1995-1996 Report to

THE AUSTRALIAN NATURE CONSERVATION AGENCY,
FERAL PESTS PROGRAM

Prey Response to 1080 Baiting Over Large Areas.

Part only of FPP Project Number 8:
Control and Ecology of the Red Fox in Western Australia

(ANCA File reference: 700/1/9)

June 1996

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Control and Ecology of the Red Fox in Western Australia - Prey Response to 1080 Baiting Over Large Areas.

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Background

This report outlines progress of the project assessing native fauna response to various levels of fox density reduction through 1080 baiting in the northern jarrah forest of southwest Western Australia for the period 1 July 1995 to 30 June 1996.

The project is one of three research projects comprising FPP Project Number 8 (see Consultancy Agreement of 4 February 1994).

The other projects funded by FPP Project Number 8 are the:

- Carnarvon Fox Study (Marlow and Thomson) formerly the fox research program at Beverley and North Bannister; and
- Fitzgerald River National Park and Perup (proposed Nature Reserve) fauna response to 1080 baiting (Kinnear).

Proposed research for the period to December 2000 is outlined in the recently submitted application for continued funding.

The northern jarrah forest fox density reduction and fauna response program is the largest fox control and research program undertaken within Australia. The project has compatible research and management objectives that have been progressively refined.

The northern jarrah forest project draws on the knowledge gained from 1080 research and is applying 4.5mg 1080 dried meat baits from the air and vehicles at a baiting intensity of 5 baits/km^2 over a total baiting area of 440,400 ha. The total study site is approximately 544,000ha with the following treatments:

- 2 baitings per year: 221,400ha.
- 4 baitings per year: 130,400ha.
- 6 baitings per year: 88,600ha.
- Unbaited control: 103,500ha.

The project is an integral part of the Co-operative Research Centre for Biological Control of Vertebrate Pest Species (CRC VBC). The research undertaken comprises Project 3.4 within the VBC Ecology Program.

The specific goal of the current VBC fox research in the northern jarrah forest of Western Australia is to determine the minimum level of fox density reduction required to allow native fauna populations to increase and be sustained. This required level of fox density reduction will set the target for fertility control.

The methodology employed to achieve this objective will result in achieving specific management objectives including:

- determining appropriate 1080 baiting regimes for fox control over large tracts of conservation estate and multiple use forest;
- establishing additional populations of a threatened species (the woylie, *Bettongia penicillata*) within its former geographic range; and
- increasing the abundance of the suite of native fauna within the northern jarrah forest, including species listed as threatened, e.g. the chuditch (*Dasyurus geoffroii*).

In addition to funding support from ANCA, CRC VBC and CALM, the project has significant support from Alcoa of Australia.

Progress to date

The northern jarrah forest project commenced in July 1993. 1080 baiting of the study site commenced in July 1994.

Fauna response to the effect of 1080 baiting is monitored through:

- twice yearly trapping over 43 grids. Each grid is approximately 10ha. Twenty seven of these are integrated trapping grids with 25 wire cage traps, 15 Elliott traps and 15 pitfall traps. The remaining 16 (4 in each treatment) are comprised of wire cage and Elliott traps only; and
- twice yearly spotlighting over 4 transects within each treatment. Each transect is 5km.

The woylie, or brush-tailed bettong, *Bettongia penicillata*, is recognised as an indicator species for medium size mammals. In January 1995 a pilot translocation was undertaken to 4 sites. During September 1995 to January 1996 a further translocation was undertaken to 18 sites. Woylie survivorship has been intensively monitored through radio-telemetry procedures, using movement sensitive mortality transmitters.

Fox density is assessed annually through the use of sandplotting.

The location of the study area, treatments, monitoring sites and woylie translocation release sites are shown in figures 1 and 2 (in plastic sleeve insert).

Figure 1. Location of Fox Control Research within the Northern Jarrah Forest of the South - West of Western Australia.

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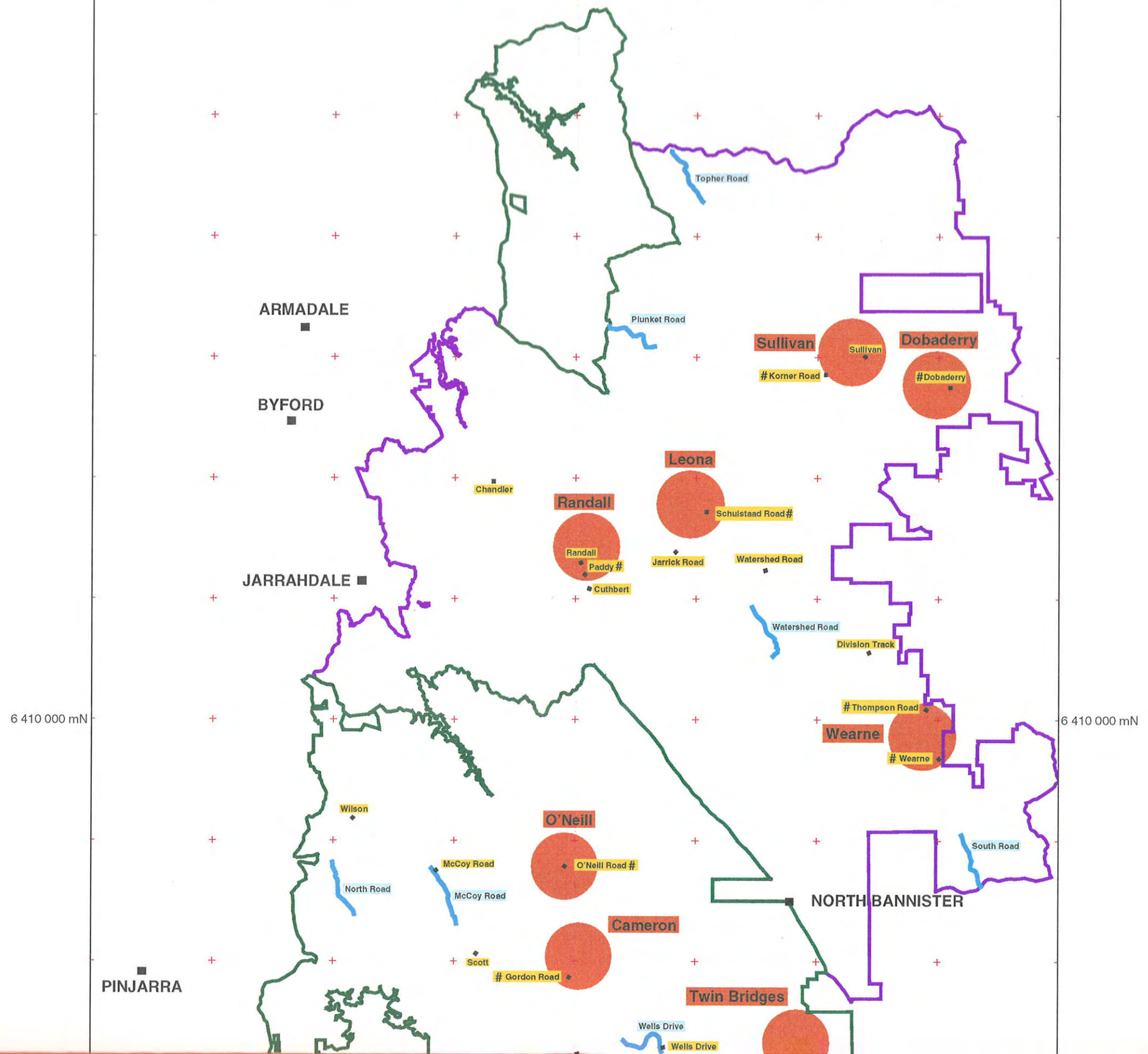
390 000 mE
6 480 000 mN

430 000 mE

470 000 mE
6 480 000 mN

NORTHERN JARRAH FOREST

- PROVISIONAL MAP ONLY -



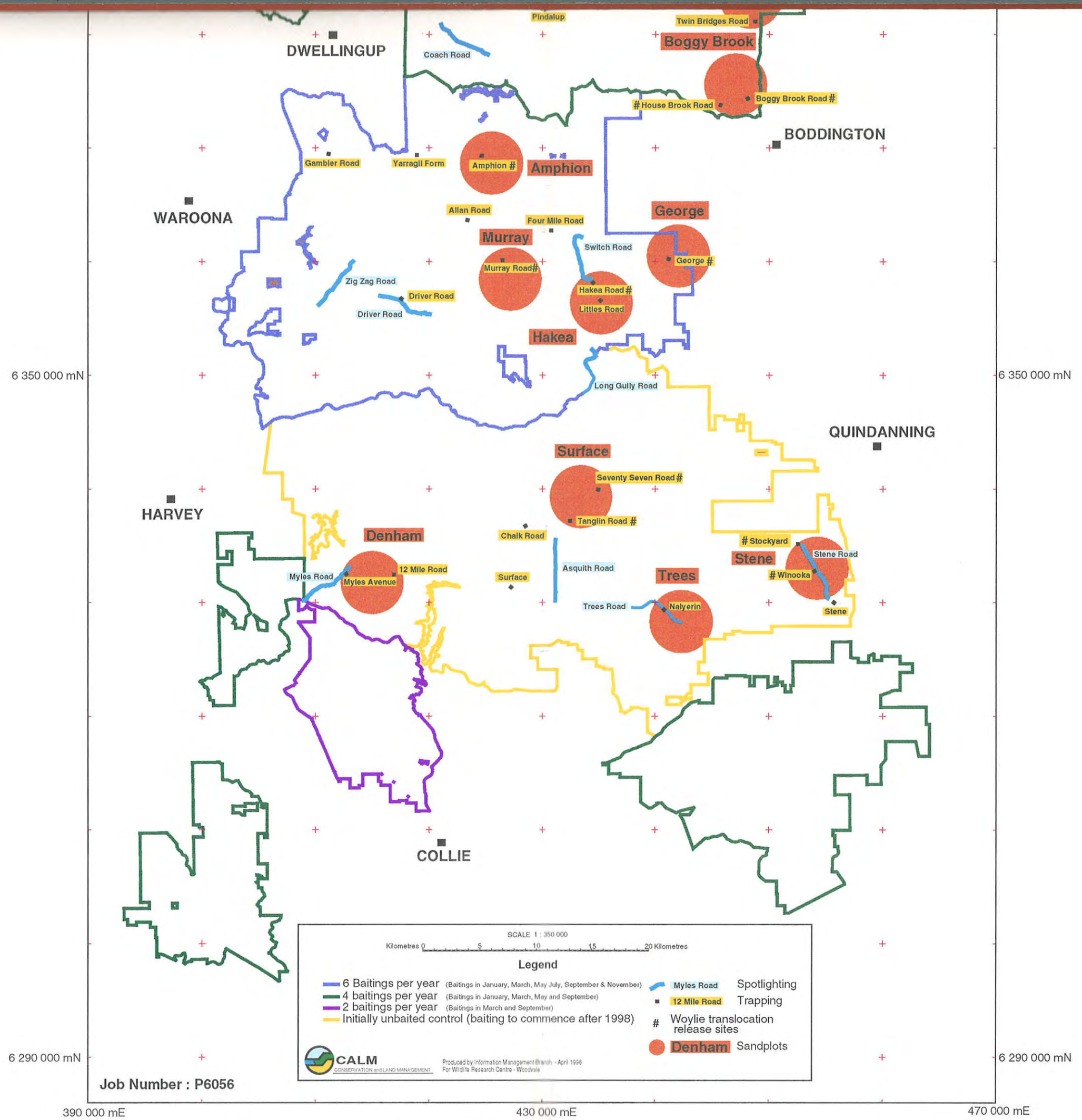


Figure 2. Location of Fauna Trapping Grids, Spotlight Transects, Woylie Translocation Release Sites and Sandplot Grids within the Northern Jarrah Forest.

Progress on Specific Items

The northern jarrah forest component of FPP Project Number 8 specifically addressed the following items listed in Schedule 1 of the consultancy agreement:

A9 Investigate the survival, population increase and habitat use of resident and translocated native prey species in large forested areas, when subjected to different 1080 baiting frequencies for fox control. The translocated species to be studied will include *Bettongia penicillata.*

Survival

Monitoring of survivorship concentrated on radio-collared populations, initially monitoring resident populations of the brushtail possum, *Trichosurus vulpecula*, and translocated populations of the woylie, *Bettongia penicillata*. Monitoring results have been provided in previous reports. In summary, the low abundance of medium size mammals, specifically brushtail possums, resulted in an insufficient sample size of resident indicator species for monitoring through radio-telemetry.

Subsequent radio-telemetry monitoring of survivorship concentrated on translocated populations of woylies.

The initial (pilot) translocation of woylies (as previously reported) indicated that two factors contributed significantly to survivorship namely:

- **frequency of baiting:** for sites at the forest/agricultural land interface, survivorship was significantly higher at higher baiting frequencies; and
- **distance from the interface with agricultural land:** within the treatment baited once prior to release of woylies, survivorship was significantly higher at the site further from the interface with agricultural land.

Data were previously presented showing Kaplan-Meier survivorship functions and results from Log-Rank tests.

Subsequent to the pilot translocation, woylies were translocated to 18 release sites within the northern jarrah forest. Release sites were at varying distances from the interface with agricultural land (see figure 2 - in plastic sleeve).

A total of 180 woylies was released, 10 at each of the 18 sites. Four woylies (2 female, 2 male) were radio-collared at each site. Woylies were released to each treatment once it had received its requisite number of baitings within the preceding 12 month period. Table 1 outlines the history of baiting and woylie releases.

Radio-collars were AVM, 2 stage whip aerial tags with movement sensitive mortality circuitry. Woylies were monitored daily after release.

Mortality tags and daily monitoring allowed immediate detection of mortality events.

Kaplan-Meier survivorship functions are shown in figure 3 for the 2, 4, 6 times per year baiting treatments and the unbaited control. Survivorship functions are shown for the period once woylies had been released to all treatments (1 January to 30 June 1996).

Table 2 shows the level of survivorship at the end of the 26 week monitoring period.

Table 1: History and schedule of 1080 baiting and history of woylie translocations within the northern jarrah forest.

Date	Baiting treatment (no. of baitings per year)			
	2 times	4 times	6 times	Unbaited control
July 1994		✓		
September 1994	✓	✓		
January 1995		✓ **TP** (perimeter)	✓ **TP** (perimeter)	
March 1995	✓	✓	✓	
May 1995		✓	✓	
July 1995			✓	
September 1995	✓ **TR**	✓ **TR**	✓	
November 1995			✓ **TR**	
January 1996		✓	✓	**TR**
March 1996[1]	✓	✓	✓	
May 1996		✓	✓	
July 1996, '97, '98, '99, 2000			X	
September 1996, '97, '98, '99, 2000	X	X	X	
November 1996, '97, '98, '99, 2000			X	
January 1997, '98, '99, 2000		X	X	
March 1997, '98, '99, 2000	X	X	X	
May 1997, '98, '99, 2000		X	X	

✓: Baiting completed at 30 June 1996

X: Baiting scheduled

TP (perimeter): Pilot translocation of woylies to perimeter sites within 2 treatments

TR: Woylies translocated to sites within each treatment. The shaded area highlights the number of baitings that had taken place in each treatment in the 12 months prior to the translocation.

[1] The March 1996 baiting was undertaken in April 1996.

Figure 3: Kaplan-Meier survivorship functions for woylies, for the period 1 January to 30 June 1996. Northern jarrah forest, all treatments.

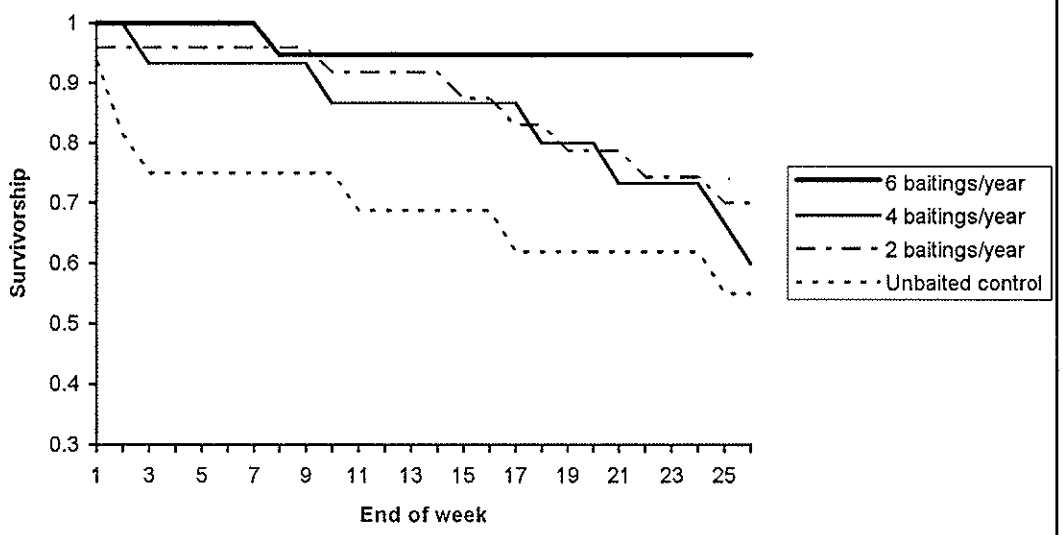


Table 2: **Woylie survivorship for all treatments, northern jarrah forest, at the end of the 26 week monitoring period, 1 January to 30 June 1996. Common superscript letters indicate a significant difference in survivorship (Log-Rank test p>5%)**

Treatment	Survivorship (from Kaplan-Meier survivorship functions) at the end of the 26 week monitoring period 1 January to 30 June 1996.
6 baitings per year	0.95^{ab}
4 baitings per year	0.60^{a}
2 baitings per year	0.70
Unbaited control	0.55^{b}

The 6 baitings per year treatment showed the highest level of survivorship, significantly higher than the 4 times per year and the unbaited control (p>5%, Log-Rank test).

There was no significant difference (p<5%, Log-Rank test) in survivorship between the unbaited control and the 2 baitings per year treatment. Similarly, there was no significant difference between the 2 and 4 baitings per year treatments, the 4 baitings per year treatment and unbaited control, nor the 2 baitings per year treatment and unbaited control.

The results should be interpreted cautiously and should recognise the limited time since commencement of 1080 baiting. A summary of 1080 baiting showing the cumulative number of baitings received by each treatment by January 1996 is shown in table 3 (by January 1996 each treatment had received its requisite number of baitings in the preceding 12 months and radio-collared woylies had been released to all treatments).

The anticipated cumulative total of baitings in each treatment for the period to end of June 1996, 1997, 1998, 1999 and 2000 is shown in table 4.

Table 3: History of 1080 baiting within the northern jarrah forest at June 1996

Treatment	Date baiting commenced	Total number of baitings at end January 1996	Total number of baitings at end June 1996
2 times per year baiting	September 1994	3	4
4 times per year baiting	July 1994	7	9
6 times per year baiting	January 1995	7	9

Table 4: Anticipated cumulative number of 1080 baitings for each baited treatment within the northern jarrah forest to 30 June 2000

Treatment	Cumulative number of baitings at:				
	30 June 1996	30 June 1997	30 June 1998	30 June 1999	30 June 2000
2 times per year baiting	4	6	8	10	12
4 times per year baiting	9	13	17	21	25
6 times per year baiting	9	15	21	27	33

Although each baiting treatment received its requisite number of baitings prior to release of woylies, the total number of baitings was the same for the 6 and 4 baitings per year treatment (table 1 and table 3). It is anticipated that the longer term effect of baiting at different frequencies will be more readily detectable 3-6 years post commencement of baiting.

The woylie survivorship data (figure 3 and table 2) are for the period 1 January to 30 June 1996. However, woylies were released in September 1995 within the 2 and 4 baitings per year treatments and additional predation events were recorded for the period 12 September to 31 December 1995.

Table 5 lists the cause of all known woylie deaths for the entire period, including the pilot translocation of January 1995. Ten deaths have been attributed to fox predation, 5 to cat predation, 33 to unknown predator(s). A further 6 deaths were from roadkills and drowning.

The increased level of survivorship in the 6 baitings per year treatment (figure 3 and table 2) in conjunction with the number of deaths attributed to predation (table 5) imply that predation is a major limiting factor to woylie survivorship. However, the study has revealed a confounding issue of predation by cats and unknown predators, i.e. predation events that could not be attributed to a particular predator species.

In the case of unknown predators (table 5), the condition of most carcasses retrieved implicated the cat or fox as the predator, but could not be clearly attributed to either. Some of these deaths may be the result of predation by dingo. There was no evidence to suggest predation by chuditch, raptor or python.

Recent research (Risbey, pers. comm.) and anecdotal accounts from arid areas of Western Australia indicate that cat numbers increase in the presence of fox control. This pattern has not been reported in forested areas or wheatbelt reserves in Western Australia where fox control has been undertaken. However, in these areas control has been undertaken intensively and over small areas. No data exist on cat density in the presence of fox control over large areas. Within the northern jarrah forest many of the woylie deaths attributed to fox predation may be attributable to cat predation. Every retrieved carcass is thoroughly examined. Where possible, deaths thought to be a result of predation are attributed to a

specific predator on the basis of the presence of particular features e.g. cached or partially cached carcasses, the component(s) of the carcass remaining etc. This procedure is subjective. In consultation with CRC scientists, less subjective methods are being pursued. The issue of identifying the predator responsible is crucial to understanding the relationship between fox density reduction and fauna response. The recently submitted proposal for continued funding incorporates this aspect of the research.

Table 5: Cause of all known woylie deaths within the northern jarrah forest. Unbracketed bold figures are for deaths recorded in the period 1 January to 30 June 1996 - when woylies had been translocated to all treatments. Bracketed figures include deaths from the pilot translocation and for the period 12 September to 31 December 1995 for the 2 and 4 baitings per year treatments.

Treatment	Cause of death				
	Fox predation	Cat predation	Unknown predator(s)	Total number of predation deaths	Other: drowning [d] roadkill [r]
6 baitings per year treatment	**0** (1)	**0** (1)	**1** (8)	**1** (10)	**1**[r] (2[r], 1[d])
4 baitings per year treatment	**2** (5)	**0** (0)	**4** (14)	**6** (19)	**0** (2[r], 1[d])
2 baitings per year treatment	**0** (1)	**4** (4)	**3** (7)	**7** (12)	
Unbaited control	**3** (3)	**0** (0)	**4** (4)	**7** (7)	
Total	**5** (10)	**4** (5)	**12** (33)	**21** (48)	**1** (6)

Population Increase

Population increase for the suite of native fauna within the northern jarrah forest is assessed through twice yearly trapping and has been addressed in previous reports. In summary, initial and subsequent trapping data and spotlight surveys confirmed anecdotal accounts and previous *ad hoc* trapping results where low abundance of medium size mammals had been reported within the northern jarrah forest.

Of these medium sized mammals known to occur within the northern jarrah forest (albeit at low density), the brushtail possum, *Trichosurus vulpecula*, the chuditch, *Dasyurus geoffroii*, and the southern brown bandicoot, *Isoodon obesulus*, were recognised as fauna response indicator species.

At completion of the summer 1995-96 trapping session, *D. geoffroii* had been trapped at 20 of the 43 grids within the northern jarrah forest and at 5 supplementary trapping locations. *Trichosurus vulpecula* had been trapped at 14 of the 43 grids and at 3 supplementary trapping locations. *Isoodon obesulus* had been trapped at 8 of the 43 grids and at 1 supplementary trapping location. *Phascogale tapoatafa* had been trapped at 3 grids only. Percentage capture for *D. geoffroii* and *T. vulpecula* are shown in tables 6 and 7 and figures 4 and 5 respectively.

Table 6: Percentage capture of chuditch, *Dasyurus geoffroii*, at trapping grids within the northern jarrah forest (number of grids) [trap nights]

Treatment	Trapping Session		
	Summer 1994-95	Winter 1995	Summer 1995-96
Unbaited control	0.70 (10) [998]	1.0 (10) [1000]	1.12 (10) [1250]
2 times per year baiting	0.31 (13) [1310]	1.54 (13) [1275]	0.31 (13) [1300]
4 times per year baiting	0.00 (10) [1000]	0.30 (10) [1000]	0.09 (10) [1150]
6 times per year baiting	0.20 (10) [1000]	2.27 (10) [1014]	0.10 (10) [1000]

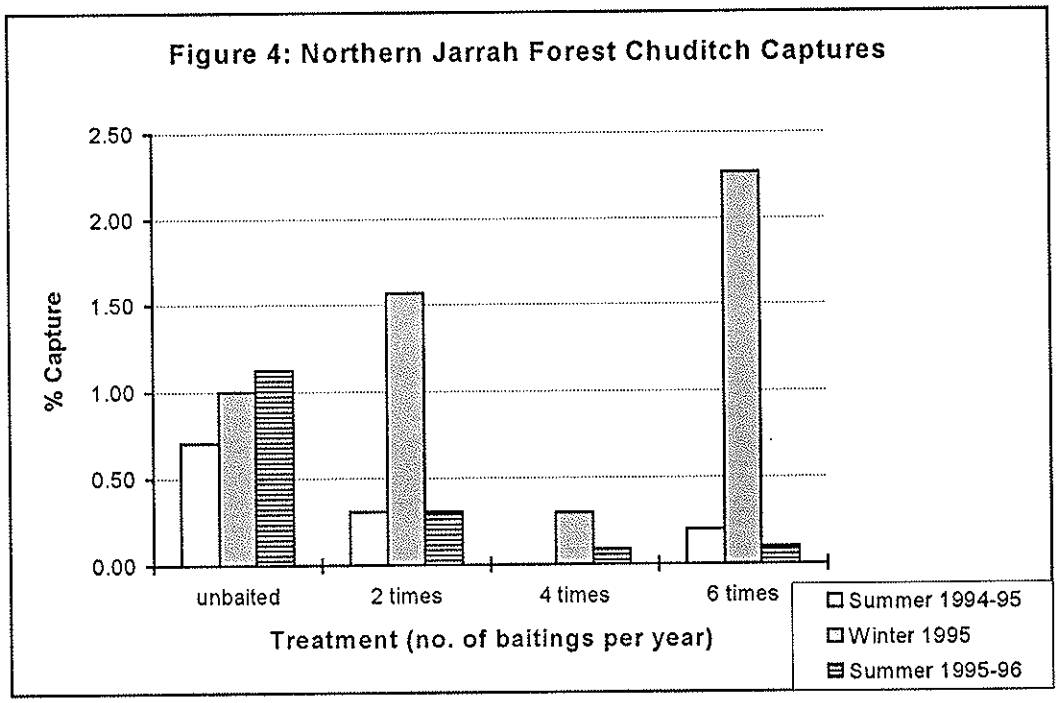
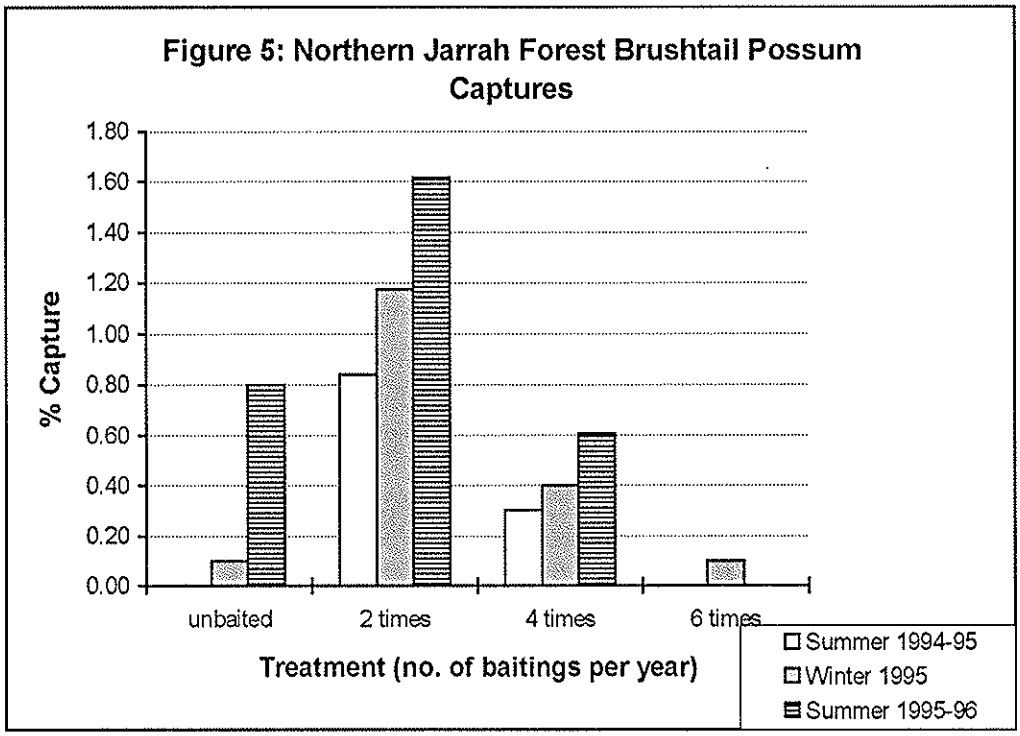


Table 7: Percentage capture of brushtail possum, *Trichosurus vulpecula*, at trapping grids within the northern jarrah forest (number of grids) [trap nights]

Treatment	Trapping Session		
	Summer 1994-95	Winter 1995	Summer 1995-96
Unbaited control	0.00 (10) [998]	0.10 (10) [1000]	0.80 (10) [1250]
2 times per year baiting	0.84 (13) [1310]	0.18 (13) [1275]	1.62 (13) [1300]
4 times per year baiting	0.30 (10) [1000]	0.40 (10) [1000]	0.61 (10) [1150]
6 times per year baiting	0.00 (10) [1000]	0.10 (10) [1014]	0.00 (10) [1000]



The woylie, *Bettongia penicillata*, is also recognised as a fauna response indicator species. However there has been insufficient time since release of woylies to detect any changes in population size through trapping. At completion of the summer 1995-96 trapping session, trapping data had been collected only once post release at the 2, 4 and 6 baitings per year treatments and had not been collected post release within the unbaited control.

The implication from the trapping data, the history of 1080 baiting (table 1), the cumulative number of baitings received by each treatment at completion of the summer 1995-96 trapping session (table 3) and from the anticipated cumulative total of baitings over the longer term (table 4) is that insufficient time has elapsed since commencement of 1080 baiting to detect a response through trapping.

A fauna response time of 3-6 years post commencement of 1080 baiting is anticipated to detect a response (increase in abundance) by resident native fauna.

Preliminary analysis of trapping data also indicate that site specific habitat factors may influence abundance and distribution of medium size mammal fauna within the northern jarrah forest. Subject to project renewal, this aspect will be addressed. Analysis of data from subsequent trapping sessions will incorporate ANOVA, specifically examining the variation in fauna abundance attributable to site specific variables including vegetation structure and floristics.

Habitat use

Habitat use was originally proposed to be assessed through spotlight surveys and radio-telemetry monitoring of brushtail possums.

Spotlight data have been collected twice yearly (March and October). At completion of the October 1995 spotlighting, data indicated no change in habitat use. As for trapping data from resident indicator species, a 3-6 year period post commencement of 1080 baiting is anticipated to detect changes in habitat use through spotlighting.

There was an insufficient sample size of brushtail possums for radio-telemetry data analysis of habitat use (see "survival" and "population increase" above).

Intensive radio-telemetry data collection for brushtail possums is proposed. The sample size will be increased through extensive trapping of sites supplementary to the 43 established grids. Monitoring will involve radio-collaring *T. vulpecula* at selected sites within the unbaited control and one or more of the baited treatments. Sites will include perimeter and central core areas. Radio-telemetry monitoring will examine survivorship, habitat use

(diurnal rest sites and nocturnal foraging areas), home range and dispersal under different levels of fox density reduction.

A10 Investigate differences in survival of native prey species (resident and translocated) at the boundary and central zone of large areas subject to 1080 baiting for fox control.

As a result of the insufficient sample size of resident brushtail possums (see above and previous reports) monitoring of survivorship concentrated on translocated populations of woylies.

The pilot translocation of woylies indicated that within the treatment baited once prior to release, there was significantly greater survivorship 5km from the interface with agricultural land than at the interface with agricultural land ($p>5\%$, Log-Rank test, see previous report).

Kaplan-Meier survivorship functions for the subsequent translocations of woylies are shown in figure 6 for release sites at the interface with agricultural land (within 1km of agricultural land) and in figure 7 for release sites more than 5km from the interface with agricultural land.

Tables 8 and 9 show the level of significance between treatments.

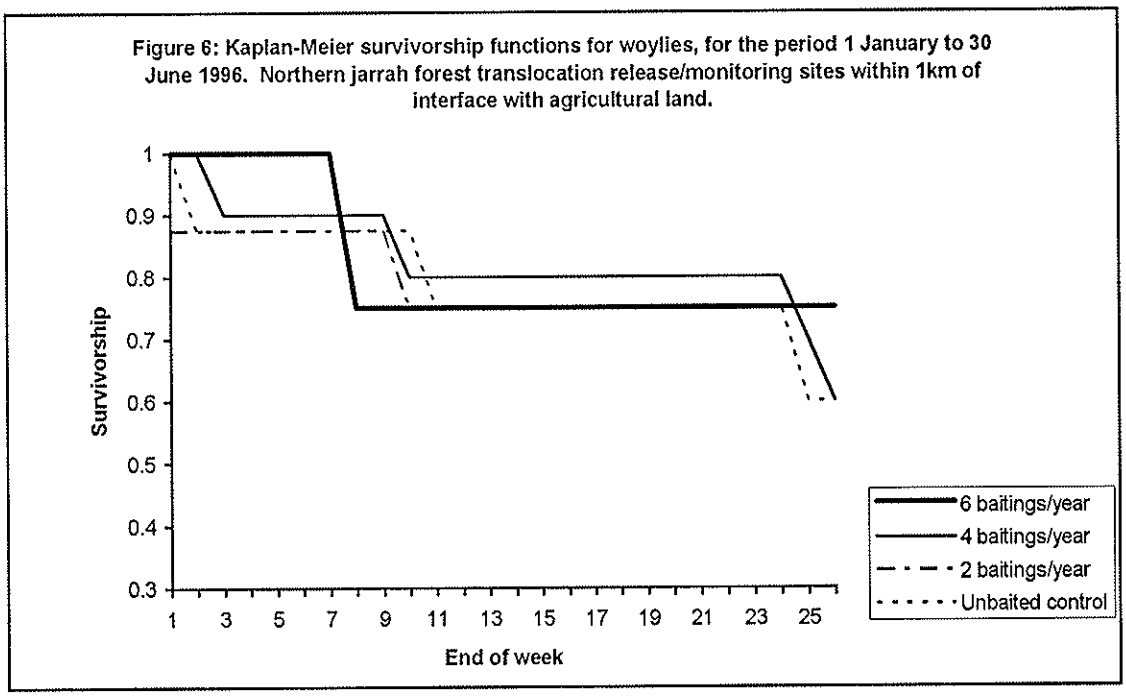


Figure 6: Kaplan-Meier survivorship functions for woylies, for the period 1 January to 30 June 1996. Northern jarrah forest translocation release/monitoring sites within 1km of interface with agricultural land.

Table 8: Woylie survivorship for release/monitoring sites within 1km of the interface with agricultural land, all treatments, northern jarrah forest, at the end of the 26 week monitoring period, 1 January to 30 June 1996. Common superscript letters indicate a significant difference in survivorship (Log-Rank test p>5%)

Treatment	Survivorship (from Kaplan-Meier survivorship functions) at the end of the 26 week monitoring period 1 January to 30 June 1996.
2 baitings per year	0.75
4 baitings per year	0.60
6 baitings per year	0.75
Unbaited control	0.60

There was no significant difference in survivorship between treatments for sites within 1km of the interface with agricultural land.

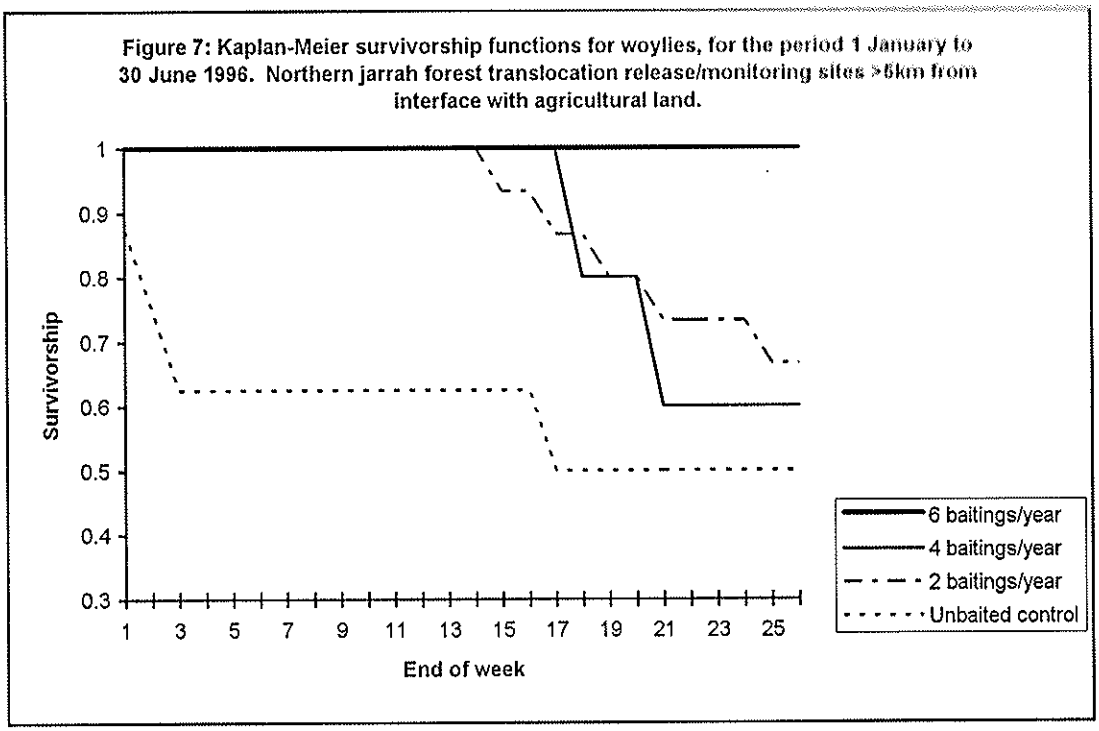


Table 9: **Woylie survivorship for release/monitoring sites >5km from the interface with agricultural land, all treatments, northern jarrah forest, at the end of the 26 week monitoring period, 1 January to 30 June 1996. Common superscript letters indicate a significant difference in survivorship (Log-Rank test p>5%)**

Treatment	Survivorship (from Kaplan-Meier survivorship functions) at the end of the 26 week monitoring period 1 January to 30 June 1996.
2 baitings per year	0.67^{b}
4 baitings per year	0.60^{a}
6 baitings per year	1.00^{abc}
Unbaited control	0.50^{c}

Survivorship was significantly higher for the 6 baitings per year treatment for sites >5km from the interface with agricultural land.

Within treatments there was no significant difference in survivorship between sites at the interface or >5km from the interface with agricultural land.

The implications from figures 6 and 7 and tables 8 and 9 are that six baitings per year is sufficient to result in a significantly higher level of survivorship at distances greater than 5km from the interface with agricultural land, but insufficient at the interface.

Further implications are that the fox density reduction (or introduced predator density reduction) achieved by 6 baitings per year is sufficient at distances >5km from the interface with agricultural land, but insufficient at the interface.

Given the recent commencement of baiting in the 6 baitings per year treatment and that the total number of baitings was the same for the 6 and 4 baitings per year treatments (tables 1 and 3), these data should be interpreted cautiously.

A11 Investigate the survival of resident and translocated native prey species in forested areas abutting a farmland buffer zone control.

This item was subject to the farmland buffer of low fox density being maintained by concurrent research program at Beverley (Marlow and Thomson). The Beverley project has been abandoned and the buffer not maintained.

A12 Derive an index to fox densities within forested areas (this scope item is to be undertaken if adequate funding is provided by the Co-operative Research Centre for biological Control of Vertebrate Pest Populations)

An index to fox density has been derived for all treatments for two consecutive years, in September 1994 and September 1995.

The data indicated no significant difference between treatments for the derived index. Again, the data should be interpreted cautiously given the number of baitings each treatment had received when the fox density estimates were derived (see table 10, below).

Table 10: Total number of baitings received by each treatment by September 1994 and September 1995, when fox density estimates were derived.

Treatment	Total number of baitings at:	
	September 1994	September 1995
2 times per year baiting	1	3
4 times per year baiting	2	6
6 times per year baiting	0	5
Unbaited control	0	0

Estimates of fox abundance relies on sandplotting and are derived once each year. The technique derives an index to fox abundance from the frequency of interference at individual sand plots and has the potential to overestimate abundance as a result of learned behaviour, therefore violating the assumption of independence of each plot. The procedure for deriving the index is currently being reviewed and refinements are being pursued.

Subject to renewed funding, the estimate/derived index to fox abundance will be supplemented by data from trapping and radio-telemetry study of foxes.

The project jointly addressed the following items listed in Schedule 1 of the consultancy agreement:

A3 Estimate the effectiveness of buffer zones on reducing the level of fox control required in conservation areas.

As for item A11, this was subject to the farmland buffer of low fox density being maintained by concurrent research program at Beverley (Marlow and Thomson). The Beverley project has been abandoned and the buffer not maintained.

A15 Liaise frequently with scientists and organisations involved in fox research, especially those scientists and organisations receiving funding from the Feral Pests Program of the Australian National Parks and Wildlife Service.

Constant liaison has been maintained with peers within Western Australia and interstate. Particularly close liaison has been maintained with relevant fox ecology researchers within the CRC VBC.

A16 Participate in ANPWS approved publicity concerning the project.

The northern jarrah forest fox control and research program has been a high profile study within Western Australia. The leading role played by ANCA has been widely acknowledged.

A17 Co-operate in an independent review of the project.

Participated in 1993 review by external panel. The project has been reviewed annually as part of the CRC VBC scientific review conducted by independent scientists.

A18 Provide an auditable statement of WACALM sourced expenditure on this project with each report.

To be provided.

Milestones

Milestones 1 to 13 from the consultancy agreement of 4 February 1994 have been addressed in previous reports.

The remaining milestones (14 to 16) are addressed in table 11, below.

Table 11: Progress towards achieving targeted milestones.

	Milestone	Achieved Yes/No	Comments
14.	Completion of second twelve months of monitoring resident and translocated indicator prey species, alternative introduced prey and fox presence	Yes	
15.	Analysis of two years of monitoring data and completion of report to ANCA/CRC	Yes	
16.	Commence preparation of manuscript(s)	No	Data are currently inconclusive. Insufficient time has elapsed since commencement of 1080 baiting to detect a fauna response.

Interaction with other Agencies

The northern jarrah forest project has significant input from other agencies. Alcoa of Australia Limited has operations in the northern jarrah forest and is a major financial contributor, primarily through provision of funds for 1080 bait purchase and delivery.

The project became part of the CRC VBC in 1993 and is an integral part of the CRC VBC. The research undertaken comprises Project 3.4 within the VBC Ecology Program.

The CRC VBC financial contribution has expanded from $35,000 in 1994/95 (1 technical officer) to $79,000 in 1995/96 (2 technical officers plus a small contribution to operating costs). A budget of $94,800 is currently sought for 1996/97.

The major CRC research objective of the project is to determine the level by which fox populations need to be reduced to enable the native fauna population to increase and be sustained. This aspect is essential in determining the role of immunocontraception in biological control of the red fox.

Interaction with other research and management programs

ANCA's recently prepared draft Threat Abatement Plan (TAP) for the fox recognised that Commonwealth funding for fox control should be determined on the basis of meeting the following criteria:

1. where fox predation presents a threat to continued survival of endangered or threatened species;
2. where there is a good potential for recovery of native populations under fox control; and
3. where large scale fox control would be efficient an effective.

The northern jarrah forest project meets all criteria.

In conjunction with the 1080 baiting in the northern jarrah forest, CALM and Alcoa have funded and implemented a program designed to assess habitat use of the mainland quokka (*Setonix brachyurus*) when fox predation is significantly reduced. Three previously known quokka sites are being assessed to determine the population size at each. As a direct result of this work, a fourth quokka site has been identified in the northern jarrah forest. This site is a northern extension of the known range of the quokka on the mainland. A fifth site, and a further extension of the known range, is currently being surveyed. A MSc student from Curtin University of Technology (co-supervisors Elizabeth Alexander, Curtin and Paul de Tores, CALM) will be commencing a research program in July 1996. At all sites, quokka population size, survivorship, habitat use and home range will be assessed. A model will be developed to predict potential quokka sites within the northern jarrah forest.

Similarly, 1080 baiting within the northern jarrah forest has facilitated translocation of the western ringtail possum, *Pseudocheirus occidentalis*. CALM is funding an Honours project, commencing July 1996, involving release of rehabilitated western ringtail possums at a high public use conservation reserve within the northern jarrah forest. The project will assess the suitability of eucalypt dominated forest (habitat from which the western ringtail possum has become locally extinct) as a release site for ringtails from coastal peppermint areas where the species is locally common. The project will also assess the suitability of long unburnt habitat (unburnt for the past 18 years) and recently burnt habitat (burnt within the previous 1.5 years) for the western ringtail possum.

Monitoring of the northern jarrah forest sites has also provided a wealth of data on distribution of the chuditch, *Dasyurus geoffroii*. The work complements chuditch monitoring elsewhere and has provided data recognised by the chuditch recovery plan as necessary for achieving recovery of the chuditch.

The translocations of woylies to the northern jarrah forest have significantly increased the range of the woylie and are recognised by the woylie recovery plan as an important contribution to its recovery.

Translocation(s) of the numbat are now proposed within the currently baited areas of northern jarrah forest.

The northern jarrah forest project is a major component of Western Shield, CALM's recently expanded fox control and fauna recovery program.

Future Research

An application for renewed funding was submitted to ANCA in May 1996. In summary, the proposal sought to continue 1080 baiting under the current regimes. Monitoring resident native fauna abundance was proposed to continue through twice yearly trapping and spotlighting. Pitfall traps were proposed for the 16 trapping grids currently with wire cage and Elliott traps only.

Monitoring of radio-collared translocated and recruited woylies will continue. Collection of data will concentrate on survivorship (mortality) and analysis will continue to be through Kaplan-Meier Survivorship Functions and Log Rank Test.

The sample size of radio collared woylies will be increased within each treatment through collaring of previously released uncollared animals as they are re-trapped, collaring of recruits to the population and supplementary translocation(s) if required.

Radio-telemetry equipment will continue to be reviewed with the view of resolving difficulties of high loss of signals and unreliability of equipment.

Radio-telemetry will incorporate monitoring of the common brushtail possum, specifically examining survivorship, habitat use, home range and dispersal patterns at varying levels of fox density reduction.

Sandplotting will continue to be used to derive an index to fox density and procedures refined.

Fox density estimates derived through sandplotting will be supplemented by trapping and radio telemetry/satellite telemetry data.

Cyanide sampling will be used in the final year following sandplotting to validate techniques used to derive the index to density.

A pilot study involving trapping for foxes and cats, using Victor Softcatch and conventional wire cage (for cats) traps, is proposed to commence in July 1996. Standard trapping transects will be established within the 6 baitings per year treatment and the unbaited control. All trapped foxes and cats will be radio-collared using movement sensitive mortality transmitters.

Subject to the outcome of the trial, trapping will be conducted routinely to supplement the sandplot derived index to fox density.

A pilot study will be undertaken to assess the feasibility of conventional movement sensitive mortality transmitters and satellite telemetry for monitoring fox and cat survivorship within the northern jarrah forest.

Subject to the outcome of the trial, data will be collected on survivorship home range and dispersal patterns. Particular emphasis will be placed on determining whether individuals survive successive 1080 baiting episodes, determining home range within the jarrah forest and whether individuals are moving between baiting treatments and/or between forested and agricultural areas.