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Investigating the influence of disease spillover between feral and domestic pigs in ASF outbreaks using AADIS

Madalene Oberin[a,b], Mark Stevenson[b], Victoria Brookes[c], Simon Firestone[b] and Richard Bradhurst[a]

[a] Centre of Excellence for Biosecurity Risk Analysis, The University of Melbourne, Parkville, VIC 3010, Australia, [b] Melbourne Veterinary School, The University of Melbourne, Parkville, VIC 3010, Australia, [c] Sydney School of Veterinary Science, The University of Sydney, Camperdown, NSW 2006, Australia
Email: madalene.oberin@unimelb.edu.au

Abstract: African swine fever (ASF) is a highly contagious viral disease of domestic and wild pigs with severe global impacts (Dixon et al. 2020). In Australia, the large feral pig population could increase the risk of spillover to commercial herds. This study parameterised the Australian Animal Disease Spread (AADIS) model with empirical feral–domestic and feral pig group contact rates from camera trap surveillance at a Queensland piggery. A sensitivity analysis of seasonal contacts showed that higher contact rates and introduction of ASF virus in autumn produced the largest simulated outbreaks. High contact rate scenarios increased predicted feral pig infections up to 12-fold compared to low contact rate scenarios, particularly during winter. These findings highlight the importance of incorporating feral pig seasonal dynamics and empirical data in ASF preparedness planning.

Keywords: *AADIS, ASF spillover, Epidemiological modelling*

1. INTRODUCTION

ASF causes high mortality in swine populations, trade restrictions, and economic disruption worldwide (ACIL Allen Consulting 2019). Australia is currently free of ASF, however the abundance of feral pigs and potential direct (nose-to-nose) and indirect (environmental or vector-borne) contact with domestic pigs pose significant risk if an incursion occurred. Seasonal conditions influence feral pig ranging behaviour, carcass persistence, and ASFV survival, affecting contact and transmission likelihood. (Mazur-Panasiuk et al. 2019). AADIS is a stochastic, spatially explicit model integrating epidemiological, ecological, and behavioural data (Bradhurst et al. 2015). Previous AADIS-ASF simulations for Queensland found that absence of feral pig control increases outbreak size and duration (Bradhurst et al. 2022). However, quantifying the wildlife–livestock interface is challenging due to scarce field data on contact rates. This study implemented empirical camera trap data to parameterise feral–domestic and feral group contact rates, assessing their seasonal influence on outbreak dynamics.

2. METHODOLOGY AND RESULTS

Contact rates were estimated from field work using camera traps deployed at a commercial piggery in southeast Queensland, which recorded the presence of feral pig groups and solitary boars. These detections were aggregated into seasonal averages with five ordinal values (minimum, maximum, midpoint, half the midpoint and quarter of the midpoint) that were used as empirical contact rates in AADIS to simulate ASF outbreaks (Table 1).

Table 1: Generated contact rate estimates used for each of the scenarios in the simulations.

	Summer	*Autumn*	*Winter*	*Spring*
Max	1.07	3.91	1.36	0.49
Midpoint	0.86	2.59	1.04	0.45
Min	0.64	1.37	0.73	0.41
Half of the midpoint	0.43	1.26	0.52	0.23
Quarter of the midpoint	0.22	0.65	0.26	0.11

Two simulations were conducted. The first varied the feral–domestic pig contact rate while keeping other parameters constant; the second varied the feral pig group contact rate also keeping other parameters constant. For each simulation, outbreaks were seeded southeast Queensland for summer, autumn, winter, and spring (500 iterations for each season). Output variables included the numbers of infected feral pig groups, infected piggeries, and animals culled, and the infected area in square kilometres (km^2). Each outcome was modelled using linear regression with season and contact rate scenario entered as fixed effects, and the winter quarter-midpoint scenario set as the reference. This approach allowed the independent influence of both season and contact rate to be estimated within the same model. In the feral–domestic spillover simulation, autumn outbreaks resulted in approximately four times as many infected feral pigs (95% PI: 3.7–4.3) and 2.5 times as many infected domestic pigs (95% PI: 2.4–2.6) as winter outbreaks (Figure 1). Increasing the contact rate from the quarter-midpoint to the maximum value increased the number of infected feral pigs by 5.6 (95% PI: 5.2–6.1), infected domestic pigs by 3.4 (95% PI: 3.2–3.5), animals culled by 4.78 (95% PI: 4.31–5.29), and infected area by 5.1 (95% PI: 4.4–5.9) compared to the winter quarter-midpoint baseline. The second simulation, which varied inter-group contact rates, produced similar seasonal patterns. Autumn seeding of infection led to more than 4.4 times as many infected feral pigs (95% PI: 4.2–4.7) and a 52% increase in infected domestic pigs (95% PI: 1.46–1.58) compared to winter. Increasing group contact rates to the maximum scenario resulted in an increase in infected feral pigs by 12 (95% PI: 11.15–12.84), an increase in infected domestic pigs by 2.87 (95% PI: 2.75–2.99), an increase in animals culled by 2.59 (95% PI: 2.30–2.91), and an increase in infected area by 3.62 (95% PI: 3.08–4.25) compared to the baseline.

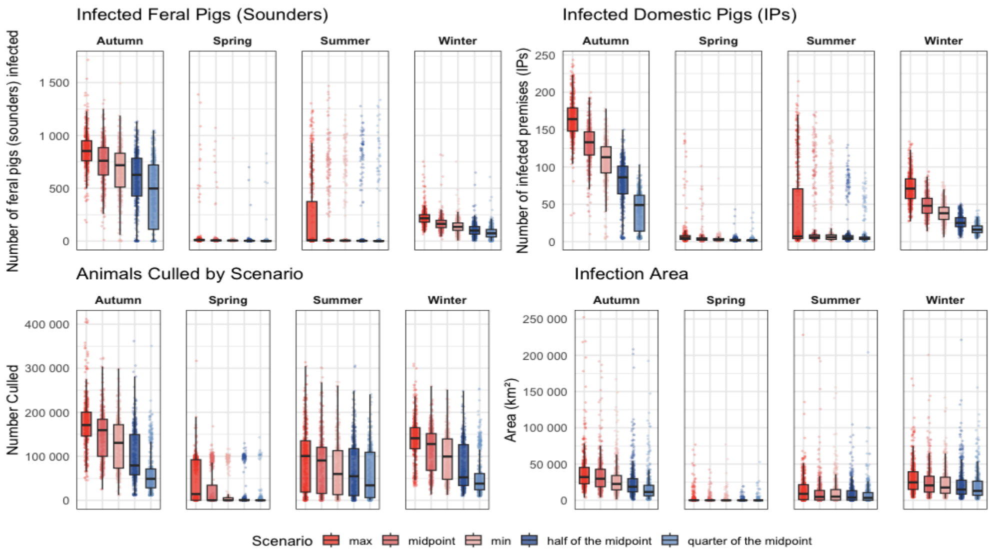

Figure 1: Key outcome metrics of varying the feral-domestic pig contact rate in AADIS (Simulation 1).

3. CONCLUSIONS

Feral–domestic and group contact rates are highly influential parameters in the AADIS model, with season acting as a major influencer of outbreak magnitude. Autumn was consistently the period of highest risk, aligning with ecological conditions that promote increased home range and congregation of feral pigs. The incremental increases in contact rates substantially escalated outbreak size, extent, and culling requirements. This potentially reflects real-world feral pig behaviour and resource availability that is associated with season. These findings suggest that surveillance and control measures should be intensified during autumn and at locations where feral pigs and domestic herds are more likely to interact, such as near water sources, crops, feedlots, or farm-adjacent attractants. The use of empirical data also demonstrated the application and value of locally derived ecological information in epidemiological modelling. Expanding such data to a broader geographic scale will enhance the applicability of AADIS to national ASF preparedness, enabling more targeted and efficient response strategies.

4. REFERENCES

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