

Possible implications of Rabbit Calicivirus Disease for malleefowl *Leipoa ocellata* Gould in the north-west of Victoria

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Parks Victoria and the Department of Natural Resources & Environment (NRE) are collaborating with agencies from the other States and the Commonwealth of Australia in a national program of detailed monitoring and surveillance of the effects of Rabbit Calicivirus Disease (RCD). A component of the Victorian study involves an investigation of possible changes in fox predation upon malleefowl *Leipoa ocellata* Gould, 1840, in the wake of reduced rabbit abundance caused by RCD. The study entails measurement of overall fox activity post-RCD, measurement of egg loss from malleefowl nests, and an assessment of any observable changes in fox diet. Measures of fox abundance/activity pre- and post-RCD suggest that the level of fox activity has not declined significantly in the 18 months since the spread of RCD in the Victorian Mallee. This contrasts with a dramatic decline in rabbit abundance giving rise to concerns about the possibility of "prey switching". Preliminary findings by Benshemesh & Burton (1997) are that there was a high level of egg loss due to foxes in the first breeding season post-RCD (1996/97). The only similar finding was by Frith (1959) in a study conducted from 1953/54 to 1957/58 at the time when myxomatosis first affected rabbit populations in Australia. Initial sampling indicates that rabbits formed a relatively small proportion of the fox diet (approximately 15% of stomach contents) at the time of the initial RCD epizootic. It is too early to draw conclusions regarding any changes in fox diet post-RCD.

Introduction

Economic damage by wild rabbits in Australia, including the cost of control and agricultural production losses, has been estimated as being \$600 million annually. The European rabbit *Oryctolagus cuniculus* (Linnaeus, 1758) causes severe environmental damage in the form of loss of vegetation, loss of habitat for native fauna and soil erosion. Effective control is particularly difficult in the arid interior of Australia because of economic constraints and the unreliability of myxomatosis carriers (Coman, 1997).

The European Rabbit Calicivirus was introduced to an Australian offshore island from which it spread onto the mainland in October 1995 (Coman, 1997). In the subsequent 18 months the virus has spread throughout most of Australia where rabbits occur. The impact of the virus has generally been greatest in drier areas (<300 mm annual rainfall) where rabbit populations have been reduced by between 65% and 90%.

The European red fox *Vulpes vulpes* (Linnaeus, 1758) was introduced to Australia in the 1860s, soon after the European rabbit. The fox has been identified as the major cause of population decline in some species of native fauna (Saunders et al., 1995). A high level of fox control has led in some cases to the recovery of species such as the black-footed rock wallaby *Petrogale lateralis* Gould, 1842, and the brush-tailed bettong *Bettongia penicillata* Gray, 1837.

There is historical evidence of a relationship between fox and rabbit abundance,

e.g. significantly fewer fox scalps were returned for bounty payment in Victoria following the initial outbreak of myxomatosis in 1951 (Saunders et al., 1995). It might reasonably be expected that there would be a similar decline in fox abundance post-RCD. Concern has been expressed about the possibility of increased predation by foxes upon native fauna, particularly if foxes remained relatively abundant.

King & Wheeler (1985) found that there was a lag of more than 12 months before a fox population declined in response to an increased incidence of myxomatosis in a rabbit population following the introduction of the European rabbit flea in Western Australia. It is during this lag period following a disease outbreak or a drought when more severe predation upon native fauna might be expected. In the case of RCD, the impact might be more prolonged if rabbit abundance remains, as is expected, at a low level for a longer period than would occur following drought or an outbreak of myxomatosis.

Parks Victoria and the Victorian Department of Natural Resources & Environment (NRE) are conducting detailed monitoring and surveillance of RCD as part of a national program initiated in mid-1996. The Victorian detailed monitoring sites are located on both agricultural land and conservation reserves in the vicinity of the township of Hattah in the Victorian Mallee region.

Malleefowl *Leipoa ocellata* Gould, 1840, was selected as an indicator species for an investigation of possible increased predation by foxes in the Victorian Mallee post-RCD. The basis for selecting malleefowl was that this species is one of the few remaining medium-sized ground dwelling vertebrates in the Victorian Mallee. Secondly, foxes are known to prey upon malleefowl eggs, chicks and adults, although malleefowl have been able to coexist with the European fox in the Victorian Mallee since the 1890s. Another consideration was the fact that Parks Victoria/NRE have detailed baseline information on malleefowl nesting activity pre-RCD.

Methods and results

Epidemiology of RCD

The presence of the virus in rabbit populations at Hattah has been confirmed by quarterly sampling and testing of serum for the presence of antibodies. Monitoring has confirmed that the virus persists in populations with subsequent major epizootics having been observed in spring of both 1996 and 1997. Rabbit abundance has remained at very low levels since the initial epizootic in autumn 1996.

Rabbit abundance

Several measures of rabbit abundance have been used to address the question of whether RCD has been the cause of a significant decline in rabbit abundance, and whether this decline has extended to mallee vegetation communities where rabbit densities have historically been relatively low.

Rabbit abundance in the Victorian Mallee, as measured by spotlight counts of rabbits per km of transect, has declined markedly since the arrival of RCD in the Mallee. Rabbit abundance remains at a generally lower level than has been recorded in the Hattah area since the commencement of systematic monitoring in 1991 (fig. 1).

In addition to the spread of RCD, an extensive program of rabbit control has also

occurred on both farmland and reserves in the Mallee involving a range of conventional techniques such as poisoning, ripping and fumigation of warrens. Control efforts have intensified in the study area since 1990. However, the sudden and uniform decline in rabbit abundance recorded since the arrival of RCD cannot be explained in terms of either improved control measures or rainfall. Rabbits have declined in all land units, including dune-field mallee habitats occupied by malleefowl (Benshemesh & Burton, 1997) where there has been no active rabbit control.

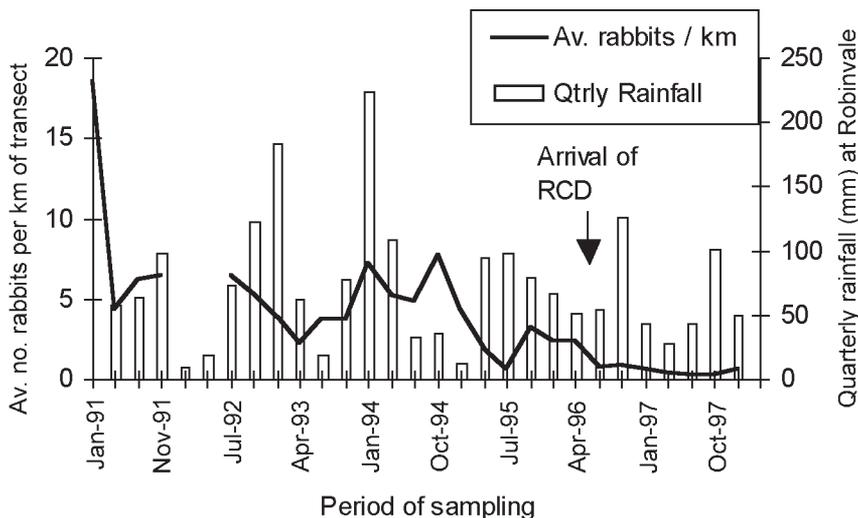


Fig. 1. Summary of rabbit abundance and rainfall data for the Hattah site. Data is aggregated from six sub-sites (different land uses) in the Hattah study area. The combined length of transect is 108 km.

The general decline in rabbit abundance has been sustained for a period in excess of 18 months with no evidence of any recovery in the population. In this respect the population response is probably different to any experienced since the initial outbreak of myxomatosis in the early 1950s.

Fox abundance

The RCD monitoring project has also examined whether there has been a reduction in fox abundance/activity associated with the widespread decline in rabbit abundance. Again, several measures of fox activity were adopted given the difficulty of estimating absolute fox populations.

Considerable spotlight count data were collected before the spread of RCD, notably from the north-west corner of Murray-Sunset N.P. These counts have continued and the resultant data indicate that, in contrast with the decline in rabbit abundance, fox populations have remained relatively stable post-RCD (fig. 2).

A second measure of fox activity has involved recording the frequency at which fox scats occur on malleefowl nests. These data have been collected on an annual basis from approximately 590 nests within 18 grids for the past two seasons (1995/96 and 1996/97). Fox scats were recorded at 61% of nests in 1995/96 and at 52% of nests

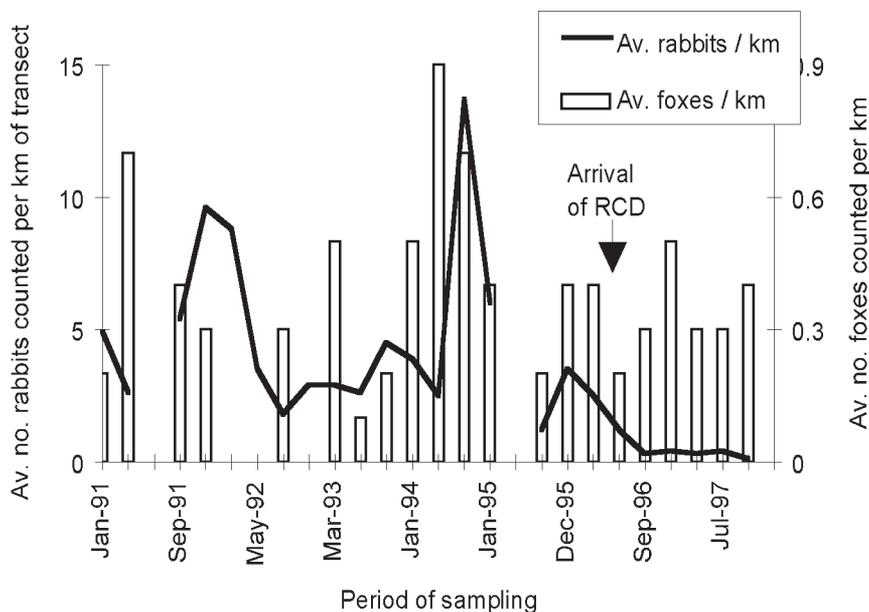


Fig. 2. Rabbit and fox transect counts from the north-west of Murray-Sunset National Park. The data represent the combined counts from five separate transects over a total distance of 137 km. Counts have generally been conducted at quarterly intervals since 1990, although foxes were not always included in the transect counts prior to 1993.

in 1996/97 (Benshemesh & Burton, 1997). This suggests that fox activity in the vicinity of malleefowl nests has declined by only a small amount, if at all.

Fox den activity has also been monitored following the spread of RCD within five malleefowl monitoring grids for the period spring 1996 - winter 1997. A total of 25 dens were included in the sample of which 48% were found to be active in spring of 1996, 43% in summer of 96/97, and 32% in winter of 1997 (Benshemesh & Burton, 1997). The last figure may have been influenced by a fox baiting program in the vicinity of one of the five grids. These data also suggest only a small decline in fox activity in the vicinity of malleefowl nests.

Dietary investigation

Rabbits are considered to be a principal prey item of foxes and feral cats *Felis catus* Linnaeus, 1758, in southern Australia (Saunders et al., 1995). Fox and cat diet is being investigated at Hattah via two processes, viz. 1) analysis of fox and cat stomach samples collected opportunistically and 2) analysis of fox scats collected seasonally from malleefowl nests.

Based on the analysis of an initial sample of 11 fox and four cat stomachs, rabbit appeared to be a staple prey item for cats pre-RCD but less important for foxes at the Hattah site. Rabbit comprised approximately 15% of fox gut contents (by weight) compared to more than 60% for a small sample of cat stomachs (Cavanagh, 1997).

Over three hundred fox scats have also been collected from malleefowl nests within 14 monitoring grids in the Murray-Sunset and Hattah-Kulkyne National

Parks. Only 73 of these have been analyzed so far, and these contained six native and seven introduced mammalian species as well as reptile, insect, feather and seed remains. The analysis suggested an extremely high intake of insects which comprised some 96% of the animal material in the scats (Brunner, 1997). Although feathers were detected in 22 of the scats, they only occurred as trace items, and egg shell was not detected in any scats. Brunner (1997) questioned whether competition between foxes and native fauna for available food resources, particularly insects, may not be of even greater concern than direct predation.

Impact of fox predation upon malleefowl nesting success

The direct impact of fox predation upon malleefowl nesting success is being assessed by means of measuring egg loss from a sample of active nests within nine monitoring grids during the course of the 1996/97 nesting season. The fate of eggs laid at 22 nests was monitored monthly, and the information collected has been compared with four previous detailed studies of the breeding biology of malleefowl in SE Australia (Benshemesh & Burton, 1997).

This study has shown a much higher level of egg predation than most previous studies, and also found differences in the type of predation that occurred on eggs. Previously there had been little evidence of foxes removing whole eggs from nests, eggs generally having been eaten in-situ. In the 1996/97 study, however, it was found that 8% of all eggs were eaten in-situ and a further 24% of eggs laid were removed from the nests without trace. Most of these eggs went missing well before they were due to hatch, and Benshemesh & Burton (1997) suggested that foxes removed most of the missing eggs. This conclusion was supported by:

- a strong correlation between the proportion of eggs in a nest that were eaten by foxes in-situ and the proportion that went missing from the same nest;
- the discovery of two eggs cached in a manner typical of foxes;
- a previous observation in the Mallee of a fox removing an intact egg from a nest; and
- the fact that foxes are the only common predator of malleefowl eggs.

Comparable levels of egg loss (37%) were reported by Frith (1959) at the time of the initial myxomatosis outbreak. However in that study, all eggs were found to have been eaten in-situ. Frith (1959) observed high levels of egg predation in four of the five nesting seasons from 1953/54 to 1957/58.

Discussion

A preliminary conclusion based on current monitoring in the Victorian Mallee is that while rabbit activity has declined, fox activity has remained relatively stable with perhaps a slight decline since the arrival of RCD. There has, therefore, been a lag of at least 18 months in any major population response of foxes to the prevailing low levels of rabbit abundance. This finding gives cause for concern that foxes might have replaced rabbits in their diet, at least to some extent, by preying more heavily upon native vertebrate fauna. Alternatively, foxes may have diversified their diets and increased their intake of invertebrates, for instance.

The investigation of fox and cat diets at the Hattah site is not far enough advanced to determine whether native vertebrate species represent a greater proportion of fox or cat diet following the spread of RCD. Larger samples of fox and cat stomachs and fox scats have been collected and are currently being analyzed.

The loss of 32% of eggs from a sample of 22 malleefowl nests during the 1996/97 season represents a higher level of predation than has been recorded since the initial myxomatosis epizootic. The fact that this apparent behaviour on the part of foxes has been recorded across a wide area (grids up to 40km apart) indicates that it is not restricted to a small number of individuals. It remains to be seen whether this level of egg loss will be repeated during subsequent nesting seasons as was the experience with the Frith study in 1953-58. If this proves to be the case, extensive fox control programs would be advisable.

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