



## **Collaboration for Environmental Evidence**

### **Systematic Review No. 24**

Do control interventions effectively reduce the impact of European red foxes on conservation values and agricultural production in Australia?

#### **Review Summary**

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McLeod, L.J., Saunders, G.R. and Kabat, T.J. (2008). Do control interventions effectively reduce the impact of European Red Foxes on conservation values and agricultural production in Australia? Systematic Review No. 24. Collaboration for Environmental Evidence ([www.environmentalevidence.org](http://www.environmentalevidence.org)).

## Cover Sheet

Title	Do control interventions effectively reduce the impact of European red foxes in Australia?
Systematic review	No.24
Reviewer(s)	Dr Glen Saunders, Lynette McLeod and Tamara J. Kabat
Date draft protocol published on website	15 <sup>th</sup> November 2006
Date final protocol published on website	20 <sup>th</sup> April 2007
Date draft review published on website	22 <sup>nd</sup> July 2008
Date final review published on website	2 <sup>nd</sup> December 2008
Date of most recent amendment	N/A
Date of most recent SUBSTANTIVE amendment	N/A
Details of most recent changes	N/A
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Sources of support	Funding provided by NFACP and IA CRC (in full)
Conflicts of interest	None reported.

# Systematic Review Summary

## Background

The European red fox (*Vulpes vulpes*) is listed as one of the IUCN's top 100 worst invasive alien species. The species occurs naturally throughout most of the northern hemisphere, and was introduced into Australia in the 1870s, where it has become one of this country's most widespread pest animals, having major environmental and agricultural impacts through predation on native wildlife and livestock. Despite the huge impact foxes have on the environment and the millions of dollars they cost the economy each year, there are no recommended levels of fox control within Australia. The need to evaluate the effectiveness of control methods, particularly the main methods of poisoning with 1080-laden baits, shooting and trapping, in different situations has been identified. Such information will have value at regional, state and national scales, informing local management or policy decisions, and has the potential to influence state and national policies and guidelines on fox management for reducing impacts on conservation values and agricultural production.

## Objectives

To systematically search and collate published and unpublished evidence in order to address the question:

“Do control interventions effectively reduce the impact of European red foxes on conservation values and agricultural production in Australia?”

The secondary objectives are:

- “Do environmental and geographical factors (e.g. ecosystem, habitat, land-use, temperature, rainfall, longitude, island/mainland populations, food resources) alter the effectiveness of fox control for reducing impacts?”
- “Do operational level variables (e.g. density of foxes, size of controlled area, previous control history, duration/effort/timing of control, fencing of controlled area, bait/poison application method, bait type) alter the effectiveness of fox control programmes for reducing impacts?”

## Search Strategy

Electronic searching was completed using the following databases, catalogues and web-engines: Agricola, Alltheweb, Australian Digital Theses Program, BIOSIS, CAB Abstracts, ConservationEvidence.com, COPAC, CSIRO Library Network Catalogue, Digital Dissertations Online, Dogpile, English Nature's “Wildlink” catalogue, Google Scholar, Index to Theses Online, ISI Web of Knowledge (inc. ISI Web of Science and ISI Proceedings), Science Direct, Scirus (all journal and web sources), Scopus and Wildlife and Ecology Studies Worldwide (NISC). Publications on 28 statutory and non-statutory organisation websites were conducted. Bibliographies of articles viewed at full text were searched for relevant additional articles. Personal contact with recognised experts and practitioners in the field of fox control and wildlife/agricultural protection in Australia was used to retrieve further recommendations and data.

## Selection Criteria

Any studies that examined the change in impact of foxes on either agricultural production or conservation values in Australia after the implementation of control

programmes using the three main techniques of 1080 lethal baiting, shooting, or trapping were included. Appropriate experimental design with spatial and temporal controls was a pre-requisite to be accepted. Studies that measured the impact of control on fox abundance alone were not included.

### **Data collection and characterisation**

The inclusion criteria were met by sixteen articles only. Of these studies, fourteen reported on the impact of foxes on varying conservation values, while the remaining two studies measured impacts on agricultural production (typically lamb production). All of the studies involved the use of baiting with 1080, with a small number also conducting shooting and trapping. One study used electrified fencing in addition to the conventional baiting and shooting techniques.

Although all included studies reported on a change in abundance and /or survival of prey species after a control intervention, the dissimilarity in monitoring techniques (density vs indices of abundance, population vs individual survival), the inconsistency in the application of the control intervention, and the range of measured outcomes precluded the use of any formal meta-analysis statistical techniques. No study reported on the cost benefits of control intervention, and only two studies investigated the cost effectiveness of their control method.

### **Main results**

The two studies investigating the impact of fox predation on agricultural production both concluded there was a response in lamb production after control intervention, however the extent of this response varied. The fourteen studies that reported on the impact of foxes on conservation values investigated an array of prey species, mainly native wildlife, in a diverse range of locations and habitats. Many native species showed a positive response in either individual or population survival after the control intervention, however there were some species which showed either no response or a negative response to fox removal. Of the two introduced species that were investigated, the non-native House mouse (*Mus musculus*) showed no response after fox control, however there was a positive response in population numbers of the rabbit (*Oryctolagus cuniculus*), although when fox control ceased these populations did not necessarily remain suppressed suggesting rabbit populations exceeding some critical density were not regulated by foxes.

Poisoning with 1080-laden baits was the major control tool used by all included studies, however there were inconsistencies in its application, in part mirroring the changing knowledge of baiting effectiveness and best practice over time. The two studies that investigated cost effectiveness compared different baiting strategies to achieve a pre-determined management outcome, and their results have had a major impact on the way conservation baiting programmes are now conducted in Australia.

### **Conclusions**

Although fox predation has been recognised as a serious threat, especially to populations of native wildlife, the complexity of the interactions with other processes has made the collection of detailed information very difficult. On examination of the studies included in this review, only a broad set of evidence-based management guidelines can be formed. Frequent, broad-scale application of 1080-laden baits is the most effective approach to controlling fox impact currently available in Australia,

however land managers will need to assess their objectives and available resources before formulating their own management programmes, then continually improve these practices through monitoring and learning.

Robust density/ damage relationships for foxes in both agricultural and conservation landscapes remain elusive and this in turn hinders more definitive bioeconomic decision making. Deriving such relationships would require costly experimental evaluations, nonetheless, opportunities and innovations for examining such relationships should not be overlooked in ongoing fox research programmes. This review also recommends further research into the implications of mesopredator release and strategies that address the simultaneous management of all predators, the re-evaluation of the efficacy of conventional baiting programmes, the improvement in lethal techniques giving consideration to welfare and ethical aspects, and the improvement and refinement of non-lethal techniques.

There is a profusion of fox management programmes conducted across Australia, but so little of the resulting information and outcomes are reported in the public arena, and an even smaller number are published in the peer reviewed literature. Managers are urged to conduct their programmes in as a controlled and replicated way as possible, and to publish their outcomes so they can be incorporated into the high quality evidence-base necessary for land managers and policy makers to make informed decisions when managing the impact of foxes.