



Systematic literature review of feral swine

by

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Background

An International Workshop on Feral Swine Disease and Risk Management was held in Fort Collins in November 2014. The author prepared a presentation to support the exposure session. During preparation of the presentation it was evident that consideration of concepts from the broader field of disease ecology was required to comprehensively address the questions posed in the session. Disease ecology can be defined as the ecological study of host pathogen interactions within the context of their environment and evolution (Kilpatrick and Altizer, 2010). For the purposes of disease management in feral swine, an understanding of disease ecology is critical because understanding will allow targeting of specific vulnerabilities within the disease ecology of the pathogen.

It was also evident that there was a very large body of published literature available on feral swine disease that could be used to understand disease ecology and other topics. For example, a search¹ of Web of Science (<http://thomsonreuters.com/thomson-reuters-web-of-science/>) revealed more than 7600 published articles. This body of literature provides an excellent opportunity to markedly expand knowledge of feral swine disease ecology and other relevant areas at very little cost (e.g. no field costs collecting or analysing data). With an appropriate focus, the published literature could be used to comprehensively address questions of interest to USDA regarding feral swine disease management. This would also allow elucidation of knowledge gaps to be addressed with precisely focused future research. Thus management of feral swine diseases in the USA could be advanced rapidly and inexpensively.

Other knowledge gaps observed by the author (BC) throughout the workshop included a relatively poor understanding of production impacts on livestock due to endemic diseases of feral swine. For example, *Leptospira* is the most common endemic infection in Australian feral pigs (Choquenot *et al.*, 1996), with a high prevalence of *Leptospira interrogans* serovar *Pomona* (Giles, 1980). *L. pomona* is well established cause of bovine abortion, and a high seroprevalence of *L. Pomona* in cattle is associated with feral pigs (Blood and Radostits, 1989). It is possible that this situation is replicated in the USA but the risk, economic impact or mitigation does not appear to be quantified in Australia, the US or internationally.

A systematic literature review is a high-level overview of primary research on a particular research question that tries to identify, select, synthesize and appraise all high quality research evidence relevant to that question in order to answer it (<http://www.cochrane.org/about-us/evidence-based-health-care>). There are many steps including (Dohoo *et al.*, 2009):

1. Specify question
2. Establish a review protocol
3. Find all studies
4. Determine relevant studies (inclusion and exclusion criteria)
5. Evaluate study quality
6. Extract relevant data from each study

¹ Search terms:

TOPIC: (Wild boar) OR TOPIC: (Sus scrofa) OR TOPIC: (Feral pig) OR TOPIC: (Feral swine) AND TOPIC: (disease)
Indexes=BIOSIS Previews Timespan=All years

7. Summarise and synthesise the results (+/- meta-analysis)

Meta-analysis was developed to determine an overall effect of a treatment from many controlled trials. Whilst most studies of disease in feral pigs are cross sectional surveys (i.e. not controlled trials, but observational studies), the use of meta-analysis in observational studies is now common (Dickersin, 2002). Thus, meta-analysis may have applications to the feral pig disease literature were a systematic review to be undertaken. Whether meta-analysis would be useful would depend on the specific question to be answered and the quantitative data available and synthesis possible. It is important to note that meta-analysis follows a systematic review but meta-analysis is not always appropriate for every systematic review.

During discussions, the author (BC), and then the facilitator (Professor Mo Salmon) identified the need for systematic reviews to enable USDA to benefit from the research of others in advancing their own research agenda. During discussions, the author (BC) agreed to prepare a short document to assist USDA in considering the need or focus of a systematic literature review. Thus, the purpose of this short document is to provide background and outline several possible systematic literature review topics.

Review topic

1. Disease ecology

Aim: To determine what influences disease² persistence, transmission and spread and what management practices/ mitigation tools are available and most effective to modify feral pig disease ecology.

Method: Systematically review theory, process modelling and observational studies on feral swine diseases to summarise the disease ecology of feral swine. This would include:

- Categorisation of feral swine diseases to assist generalisation of disease ecology by category (e.g. frequency verse density dependent diseases, viruses/bacteria, endemic/trans-boundary diseases etc.).
- 'Drivers of disease' or other risk factors
- Other epidemiological features such as transmission, hosts, spatial and temporal spread patterns, distribution etc.
- Identify risk mitigation tools and where/how they can be best targeted with respect to knowledge of disease ecology
- Identify knowledge gaps where future strategic research can be applied and the most appropriate research techniques.

Alternatively, it is possible that even with disease categorisation the topic is simply too broad. In this instance a different approach may be useful, including a holistic prioritisation of diseases and assessment of the disease ecology of some specific high priority diseases (see 2 below).

² Note disease used throughout, although it is acknowledged that infection with an organism may lead to the clinical expression of pathology (disease), but that not all infections lead to disease.

2. Holistic assessment and selected disease ecologies

Aim: List the major feral swine diseases, prioritise them and assess disease ecology of selected diseases.

It is unlikely the workshop report will be comprehensive enough for confidence that all diseases of importance are identified or even prioritised/ranked appropriately for the USDA (even given the excellent hazard table produced by Sophie Rossi). Hence further work is likely to be required to identify important diseases and to investigate their disease ecology and mitigation possibilities.

Method: Use a systematic review approach to identify a comprehensive list of most diseases of swine (feral and domestic), divide these into foreign animal, production, wildlife or public health diseases, prioritise these diseases and investigate the disease ecology of the most important diseases.

It is likely that most public health diseases are associated with hygiene during hunting and meat processing. Hence the mitigation steps would likely be associated with public health messages. It may therefore be relatively unrewarding to review the ecology of public health diseases.

Thus it will be important to focus the review of disease ecology on the most important foreign animal (FAD), wildlife and production (endemic) diseases. The same review of disease ecology as outlined above, but focusing only on priority diseases should be pursued. It may be prudent to consult industry and wildlife health experts on their opinion of the most important FAD diseases rather than relying solely on literature. These specialists may be less likely to understand which production diseases are important as little research has been conducted.

3. Production diseases

There appears to be a knowledge gap on the impact of feral swine diseases on agricultural production. A review of the literature is indicated to identify the major production diseases of feral swine in the USA and internationally. A priority should be given to identifying diseases that can cross the species barrier and infect livestock species, that have been demonstrated to cause disease in livestock species and that are present in the USA (or may be likely to be present). *Leptospira spp.* is a good example. The review should cover:

1. Identify important economic/production diseases of feral swine
 - Can/does spread to livestock
 - High economic impact (e.g. production losses, trade impact etc.)
 - Human health impact
2. Understand the disease ecology (including epidemiology, distribution, spatial and temporal occurrence, disease type and knowledge gaps) of these identified diseases
3. Collect economic data on the impact of these diseases sufficient to conduct a cost benefit analyses that will justify research and control of feral swine.
4. Risk mitigation steps possible and their efficacy.

Discussion

There is a large body of literature available internationally that the USDA could use to advance their own research agenda in an inexpensive and rapid manner. There are good methods available to investigate this body of literature that are more successful than the traditional narrative review. Systematic literature reviews with or without associated meta-analyses are suitable techniques.

In general, a thorough understanding of disease ecology in feral swine generally, or on specific diseases may allow improved risk mitigation against the impact of feral swine diseases. There is a very large body of literature on this topic, but a major review would allow commonalities to be extracted and synthesised. These learnings could then be used to identify suitable risk mitigation strategies, tools or methods and could assist further research to address important strategic gaps. In particular, the role or economic impact of endemic production and wildlife diseases of feral swine are poorly understood.

Any reviews would require some flexibility to change direction and focus. The body of literature is large with little cohesion, partly because new world research on feral pigs is very different to old world research (i.e. the conservation status of the wild pig differs in the new and old world). Only when a literature review was partially completed and the body of literature understood could the opportunities be more completely understood.

The author is uncertain of the exact direction and completed activities of the USDA feral pig disease program, and apologises if some works suggested are impractical or even already completed! In general though, there is a large body of literature available that can address many questions of interest to you, at little expense.

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