

The Impact of Rabbit Calicivirus Disease on Raptor Reproductive Success in the Strzelecki Desert, South Australia: A Preliminary Analysis.

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INTRODUCTION

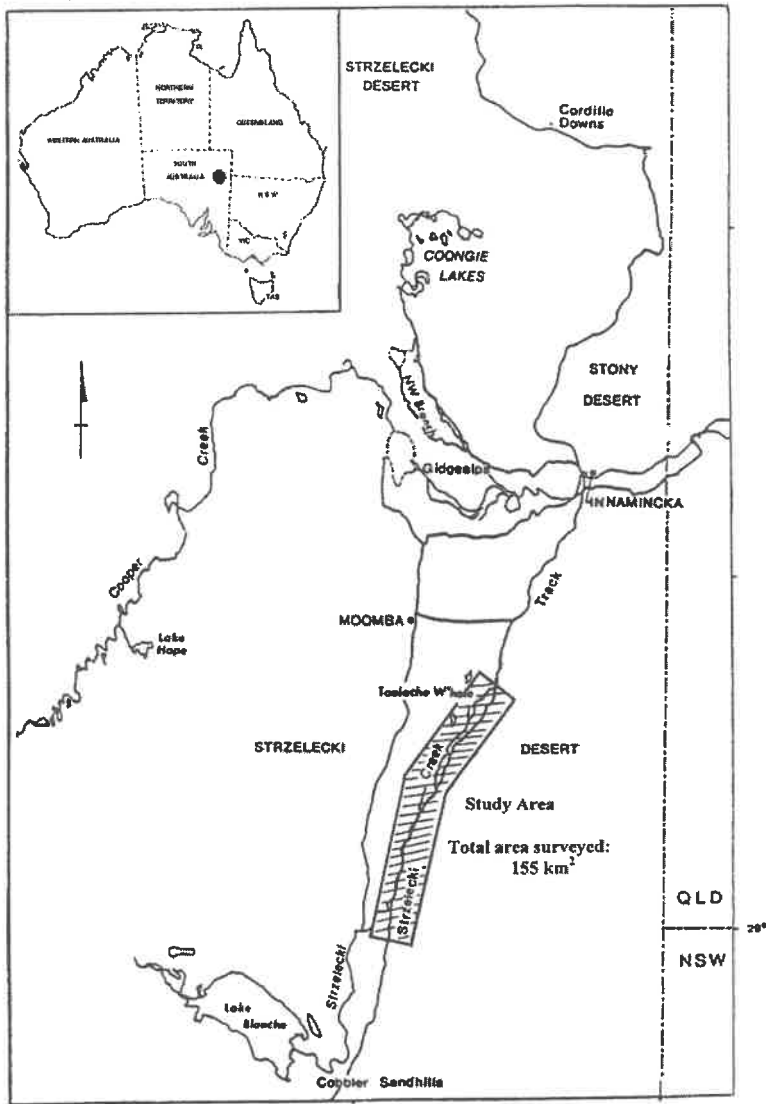
The Strzelecki Drainage System is recognised as one of Australia's most important raptor breeding areas. In September 1981 along a 20 km stretch of the Strzelecki Creek floodplain extending to a maximum width of 3 km, 73 pairs of ten species were recorded nesting (Mace 1981). The area provides one of the highest known concentrations of breeding raptors in the world and highlights the importance of tree-lined drainage systems in arid areas (Olsen 1995). A number of species that regularly breed there are listed as rare or threatened (eg. Grey Falcon *Falco hypoleucos* & Black-breasted Buzzard *Hamirostra melanosternon*, Olsen 1995).

The introduced European rabbit *Oryctolagus cuniculus* is one of Australia's major environmental pests, particularly in arid and semi arid areas and is a significant component of the diet of seven species of raptors found breeding in the Strzelecki. This study was initiated in November 1995 as a response to the unplanned release of the Rabbit Calicivirus from Wardang Island, South Australia, where field tests were being performed to assess its possible use as a biological control agent in Australia. A highly infectious virus, Rabbit Calicivirus Disease (RCD) kills rabbits quickly, without infecting other animals, including predators of rabbits.

RCD was first confirmed in the Strzelecki Creek area in mid November 1995, having arrived through natural spread. This project aims to study the reproductive responses of raptors to the expected RCD-induced decline in rabbit numbers. Combined with historical productivity data (post-1981), this study will provide a bench mark against which to measure any future changes in raptor productivity as a result of the removal of a major prey source. This project is ongoing and the results presented are preliminary.

Few previous opportunities have arisen to study the indirect effects of a biological control agent on native wildlife species in Australia, particularly in environmentally important and ecologically sensitive areas.

Figure 1. Far north east of South Australia showing study location and area surveyed for raptor breeding.



STUDY AREA AND METHODS

The Strzelecki Creek is lined by relatively narrow riparian woodland surrounded by a complex system of longitudinal red sand dunes in the Strzelecki Desert located in the far northeast corner of South Australia (Figure 1). The Strzelecki Creek is unusual in that it receives flows from the Cooper Creek only under extreme flood conditions. In consequence the inundation of this system is much less frequent than that of the Cooper.

The study area comprises mostly a dry creek and associated floodplain extending 40km south from Merty Merty Station to Tinga Tingana Crossing (110km²) and 15km from Toolache Waterhole to Tilparce Waterhole (45km²) (Figure 1). Distance from the creek bed to the edge of the floodplain varies from about 500 metres to 3 km.

RAPTOR PRODUCTIVITY

A systematic search was undertaken in the study area to locate all active raptor nests. In 1995 one survey was undertaken, in 1996 and 1997, two surveys were undertaken during each breeding season to determine raptor productivity and nesting success based on the terminology of Postupalsky (1974).

The survey was conducted by three teams who searched prescribed transects using a combination of 4WD vehicles, four-wheel quad motorcycles and walking in order to sample all habitat types including the dry creek bed. Transects crossed the creek bed and associated flood plain at intervals ranging from 100 to 150 metres, depending upon vegetation density and terrain.

A series of dry tree-lined clay pans beyond the defined drainage channel were also checked for nesting activity. Two four-wheel motorcycles were used to investigate nests that were located in particularly remote saltbush *Atriplex vesicaria*, *lignum Muehlenbeckia florulenta* and cane grass *Eragrostis australasica* flats. Each nest site was inspected for breeding activity. Active nests were determined by the presence of fresh nesting material and prey remains, castings and excreta below the nest and, if birds were seen at the nest, were checked whether eggs, young or fledglings were present using telescopic poles with mirror attached at 45° angle. Locations of nests were recorded using Garmin GPS instruments which provided sufficient accuracy to locate nest sites during the next survey.

All prey remains were collected from each nest and identified to species where possible. Prey items were quantified by determining percentage by number of the total number collected from each nest.

Historical Productivity

Historical reproductive data for the area were sourced from the Australian Bird and Bat Banding Schemes (Environment Australia), the Nest Record Scheme (Birds Australia) and from surveys undertaken by bird banders. Other data collected by the authors during 1984-87 were also included.

Rabbit Distribution and Density

For each year from 1995 to 1997, rabbit numbers were assessed by spotlight surveys, conducted at night between 2000 hrs and 2300 hrs. Twenty one (21) transects, each two (2) kilometers long and one hundred (100) meters wide were established in the study area. Each survey was undertaken by a team of 3 persons, comprising a driver, recorder and observer. Each team repeated the counts two days later, at approximately the same time. A speed of 10 km/hr was maintained during the surveys. All transects were established along existing tracks and exploration survey lines.

RESULTS

Reproductive Success of Raptors (1981-97)

Generally raptors were observed in very low numbers throughout the study area. A total of 18 active nests of rabbit-dependent raptor species were recorded with young in 1995, 6 in 1996, and 4 in 1997 (Table 1). In five of the seven species no nests with young were recorded in 1997.

Productivity for Black Kites *Milvus migrans*, Whistling Kites *Milvus sphenurus*, Black-breasted Buzzards *Hamirostra melanosternon* and Black Falcons *Falco subniger* decreased during the period 1995-97 (Table 1).

Brown Falcons *Falco berigora*, Black Kites and Black-breasted Buzzards were the only species to successfully produce young during 1996 and Brown Falcons and Little Eagles *Hieraaetus morphnoides* were the only species to successfully produce young in 1997. All monitored nesting of other species failed to successfully produce young.

The number of successful pairs for each species in the study area, post RCD was considerably lower than pre RCD historical data, however a clear trend appears to be emerging from these preliminary results indicating lower productivity for Black Kites, Whistling Kites, Black-breasted Buzzards and Black Falcons. Wedge-tailed Eagles *Aquila audax* have failed to successfully breed since 1995.

Non rabbit-dependent raptor species were found with young during the study, including Australian Kestrels *Falco cenchroides*, Grey Falcon *Falco hypoleucos* and Australian Hobby *Falco longipennis*, but have not been included in these results.

Historically the combined total number of productive nests for Wedge-tailed Eagles, Black Kites, Whistling Kites, Little Eagles, Black-breasted Buzzards, Brown Falcon and Black Falcon found in the area peaked in 1985 with 212 nests (Figure 2). The number of active nests then declined to 38 in 1986 and to 19 in 1987. No data were obtained in 1989 to 1994.

Table 1. Numbers of pairs and productivity of various raptor species, Strzelecki Creek.

Species	Pre-RCD				Post-RCD		
	1984	1985	1986	1987	1995	1996	1997
Wedge-tailed Eagle							
Number of Pairs	4	12			1		
Number of Young	6	17			1		
Mean Young / pair	1.50	1.40	na	na	1.00	F	F
Black Kite							
Number of Pairs	42	144	29	17	4	2	
Number of Young	65	181	42	22	4	2	
Mean Young / pair	1.54	1.25	1.44	1.29	1.00	1.00	F
Whistling Kite							
Number of Pairs	4	14	3		3		
Number of Young	9	25	6		4		
Mean Young / pair	2.25	1.78	2.00	na	1.30	F	F
Little Eagle							
Number of Pairs	14	3			3		1
Number of Young	16	3			3		1
Mean Young / pair	1.14	1.00	na	na	1.00	F	1.00
Black-breasted Buzzard							
Number of Pairs	3	10	4	2	2	2	
Number of Young	4	15	6	2	1	1	
Mean Young / pair	1.33	1.50	1.50	1.00	0.50	0.50	F
Brown Falcon							
Number of Pairs	12	24	1		3	2	3
Number of Young	23	45	1		4	3	6
Mean Young / pair	1.90	1.87	1.00	na	1.33	1.5	2.00
Black Falcon							
Number of Pairs	2	5	1		2		
Number of Young	4	10	2		2		
Mean Young / pair	2.00	2.00	2.00	na	1.00	F	F

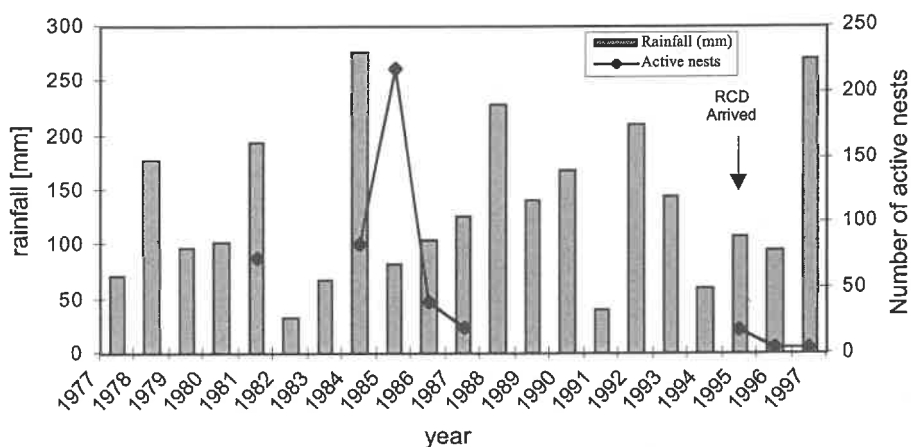
Note: na = not available; F = failed:
1984-87 - data collected by Waterman.

Productive nests for 1995 to 1997 declined from 18 to 4 (Figure 2 and Table 1). The high peak in active nests for the area during 1985 followed a year of relatively high rainfall. The 270 mm of rain recorded during 1997 compares with 1984 when 276 mm of rain were recorded (Figure 2). Yet the difference in numbers of raptor nests recorded in these two years is striking.

Prey Analysis

During the 1995 survey, the most common prey item in the diet of raptors was rabbit, followed by reptiles (Table 2). Rabbits made up the bulk of the breeding season diet (86% to 100%) of Wedge-tailed Eagles, Whistling Kites, Black Kites and Brown Falcons. For Black-breasted Buzzards, Black Falcon and Little Eagles, rabbit comprised 75% and 63% of the diet respectively. The sample size of prey items was low and no great weight should be put on these results.

Figure 2. Annual rainfall (mm) for Merty Merty Station and number of active raptor nests recorded in the study area.



Other prey remains included one Fat-tailed Dunnart *Sminthopsis crassicaudata* found in a Whistling Kite's nest, and Netted Dragons *Ctenophorus nuchalis*, Bearded Dragons *Pagona vitticeps* and Sand Goanna *Varanus gouldii*, found in Little Eagle and Black-breasted Buzzard nests (38% and 25% of all prey items respectively).

Table 2. Prey remains represented as a percentage of total collected from each raptor nest - November 1995.

Species	Rabbit	Birds	Reptile	Small Mammal	Other	Total no of items
Wedge-tailed Eagle	88 [7]		12[1]			8
Whistling Kite	89[8]			11[1]*		9
Black-breasted Buzzard	75[9]		25[3]			12
Little Eagle	62[5]		38[3]			8
Black Kite	100[14]					14
Brown Falcon	86[6]				14[1]ψ	7
Black Falcon	75[3]	25[1]f				4

Note: * Fat-tailed Dunnart, f Galah, ψ unable to identify remains
Figures in parenthesis represent number of prey items

Few prey remains were found in or beneath active nests during the 1996 and 1997 surveys. However, prey remains recorded include; Little Corella *Cacatua pastinator* from a Little Eagle nest

and Bearded Dragon and Netted Dragon from a Brown Falcon nest. Two pellets collected from beneath a Black-breasted Buzzard nest in 1997 comprised bird feathers (species unknown) and rabbit. Most of the items from rabbit-feeding species in these years were not rabbits, reflecting the shortage of the primary prey.

Rabbit Density and Presence of RCV

Two rabbit carcasses excavated from burrows near Toolache Waterhole (Site 2) during the 1995 survey tested positive to RCD. Spotlight counts indicated a 94% decrease in numbers from November 1995 through November 1996 to November 1997 (5.7, 0.4 and 0.3 rabbits/km respectively, figure 3 and 4).

Figure 3 Number of rabbits seen per kilometre at Tinga Tingana and Merty Merty (mean over two nights). Total length of spotlight transects = 24 km.

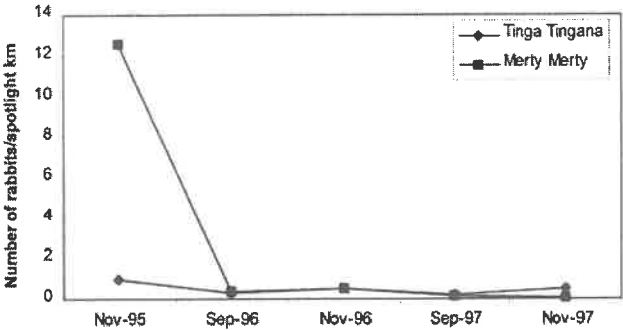
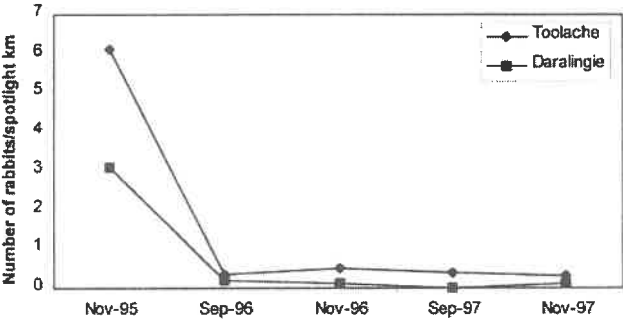


Figure 4 Number of rabbits seen per kilometre at Toolache and Daralingie (mean over two nights). Total length of spotlight transects = 18 km.



Serological testing was not undertaken on rabbits in 1996, but we presume that the virus was the major influence in the observed decline in rabbit numbers. During September 1997, four rabbits were collected, ranging in age from 150 to 220 days. Three were seropositive for RCD antibodies, reflecting possible RCD outbreaks in August-September 1996 and again in February-March 1997.

By contrast at Bollards Lagoon Station in September 1997 about 70 km east of Merty Merty Station and outside our raptor study area, rabbit numbers were relatively high. The spotlight survey of the Bollards Lagoon area found 7.5 rabbits/km and 40 rabbits/km. It seems, therefore, that rabbit density was highly variable over the region as a whole.

DISCUSSION

The 1995 results indicate a high degree of dependence of seven species of raptors on rabbits for food. During the 1995 breeding season, the population of Wedge-tailed Eagles (3 pairs) produced one young. Two pairs were present at nests but did not produce young and were not included in the results. During the 1997 season a total of 17 Wedge-tailed Eagle nests were checked for activity. No adults were observed near any of the nests, but two had been lined with fresh leaves, perhaps a month prior to our visit. These nests are not included in the above figures for total active nests, as adults were not present. Many of these nests were in a bad state of repair, showing considerable deterioration from previous years.

A study in Western Australia found that Wedge-tailed Eagles did not breed unless the late summer or early winter index of rabbit abundance had reached at least 1.6 per kilometre (determined by spotlight counts, Ridpath and Brooker (1985). Consistent with this, the mean number of rabbits per spotlight km for the Strzelecki Creek in 1997, when no Wedge-tailed Eagles successfully produced young in the study area, was less than 0.5 per km.

In their arid-zone study of Wedge-tailed Eagles, Ridpath and Brooker (1985) found that, where the mean annual rainfall was distributed more erratically between years and was combined with less diverse flora, there were periods of up to 4 years between the successful breeding of particular pairs.

Given the good rainfall figures in our area for 1997, it would appear that factors other than rainfall contributed to the decline in nesting activity of raptors there. Whilst lower rainfall during 1994 to 1996 may have accounted for lower raptor breeding during this period there appears to have been no increase coinciding with good rains in 1997. We can suggest no explanation other than the disease-induced scarcity of rabbits.

During the 1997 survey very few raptors were observed compared to previous years. Even Black Kites, which are normally very common and conspicuous as they soar above the floodplain, were noticeably scarce.

The observed decrease in rabbit numbers, resulting from the combined effects of drought and RCD and apparent low populations of potential alternative prey may have had an effect on the number of raptors breeding in the area.

Severe storms occurred in the area prior to the November 1997 survey and may have contributed to some nesting failure. Although no carcasses were found beneath nests, other predators and scavengers might have removed any that occurred.

Bird-eating species of raptors may well benefit in time from the increased vegetation cover and resulting increased seed and herbage production for prey species (ie improved habitat conditions for prey species).

In Britain, where rabbit numbers were greatly reduced by the disease Myxomatosis, the numbers and productivity of Common Buzzards *Buteo buteo* were much reduced. In some areas, most pairs failed to breed, as alternative prey were insufficient. As rabbit numbers recovered buzzard breeding improved (Newton 1979. Sumption and Flowerdew 1985).

Studies undertaken by Olsen & Marples (1992) demonstrated that the clutch sizes in raptors such as Whistling Kites, Brown Goshawks *Accipiter fasciatus* and Wedge-tailed Eagles decreased significantly following rabbit control with myxomatosis. In raptors which occurred in the same areas, but which rarely took rabbits, clutch size remained unchanged (Olsen & Marples 1992). North of 26° S where rabbits are rare, clutch sizes remained unchanged as well.

Myxomatosis has had little impact on raptors in arid regions of Australia, which may explain why many raptor populations remain in a relatively healthy state. A major decline in numbers of rabbits is likely to result in a decline in the breeding success of many raptor species; since the 1995 breeding season, Wedge-tailed Eagles have failed to reproduce.

In conclusion, the decline in raptor breeding activity in the Strzelecki Creek would appear to be linked to the RCD induced decline in the rabbit population. We consider that further investigation into this little known aspect of predator/prey relationships is important for the future preservation of our raptor populations.

ACKNOWLEDGMENTS

This project has been financed by the Bureau of Resource Science, Department Primary Industries and Energy, Canberra and National Parks and Wildlife, South Australia (NPWSA). A special thanks to Nick Mooney for presenting this paper at the conference and for support and advice with the field work since 1995. Also a special thanks to Jim Robinson for his dedication and commitment to this project each season and thanks to Mark Holdsworth, Tim Collins, Mark Boulet, Nick Birks, Katrina Gray, Dawn Hay, Pat Kennedy, Wally Klau, Bill Brown and Niel Jarvis for their commitment to the field work often under harsh and hot conditions. Also thanks to Ron Sinclair and Peter Bird of the Animal Plant Control Commission SA for their assistance and support during the September 1997 survey.

Thanks to Steve Coulthard (Aboriginal Ranger) for his expertise and skill with identifying animal tracks and to Pam and Martin Rieck, Managers of Merty Merty Station for supplying rainfall information and allowing the survey teams to camp on the station. Ron Sinclair and Peter Bird also provided helpful advice and comments on this report. Thanks to Peter Alexander (Wildlife Management NPWSA) and Phil Strachan (Balcanoona NPWSA) for assistance with vehicles and equipment, Cheryl Vale (NPWSA) for preparation of illustrations and diagrams, to the Australian Bird and Bat Banding Schemes (Environment Australia) and Nest Record Scheme (Birds Australia) for access to data and records. Also special thanks to Mr Max Waterman for allowing access to his comprehensive banding records from the Strzelecki Creek.

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