kept for several years with no incursions by infected canids.

7. References

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8. Appendix

8.1 Assessment codes grouped into 'Other comorbidities'

Assessment Group	Assessment ID	Assessment Name
Arthritis	ART	Arthritis
Arthritis	ARTELB	Arthritis Elbow
Arthritis	ARTFKN	Arthritis Fore Knuckle
Arthritis	ARTFSH	Arthritis Fore Shoulder
Arthritis	ARTHIP	Arthritis Hip
Arthritis	ARTHOC	Arthritis Hock
Arthritis	ARTPOL	Arthritis Poly
Arthritis	ARTSTI	Arthritis Stifle
Bruising	1 BUT	Bruise Buttock
Bruising	2 HIP	Bruise Hip
Bruising	3 BAK	Bruise Back
Bruising	4 FQ	Bruise F/Quarter
Bruising	5 2HQ	Bruise 2 HQ Cuts
Bruising	6 3HQ	Bruise 3 HQ Cuts
Bruising	7 FHQ	Bruise 1 FQ & HQ
Bruising	8 FQH	Bruise 1 FQ/2 HQ
Bruising	9 FQH	Bruise 4 Serious
Bruising	EXTBRU	Extensive Bruise
Carcase Defects	C ABIO	Antibiotic Treated
Carcase Defects	C ABS	Abcess
Carcase Defects	C ABSS	Multiple Abscesses
Carcase Defects	C ACT	Carcase Actino
Carcase Defects	C ANAE	Anaemia
Carcase Defects	C ART	Carcase Arthritis
Carcase Defects	C BOV	Carcase C Bovis
Carcase Defects	C BRUI	Carcase Bruise
Carcase Defects	C CAN	Carcase Cancer
Carcase Defects	C ECA3	Carcase ECA-3 Released
Carcase Defects	C ECCY	Carcase Ecchymosis
Carcase Defects	C EMAC	Carcase Emaciation
Carcase Defects	C EMYO	Carcase E.Myosotis
Carcase Defects	C FB	Foreign Body
Carcase Defects	C FRAC	Carcase Fracture
Carcase Defects	C GRAN	Carcase Granuloma
Carcase Defects	C HIDE	Hide Contam.
Carcase Defects	C JAUN	Carcase Jaundice
Carcase Defects	C LABS	Carc Lymph Node Abscess
Carcase Defects	C LIPO	Carcase Lipoma

Carcase Defects	C MEL	Carcase Melanosis
Carcase Defects	C MET	Carcase Metritis
Carcase Defects	C MYO	Carcase E. Myosotis
Carcase Defects	C MYOC	Carcase E. Myocarditis
Carcase Defects	C NEO	Carcase Neoplasms
Carcase Defects	C NEUR	Neuro- fibroma
Carcase Defects	C ODEM	Carcase Oedema
Carcase Defects	C ODOU	Carcase Odour
Carcase Defects	C OVIS	Cyst Ovis
Carcase Defects	C PERT	Carcase Peritonitis
Carcase Defects	C PLU	Carcase Pleurisy
Carcase Defects	C PNU	Carcase Pneumonia
Carcase Defects	C POLY	Carcase Polyps
Carcase Defects	C SAL	Carcase Septicaemia
Carcase Defects	C SCAR	Carcase Scarring
Carcase Defects	C SEPT	Carcase Septicaemia
Carcase Defects	C URAE	Carcase Uraemia
Carcase Defects	C WOUN	Carcase Wound
Carcase Defects	C XAN	Carcase Xanthosis
Carcase Defects	CD BUT	Condemn Butt
Carcase Defects	CD FQ	Condemn F/Quarter
Carcase Defects	CD HQ	Condemn H/Quarter
Carcase Defects	CYST	Cyst
Carcase Defects	DAM	Damaged Cut
Carcase Defects	DOWNER	Downer
Carcase Defects	DROP	Dropped Body
Carcase Defects	IMA	Imature Calves
Carcase Defects	LFQABS	L FQ Abscess
Carcase Defects	LFQART	L FQ Arthritis
Carcase Defects	LFQBRU	L FQ Bruise
Carcase Defects	LFQCYS	L FQ Cyst
Carcase Defects	LFQECY	L FQ Ecchymosis
Carcase Defects	LFQFRA	L FQ Fracture
Carcase Defects	LFQHDE	L FQ Hide
Carcase Defects	LFQMET	L FQ Lead Shot / Metal
Carcase Defects	LFQMIL	L FQ Milk
Carcase Defects	LFQOTH	L FQ Other
Carcase Defects	LFQSCA	L FQ Scarring
Carcase Defects	LFQURN	L FQ Urine
Carcase Defects	LFQWND	L FQ Wound
Carcase Defects	LFQ_FB	L FQ Foreign Body
Carcase Defects	LHQABS	L HQ Abscess
Carcase Defects	LHQART	L HQ Arthritis

Carcase Defects	LHQBRU	L HQ Bruise
Carcase Defects	LHQCYS	L HQ Cyst
Carcase Defects	LHQECY	L HQ Ecchymosis
Carcase Defects	LHQFEC	L HQ Faecal
Carcase Defects	LHQFRA	L HQ Fracture
Carcase Defects	LHQHDE	L HQ Hide
Carcase Defects	LHQMET	L HQ Lead Shot / Metal
Carcase Defects	LHQMIL	L HQ Milk
Carcase Defects	LHQOTH	L HQ Other
Carcase Defects	LHQSCA	L HQ Scarring
Carcase Defects	LHQWND	L HQ Wound
Carcase Defects	LHQ_FB	L HQ Foreign Body
Carcase Defects	MYOSIT	Myositis
Carcase Defects	NEU-FQ	Neurofibroma F1/4 Condemn
Carcase Defects	OR GIM	Oral N Cav Grass Impactio
Carcase Defects	OR POL	Oral Nasal Cavity Polyps
Carcase Defects	OR SIN	Oral Nasal Cav Sinusitis
Carcase Defects	PLU	Carcase Pleurisy
Carcase Defects	PLUACU	Pleurisy Acute
Carcase Defects	PLUCHR	Pleurisy Chronic
Carcase Defects	PLUDIA	Pleurisy D/Mem
Carcase Defects	PLUMAJ	Pleurisy Major
Carcase Defects	PLUMIN	Pluerisy Minor
Carcase Defects	PLUTHK	Pleurisy ThickSkirt
Carcase Defects	PLUTHN	Pleurisy Thin Skirt
Carcase Defects	PNU	PNU NOT ACTIVE DO NOT USE
Carcase Defects	PUTBRK	Putty Brisket
Carcase Defects	PYO	Pyogenic Lesions
Carcase Defects	RFQABS	R FQ Abscess
Carcase Defects	RFQART	R FQ Atrhritis
Carcase Defects	RFQBRU	R FQ Bruise
Carcase Defects	RFQCYS	R FQ Cyst
Carcase Defects	RFQECY	R FQ Ecchymosis
Carcase Defects	RFQFRA	R FQ Fracture
Carcase Defects	RFQHDE	R FQ Hide
Carcase Defects	RFQMET	R FQ Lead Shot / Metal
Carcase Defects	RFQOTH	R FQ Other
Carcase Defects	RFQSCA	R FQ Scarring
Carcase Defects	RFQWND	R FQ Wound
Carcase Defects	RFQ_FB	R FQ Foreign Body
Carcase Defects	RHQABS	R HQ Abscess
Carcase Defects	RHQART	R HQ Arthritis
Carcase Defects	RHQBIL	R HQ Bile

Carcase Defects	RHQBRU	R HQ Bruise
Carcase Defects	RHQCYS	R HQ Cyst
Carcase Defects	RHQECY	R HQ Ecchymosis
Carcase Defects	RHQFRA	R HQ Fracture
Carcase Defects	RHQHDE	R HQ Hide
Carcase Defects	RHQMET	R HQ Lead Shot/Metal
Carcase Defects	RHQOTH	R HQ Other
Carcase Defects	RHQSCA	R HQ Scarring
Carcase Defects	RHQWND	R HQ Wound
Carcase Defects	RHQ_FB	R HQ Foreign Body
Carcase Defects	SEPTWD	Septic Wound
Carcase Defects	SOFT	Soft Siding
Carcase Defects	TL OTH	Tail Other
Carcase Defects	TRIM	Trim Required
Carcase Other Cause	BK BCO	Broke BoneComp Fault
Carcase Other Cause	BRKBON	Broken Bone
Carcase Other Cause	C DEFR	Carcase Deformed
Carcase Other Cause	C FEVE	Carcase Fever
Carcase Other Cause	C ISL	Injection Lesion
Carcase Other Cause	C OTHR	Carcase Other Causes
Carcase Other Cause	C SARC	Carcase Sarco
Carcase Other Cause	CUNECK	Copper Lesions
Carcase Other Cause	EMGSLT	Emergency Slt Animal Wel
Carcase Other Cause	SHOTG	Shotgun Pallets
Condemned Cheek	CK ACT	Cheek Actinobacillosis
Condemned Carcase	C COND	Carcase Condemned
Condemned Carcase	CD ABC	Condemn Abcesses
Condemned Carcase	CD ACT	Condemn Actino
Condemned Carcase	CD ANA	Condemn Anaemia
Condemned Carcase	CD ANE	Condemn Anaemia
Condemned Carcase	CD ART	Condemn Arthritis
Condemned Carcase	CD BOD	Condemn-Not Fit Human Con
Condemned Carcase	CD CAN	Condemn Cancer
Condemned Carcase	CD CBO	Condemn C Bovis
Condemned Carcase	CD CLA	CD CaseousLymph.
Condemned Carcase	CD CON	CD Contam Other
Condemned Carcase	CD COV	Condemn Cyst Ovis
Condemned Carcase	CD DEF	Condemn Deformed
Condemned Carcase	CD EMA	Condemn Emaciation
Condemned Carcase	CD EYE	CD Eye Cancer
Condemned Carcase	CD FEV	Carcase Fever
Condemned Carcase	CD FEX	CD Facial Eczema
Condemned Carcase	CD GAN	Condemn Gangrene

Condemned Carcase	CD GUN	Condemn Shotgun Pellets
Condemned Carcase	CD JAU	Condemn Jaundice
Condemned Carcase	CD LMA	Condemn Lipoma
Condemned Carcase	CD MAL	Condemn Malignancy
Condemned Carcase	CD MEL	Condemn Melanosis
Condemned Carcase	CD MET	Condemn Metritis
Condemned Carcase	CD MYO	Condemn Myositis
Condemned Carcase	CD NEO	Condemn Neoplasms
Condemned Carcase	CD NER	Condemn Nerosis
Condemned Carcase	CD NEU	Condemn Neurofibroma
Condemned Carcase	CD ODE	Condemn Oedema
Condemned Carcase	CD ODR	Condemned for Odour
Condemned Carcase	CD OIL	Condemn Hydralic Oil Cont
Condemned Carcase	CD OTH	Condemn Other
Condemned Carcase	CD PAR	Condemn Poly Arthritis
Condemned Carcase	CD PEL	Condemn Shotgun Pellets
Condemned Carcase	CD PER	Condemn Peritonitis
Condemned Carcase	CD PEU	Condemn Pneumonia
Condemned Carcase	CD PLU	Condemn Pleurisy
Condemned Carcase	CD PYO	Condemn Pyo Lesion
Condemned Carcase	CD RED	Condemn Redwater
Condemned Carcase	CD SAL	Condemn Septicaemia
Condemned Carcase	CD SAR	Condemn Sarcocyst
Condemned Carcase	CD SHD	Condemn Shoulder
Condemned Carcase	CD SNP	Condemn Septic Nephritis
Condemned Carcase	CD TOX	Condemn Toxemia
Condemned Carcase	CD URA	Condemn Uraemia
Condemned Carcase	CD WB	CD Wounds & Bruises
Condemned Carcase	CD WND	Condemn Wounds
Condemned Carcase	CD XAN	Condemn Xanthosis
Condemned Carcase	CDCARC	Carcase condemned
Condemned Carcase	CDCHEM	Condemn - Ext Chem Contam
Condemned Carcase	P CIY	Condemned In Yards
Condemned Carcase	P COA	Condemned On Arrival
Viscera Other	GO ENT	Green Off - Enteritis
Viscera Other	GO FOE	Green Off Foetus
Viscera Other	GO INF	Green Off Peritonitis
Viscera Other	GO ING	Green Off - Ingesta Con
Viscera Other	GO MET	Green Off Metritis
Viscera Other	GO OTH	Green Off Other
Viscera Other	GO PLA	GrnOff RetPlacenta
Viscera Other	GO POL	Green Off Polyps
Viscera Other	GO UTE	GrnOff RupUterus

Viscera Other	H ABSC	Heart Abcess
Viscera Other	H HPC	Heart Pericarditis
Viscera Other	H OTH	Heart Other
Viscera Other	H PERI	Heart Pericarditis
Viscera Other	H VAL	Heart Valve Lesions
Viscera Other	K CAN	CD Kidney Cancer
Viscera Other	L ABSC	Lung Abscess
Viscera Other	L EMPH	Lung Emphysema
Viscera Other	L PNEU	Lungs - Pneumonia
Viscera Other	LGEFOE	Large size Foetus
Viscera Other	LYABSC	Lymph NodeAbscess
Viscera Other	LYGRAN	Lymph NodeGranuloma
Viscera Other	LYLEUC	Lymph Node Bov Leucosis
Viscera Other	LYMPHA	Lymphadenitis
Viscera Other	MEDFOE	MediumSize Foetus
Viscera Other	RO BIL	Red Offal - Bile Cont
Viscera Other	RO ING	Red Offal - Ingesta Cont
Viscera Other	SMLFOE	Small Size Foetus
Viscera Other	TK ABS	Thick Skt Abscess
Viscera Other	TK BIL	Thick Skt - Bile Cont
Viscera Other	TK ING	Thick Skt - Ingesta Con
Viscera Other	TK OTH	Thick Skt Other
Viscera Other	V HPC	Heart Pericarditis
Viscera Other	V KCAD	Kidney Cadmium
Viscera Other	V KHDR	Kidney Hydronephrosis
Viscera Other	V KHEM	Kidney Haemorhage
Viscera Other	V KLEP	Kidney Leptospirosis
Viscera Other	V KOC	Kidney Other
Viscera Other	V L OC	Liver Other Causes
Viscera Other	V LIV	Liver Other Causes
Viscera Other	V METR	Metritis
Viscera Other	V NS	Neoplasm Spleen
Viscera Other	V SPRU	Spleen Ruptured
Viscera Other	V VCO	Viscera Cyst Ovis
Viscera Other	VHPERI	Visc HeartPericarditis
Viscera Other	VHRTOC	Heart Other Causes
Viscera Other	VLPERT	Visc LiverPeritonitis
Cut Assessment	ECY	Eccymosis
Dead Prior Stunning	D DE-S	Dead Destroyed -Skinned
Dead Prior Stunning	D DE-U	Dead Destroyed -Unskinned
Dead Prior Stunning	D IP-S	Dead in Pen -Skinned
Dead Prior Stunning	D IP-U	Dead in Pen -Unskinned
Dead Prior Stunning	D IT-S	Dead in Truck -Skinned

Dead Prior Stunning	D IT-U	Dead in Truck -Unskinned
Dead Prior Stunning	D IW-S	Dead in Wash -Skinned
Dead Prior Stunning	D IW-U	Dead in Wash -Unskinned
Dead Prior Stunning	DIT	Dead In Transport
Dead Prior Stunning	DIY	Dead In Yards
Feedlot Death Reasons	ACIDOS	Acidosis - Death
Feedlot Death Reasons	ACIDOT	Acidosis Treat - Death
Feedlot Death Reasons	BLOAT	Bloat - Death
Feedlot Death Reasons	BRKLEG	Broken Leg - Death
Feedlot Death Reasons	BULLER	Buller - Death
Feedlot Death Reasons	CALVED	Calving - Death
Feedlot Death Reasons	FEDCUL	FEEDLOT CULL KILLS
Feedlot Death Reasons	FOOTRO	FootRot-Infectious -Death
Feedlot Death Reasons	HEATST	Heat Stress - Death
Feedlot Death Reasons	HONKER	Honker - Death
Feedlot Death Reasons	METABL	Metabolic/Acidosis - Deat
Feedlot Death Reasons	NONEAT	Non Eater - Death
Feedlot Death Reasons	OTHERD	Other - Death
Feedlot Death Reasons	PEM	PEM - Death
Feedlot Death Reasons	PNEUMO	Pneumonia - Death
Feedlot Death Reasons	PROPIZ	Prolapsed Pizzle - Death
Feedlot Death Reasons	PROREC	Prolapsed Rectum - Death
Feedlot Death Reasons	PROUTE	Prolapsed Uterus - Death
Feedlot Death Reasons	RESPIR	Repiratory - Death
Feedlot Death Reasons	ROARER	Roarer - Death
Feedlot Death Reasons	SALMON	Salmonella/Scours - Death
Feedlot Death Reasons	SWELL	Swelling/Abscess/Haem - D
Feedlot Death Reasons	SWOLJT	Swollen Joints - Death
Feedlot Death Reasons	SWOLLN	Swollen Sheath - Death
Feedlot Death Reasons	TEMP	Temperature - Death
Feedlot Death Reasons	TRACH	Tracheitis - Death
Feedlot Death Reasons	UNKNOW	Unknown Reason - Death
Feedlot Death Reasons	WATERB	Waterbelly - Death
Grading Defect	DOGBT	Dog Bite
Head Condemns	CD H&T	Head & Tongue Condemn
Head Condemns	CD HM	Head Meat Condemn
Head Condemns	CD TR	Condemn TongueRoot
Head Condemns	H HATP	Hd & Tong Pathology
Head Condemns	H PATH	Head Pathology
Head Condemns	H TRPA	T Root Pathology
Head Condemns	HD ABS	COND Head Abscess Lymph N
Head Condemns	HD CAN	COND Eye Cancer
Head Condemns	HD CYS	COND Head Cyst

Head Condemns	HD GRA	COND Head Granuloma
Head Condemns	HD HOR	COND Head Ingrown Horn
Head Condemns	HD MEL	COND Head Melanosis
Head Condemns	HD MYI	COND Head Myositis
Head Condemns	HD MYO	COND Head Myosotis
Head Condemns	HD OTH	COND Head Other
Head Condemns	HD XAN	COND Head Xanthosis
Head Condemns	SQ EYE	COND Eye Cancer/Squamous
Head Contamination	CLPING	Lips Ingesta
Head Contamination	H CKCO	Cheeks Contam.
Head Contamination	H HDCO	Head Meat Contam
Head Contamination	H HDTG	Hd & Tong Contam
Head Contamination	H ING	Head C/Tam Ingesta
Head Contamination	H LPCO	Lips Contam
Head Contamination	H TGCO	Tongue Contam
Head Contamination	H TGIN	Tongue Ingesta
Head Contamination	HCKING	Cheeks Ingesta
Head Contamination	HHMING	Head Meat Ingesta
Head Contamination	HTGING	Tongue Ingesta
Head Diseases	H CKPA	Cheeks Pathology
Head Diseases	H HDPA	Head Meat Pathology
Head Diseases	H LJAW	Suspect Lumpy Jaw
Head Diseases	H LPPA	Lips Pathology
Head Diseases	H MYO	Head Myosotis
Head Diseases	H TGAC	Tongue Actino
Head Diseases	H TGPA	Tongue Pathology
Head Defects	CDHEAD	Condemned Head
Head Defects	CHKOTH	Cheek Other
Head Defects	CK ABS	Cheek Abcess
Head Defects	CK CON	Cheek Contam
Head Defects	CKGRAS	Cheek Grass Seed
Head Defects	H ACT	Head Actino
Head Defects	H BRU	Head Bruising
Head Defects	H CANE	Head Eye Cancer
Head Defects	H CKAC	Cheek Actino
Head Defects	H CKPR	Cheeks Parasites
Head Defects	H COND	Head Condemned
Head Defects	H CONT	Head Hair/Ingesta
Head Defects	H CTAM	Head Contam Hair
Head Defects	H CYST	Head Cyst (inc Bovis)
Head Defects	H ECCO	Ext Cheek Contam.
Head Defects	H GRAN	Head Granuloma
Head Defects	H INCO	Int Cheek Contam.

Head Defects	H LPPR	Lips Parasites
Head Defects	H MEL	Head Melanosis
Head Defects	H NEO	Head Neoplasms
Head Defects	H OC	Head OtherCauses
Head Defects	H PYO	Head Pyo Lesions
Head Defects	H SAL	Head Septicaemia
Head Defects	H TGPR	Tongue Parasites
Head Defects	H TRAC	Tongue Root Actino
Head Defects	H TRCO	T Root Contam
Head Defects	H XAN	Head Xanthosis
Head Defects	HD DAM	Whole Head Damaged
Head Defects	HD WB	Head Wound/Bruise
Head Defects	HDCONT	Whole HeadContamTrim
Head Defects	T ABSC	Tongue Abscess
Head Defects	T CONT	Tongue Contam
Head Defects	T GRAS	'ongue Grass Seed
Head Defects	T GRST	Tongue GrsSeed Trim
Head Defects	T OTH	Tongue Other
Head Defects	TR ABS	Tong RootAbscess
Head Defects	TR CON	Tong Root Contam
Head Defects	TR OTH	Tong Root Other
Head Defects	TRGRAS	Tongue Root Grass Seed
Head Defects	V TOAB	Tongue Abscess
Head Defects	V TOAC	Tongue Actinomycosis
Hide Assessments	EPIDRM	Epidermis Hide
Hide Assessments	PARAST	Hide Parasite Damage
Hide Assessments	SCRATS	Hide Scratch Damage
Hide Assessments	TICKY	Tick Hide
Hold Code Assessments	ECOLI	E-Coli Presumptive Hold
Hold Code Assessments	FLODAM	Rocky Flood Damage
Condemned Heart	HR ABS	COND Heart - Abscess
Condemned Heart	HR CVL	COND - Chron Valve Lesion
Condemned Heart	HR EMA	CD Heart Emaciation
Condemned Heart	HR NEU	COND Heart - Neurofibroma
Condemned Heart	HR OTH	COND Heart - Other
Condemned Heart	HR OVL	COND - Obv Valve Lesions
Condemned Heart	HR PER	COND-Hrt Chronic Pericard
Condemned Heart	HR XAN	CD Heart Xanthosis
Condemned Heart	HRMYOC	COND-Hrt E. Myocarditis
Condemned Kidney	K ABSC	Kidney Abscess
Condemned Kidney	K CAD	CD Kidney - Cadmium Level
Condemned Kidney	K CYST	CD Kidney Cyst
Condemned Kidney	K NEO	CD Kidney Neoplasia

Condemned Kidney	K NEPH	CD Kidney Nephritis
Condemned Kidney	K OTH	Cond Kidney - Other
Condemned Lung	L ABS	Cond Lung Abscess
Condemned Lung	L BLIN	CD Lung Blood Inhalatio
Condemned Lung	L GRAN	CD Lung Granuloma
Condemned Lung	L NEO	CD Lung Neoplasia
Condemned Lung	L OTH	CD Lungs Other
Condemned Lung	L PLU1	CD Lung PleurisyG1
Condemned Lung	L PLU2	CD Lung PleurisyG2
Condemned Lung	L PLU3	CD Lung PleurisyG3
Liver Defects	L TB	Liver Tuberculosis
Condemned Liver	LV AB1	CD Liver Abscess G1
Condemned Liver	LV AB2	CD Liver Abscess G2
Condemned Liver	LV AB3	Cond Liver - Abscess Grd3
Condemned Liver	LV ADH	CD Liver Adhesions
Condemned Liver	LV CAD	CD Liver - Cadmium Level
Condemned Liver	LV CIR	CD Liver Cirrhosis
Condemned Liver	LV FIB	CD Liver Fibrosis
Condemned Liver	LV HEP	CD Liver Hepatitis
Condemned Liver	LV MIL	CD Liv Miliary Necrosis
Condemned Liver	LV OTH	CD Liver Other
Condemned Liver	LV TEL	CD Liver Telangiectas
Other Causes	RIBBRK	Broken Rib
Pet Food Viscera	P ALL	Pet Food All Viscera
Pet Food Viscera	P CHK	Pet Food Cheek
Pet Food Viscera	P HRT	Pet Food Heart
Pet Food Viscera	P KID	Pet Food Kidney
Pet Food Viscera	P LIV	Pet Food Liver
Pet Food Viscera	P LUNG	Pet Food Lung
Pet Food Viscera	P PFV	Pet Food Vell
Pet Food Viscera	P SKRT	Pet Food Skirt
Pet Food Viscera	P TUNG	Pet Food Tongue
Pet Food Viscera	SLINK	In Calf
Condemned Spleen	S DGEN	COND Spleen - Degenerated
Condemned Spleen	S OTH	CD Spleen Other
Condemned Spleen	S RUPT	COND Spleen - Ruptured
Specified Vet Dispos *	EMGKIL	Emergency Kill
Specified Vet Dispos *	ES	Emergency Slaughter
Specified Vet Dispos *	REPATH	Retain ForPathology
Specified Vet Dispos *	S ART	Suspect Arthritis
Specified Vet Dispos *	S BACK	Suspect Back
Specified Vet Dispos *	S FOOT	Suspect Foot
Specified Vet Dispos *	S HERN	Suspect Hernia

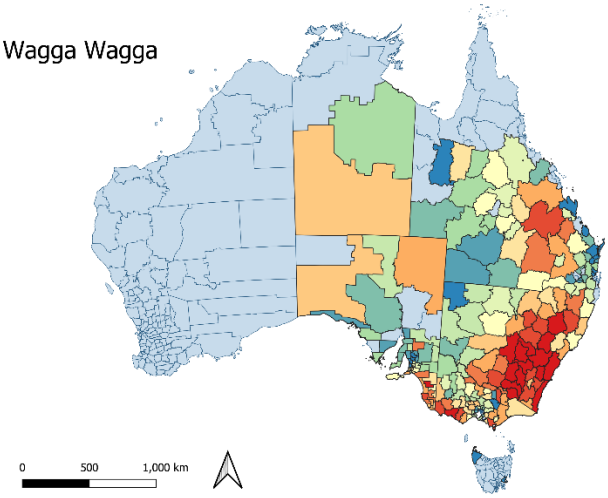
Specified Vet Dispos *	S PIZZ	Suspect Pizzle
Specified Vet Dispos *	S RAM3	Fed RAM Check Eligibility
Specified Vet Dispos *	S SKIN	Suspect Skin
Specified Vet Dispos *	SACT	Suspect Actino
Specified Vet Dispos *	SCE	Suspect Cancer Eye
Specified Vet Dispos *	SFL	Suspect Fore Leg
Specified Vet Dispos *	SFOOT	Suspect Foot
Specified Vet Dispos *	SHL	Suspect Hind Leg
Specified Vet Dispos *	SMAST	Suspect Mastitis
Specified Vet Dispos *	SOTHER	Suspect Other
* Stop Kill *	WARN36	AQ - Anthrax No Human Con
* Stop Kill *	WARN37	AV - Anthrax No Human Con
* Stop Kill *	WARN41	JD - Johnes disease
Condemn Tongue	T ACT	Tongue Actinobacillosis
Condemn Tongue Root	TR ACT	Tong Root Actinobacillosi
Condemn Tongue Root	TRGSAB	Tong R Grass Seed Abscess
Condemned Viscera	CD ALL	Condemn All Viscera
Condemned Viscera	CD CHK	Condemn Cheek
Condemned Viscera	CD HRT	Condemn Heart
Condemned Viscera	CD KID	Condemn Kidney
Condemned Viscera	CD LIP	Condemn Lips
Condemned Viscera	CD LIV	Condemn Liver
Condemned Viscera	CD PAU	Condemn Paunch
Condemned Viscera	CD RUN	Condemn Runner
Condemned Viscera	CDLUNG	Condemn Lung
Condemned Viscera	CDPAUN	Condemn Paunch
Condemned Viscera	CDSKRT	Condemn Skirt
Condemned Viscera	CDTAIL	Condemn Tail
Condemned Viscera	CDTUNG	Condemn Tongue
Condemned Viscera	CDVCON	CD Vell Contam.
Condemned Viscera	CDVDIS	CD Vell Disease
Condemned Viscera	CDVOTH	CD Vell Other
Condemned Viscera	PATH	Pathological
Condemned Viscera	V CV	Condemn Vell
Condemned Viscera	V SETM	Cond V-Set Eos Myosotis
Condemned Viscera	V SETO	Cond Visc F-Set Other
Viscera Contamination	C LIV	Liver Contam.
Viscera Contamination	CONT	Contamination
Viscera Defects	BUNG	Bung
Viscera Defects	L ABC	Liver Abscess
Viscera Defects	L LTR	Liver Larval Tracts
Viscera Defects	L PERT	Liver Peritonitis
Viscera Defects	P ABC	Paunch Abscess

Viscera Defects	P BILE	Paunch Bile Contam
Viscera Defects	P OTH	Paunch Contam.
Viscera Defects	P PERT	Paunch Peritonitis
Viscera Defects	P PYO	Paunch PyoLesions
Viscera Defects	P URIN	Paunch Urine Contam.
Viscera Defects	SAW	Brisket Saw Fault
Viscera Defects	V ACT	Viscera Actino
Viscera Defects	V ALLP	All Offal Parasites
Viscera Defects	V CLA	Viscera Caceous Lymphad
Viscera Defects	V COD	Cyst Ovis Diaphram
Viscera Defects	V COH	Cyst Ovis Heart
Viscera Defects	V COO	Cyst Ovis Osophagus
Viscera Defects	V EMAC	Viscera Emaciation
Viscera Defects	V GANG	Viscera Gangrene
Viscera Defects	V HEPR	Heart Parasites
Viscera Defects	V KIPR	Kidney Parasites
Viscera Defects	V KWS	Kidney White Spots
Viscera Defects	V LIPR	Liver Parasites
Viscera Defects	V LUAB	Lung Abscess
Viscera Defects	V LUPR	Lung Parasites
Viscera Defects	V LUWM	Lung Worm
Viscera Defects	V NEO	Neoplasms
Viscera Defects	V PERT	Viscera Peritonitis
Viscera Defects	V PLU	Viscera Pleurisy
Viscera Defects	V PNU	Viscera Pneumonia
Viscera Defects	V PUPR	Paunch Parasites
Viscera Defects	V PYO	Viscera Pyo Lesion
Viscera Defects	V RUPR	Runners Parasites
Viscera Defects	V SAL	Viscera Septicaemia
Viscera Defects	V SAR	Viscera Sarcosis
Viscera Defects	V SPDG	Spleen Degeneration
Viscera Defects	V TABR	Tail Bruising
Viscera Defects	V URAE	Viscera Uraemia
Viscera Defects	V XAN	Viscera Xanthosis
Viscera Diseases	HRT NF	Heart Neurofibromas
Viscera Diseases	HRTMYO	Heart Myosotis
Viscera Diseases	L ALX	Liver Acute Eczema
Viscera Diseases	L CLX	Liver Chronic Eczema
Viscera Diseases	L LFE	Liver Facial Eczema
Viscera Diseases	L TEL	Liver Telangiactasis
Viscera Diseases	V APAT	Visc All Pathology
Viscera Diseases	V BOV	Viscera Bovis
Viscera Diseases	V DIPA	Diaphram Pathology

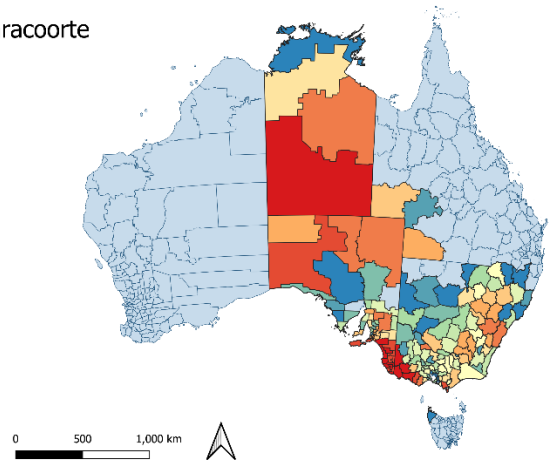
Viscera Diseases	V EMYO	Viscera ALL E Myosotis
Viscera Diseases	V FNEC	Viscera Fat Necrosis
Viscera Diseases	V HEPA	Heart Pathology
Viscera Diseases	V KIPA	Kidney Pathology
Viscera Diseases	V LIPA	Liver Pathology
Viscera Diseases	V LUPA	Lung Pathology
Viscera Diseases	V PAPA	Paunch Pathology
Viscera Diseases	V RUPA	Runners Pathology
Viscera Diseases	V TAPA	Tail Pathology
Viscera Diseases	V THPA	Thick S Pathology
Viscera Diseases	V TNPA	Thin S Pathology
Warning Notice	WARN05	NARM K2 Condemn Kidneys
Warning Notice	WARN06	NARM K3 - Persistent Anti
Warning Notice	WARN25	VBM CB Inspect B Measles
Warning Notice	WARN26	PARS P Lot test Alkaloids
Warning Notice	WARN51	Infected with F&M Disease
Warning Notice	WARN54	Infected with Rift Valley
Warning Notice	WARN56	Cotton Trash Access

8.2 Total cattle by catchment for each processor

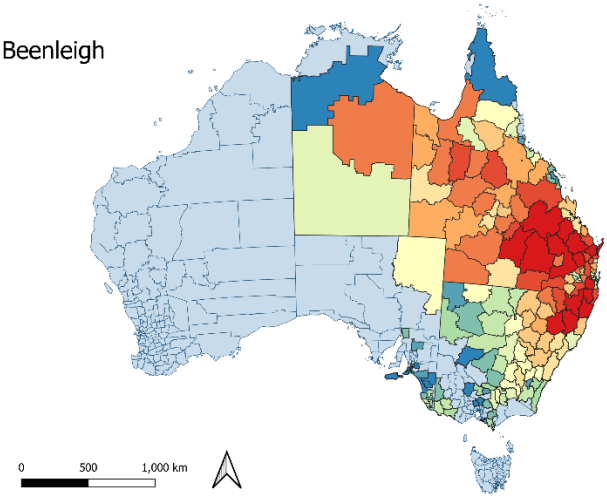
Wagga Wagga



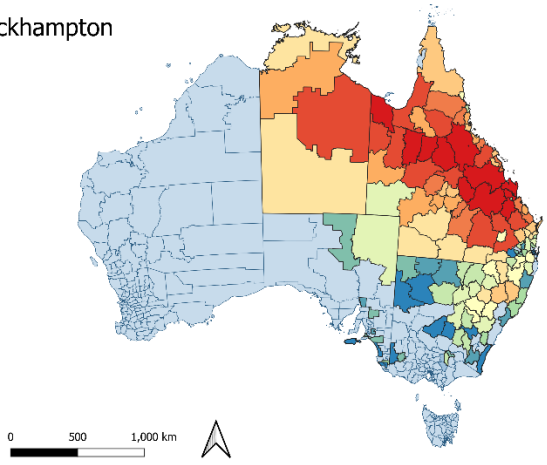
Naracoorte



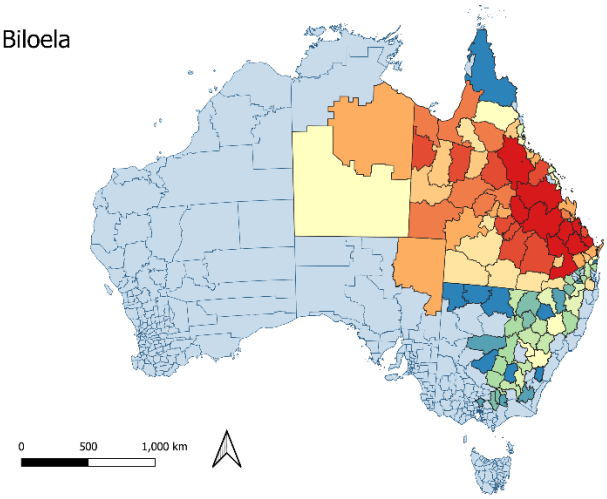
Beenleigh



Rockhampton



Biloela



Beenleigh	Wagga Wagga	Naracoorte	Rockhampton	Biloela
1 - 5	1 - 7.8	1 - 8	1 - 4	1 - 2
5 - 9.9	7.8 - 19	8 - 18.6	4 - 8	2 - 5
9.9 - 20.2	19 - 33	18.6 - 27.9	8 - 13	5 - 7.8
20.2 - 37.7	33 - 62.2	27.9 - 42.9	13 - 26.4	7.8 - 14.5
37.7 - 74.6	62.2 - 124.8	42.9 - 69.5	26.4 - 46.9	14.5 - 35.1
74.6 - 133.8	124.8 - 216.3	69.5 - 107.7	46.9 - 98.4	35.1 - 49.5
133.8 - 282.7	216.3 - 319	107.7 - 146.5	98.4 - 186.2	49.5 - 101.1
282.7 - 461.9	319 - 513.4	146.5 - 223.5	186.2 - 294.6	101.1 - 168.8
461.9 - 978.6	513.4 - 793.9	223.5 - 388.8	294.6 - 757.3	168.8 - 283.7
978.6 - 1905.8	793.9 - 1205.4	388.8 - 533.5	757.3 - 1666.5	283.7 - 549.6
1905.8 - 3115.2	1205.4 - 2143.5	533.5 - 814.5	1666.5 - 4759.2	549.6 - 1177.6
3115.2 - 6362.1	2143.5 - 5189.5	814.5 - 3578.4	4759.2 - 13091.8	1177.6 - 4029
6362.1 - 47645	5189.5 - 26570	3578.4 - 16844	13091.8 - 107732	4029 - 99387

8.3Proportion of cattle with hydatid by year processed and age (dentition)