# Situation report and project proposal: Identifying the cause(s) for the recent declines of woylies in south-western Australia.

## A report to the Department of Conservation and Land Management Corporate Executive.

1 May 2006


by the Woylie Decline Steering Group* and associates

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GOVERNMENT OF WESTERN AUSTRALIA

DEPARTMENT OF Conservation AND LAND MANAGEMENT
Conserving the nature of WA

## CONTENTS

# SUMMARY OF CURRENT SITUATION

## Background

Substantial declines in woylie (*Bettongia penicillata ogilbyi*) populations, and possibly other medium-sized mammals, have been identified from long-term research and monitoring conducted by the Western Shield program, the Science Division and other Donnelly District trapping in the Upper Warren region (east of Manjimup). Woylies at Dryandra have declined by about 90% since 2001 (Figure 1). The Perup and surrounding Upper Warren region have supported the largest and most extensive woylie populations within its former pan-continental range during the last decades of the 20th Century. First recognised in late 2005 but beginning as early as 2002, these populations have so far declined by 90% (Figures 3, 4, 5 and 6, Table 1). Similarly, woylies at Batalling (a 1982 reintroduction site east of Collie; Figure 2) have declined by 70% since 2003. A number of other Western Shield monitoring sites (Orell 2004), also indicate declines throughout south-western Australia, all of which remain at low to undetectable densities. Based on the patterns of decline, the few remaining moderate densities of woylies (formerly high-density areas) in the south-western Australia are expected to reach 0% to 10% of their former densities during 2006.

Having previously had a pan-continental distribution throughout much of southern Australia (Figure 7), the Perup/Upper Warren, Dryandra and Tutanning (at low densities since at least 1995) areas supported the last remaining 'natural' populations of woylies prior to fauna recoveries resulting from broad-scale fox control and reintroductions. These natural populations, and those at Batalling, have constituted the most substantial woylie populations in the wild and are still considered fundamental to sustaining the species in the wild in Western Australia. Other more recent translocations of woylies have had limited sustained success and none are currently considered to be at moderate or high densities. Therefore, no other large and wild woylie populations in Western Australia remain unaffected (Figure 8). The reintroduced and fenced woylie population at Karakamia Wildlife Sanctuary (Australian Wildlife Conservancy) remains the exception with densities remaining high. Woylies have been translocated to South Australia - two islands (St Peters and Wedge) and a fenced peninsula (Venus bay) - and to the fenced Scotia sanctuary (AWC) in New South Wales. These populations are persisting at moderate densities.

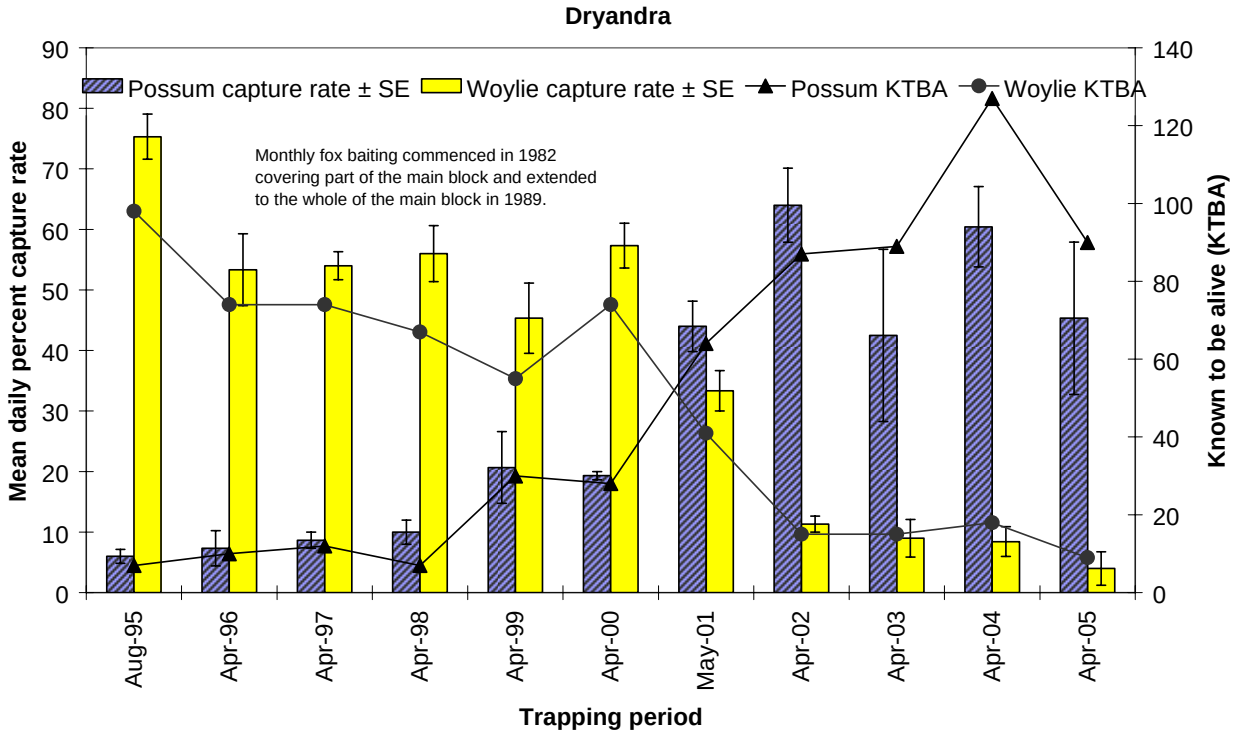


**Figure 1. Woylie and koomal abundance in Dryandra woodland**

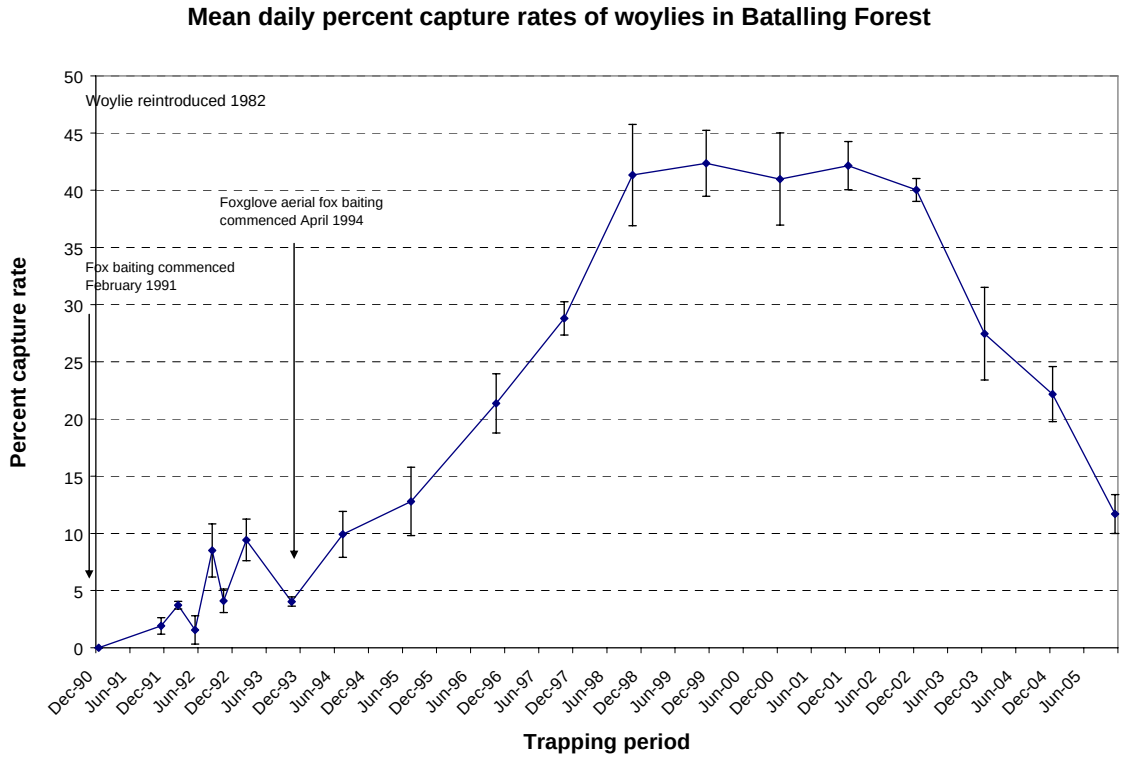


**Figure 2. Woylie abundance in Batalling, east of Collie**

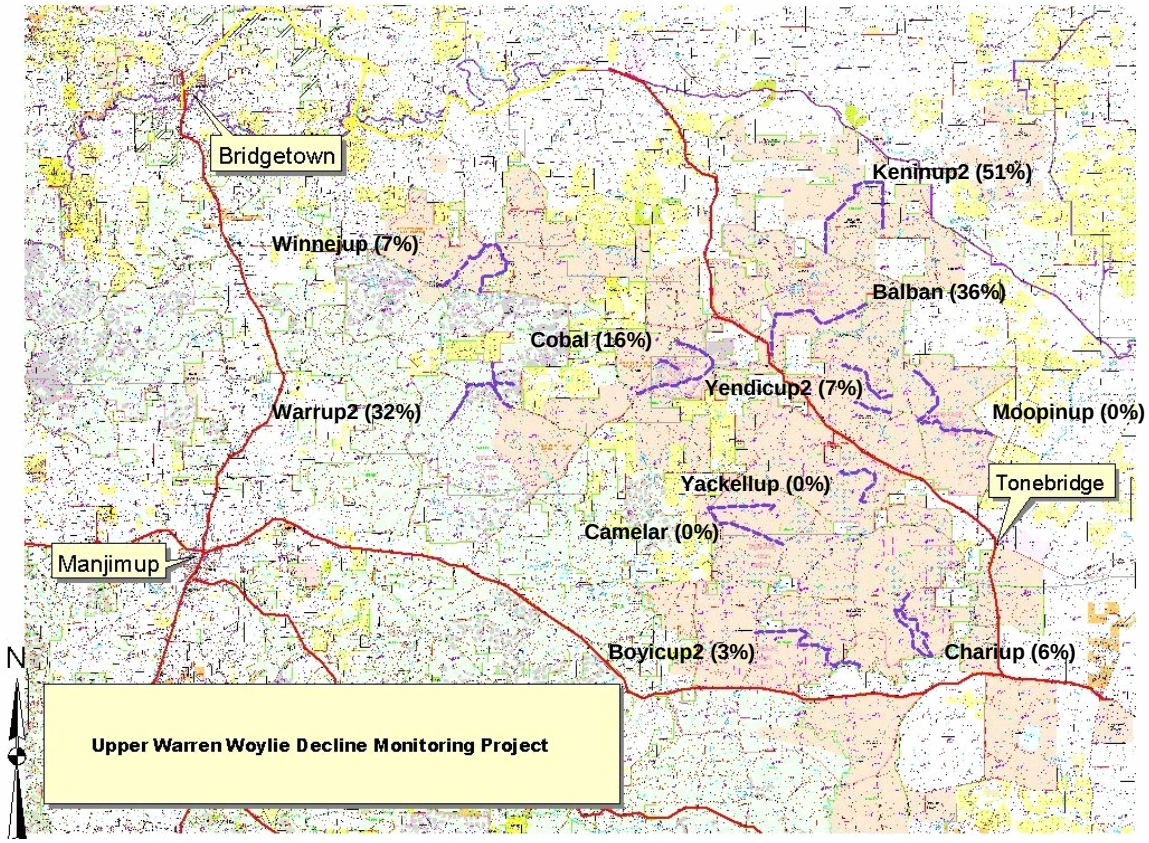


**Figure 3. The location of the 11 key monitoring transects in the Upper Warren region (east of Manjimup) and the percentage trap success rates for woylies in March/April 2006.**

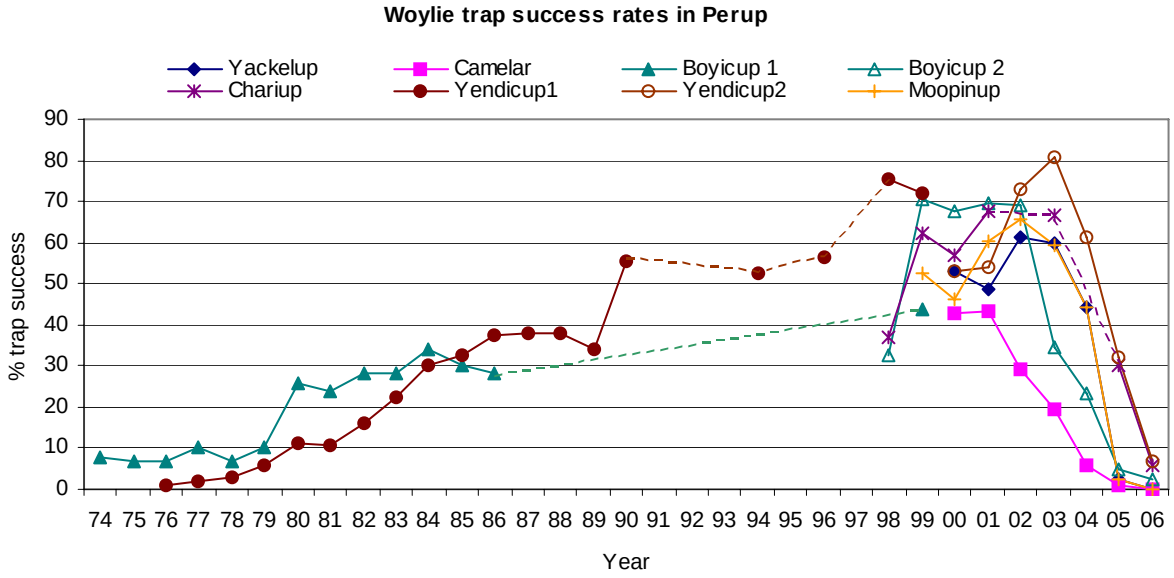


**Figure 4. The annual average percentage trap success rates of woylies in the Perup Nature Reserve, Upper Warren Region, east of Manjimup.**

Note:

Transect names with the suffix 1 and 2 distinguish relatively similar transects within the same area with slightly different methodologies surveyed by different groups (e.g. slightly different transect locations, trapping frequency, etc).

The dashed lines are indicative trends during the intervening periods between trapping events in non-successive years

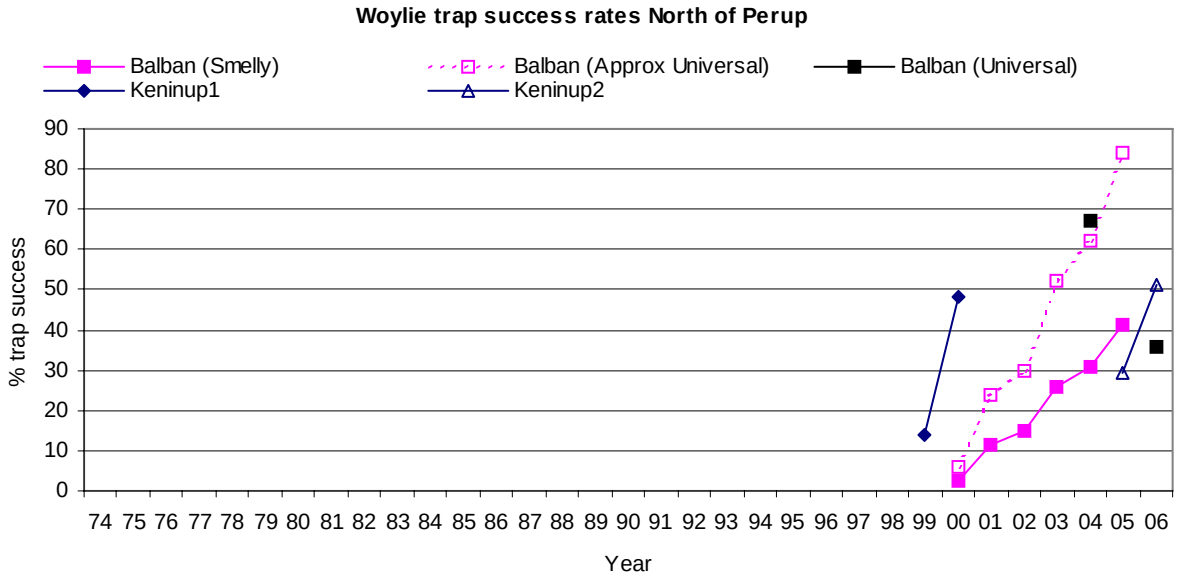


**Figure 5. The annual average percentage trap success rates of woylies in northern Perup, Upper Warren Region, east of Manjimup.**

Note:
Transect names with the suffix 1 and 2 distinguish relatively similar transects within the same area with slightly different methodologies surveyed by different groups (e.g. slightly different transect locations, trapping frequency, etc).
'Balban (Smelly)' is an atypical transect given that it uses a pro-chuditch bait, which catches approximately 50% of the woylies than conventional universal bait.
'Balban (Approx Universal)' is an estimation of woylie numbers that would be expected to be caught on the Balban (Smelly) surveys, had universal bait been used instead of smelly bait (i.e. values = 2 x Balban smelly data)
'Balban (universal)' are surveys on the identical transects as Balban (smelly), the only difference being that universal bait was used throughout the survey rather than smelly bait.
** Indications from the March/April surveys of Balban are that woylies in this area may have declined some 50% in the last 6 months.

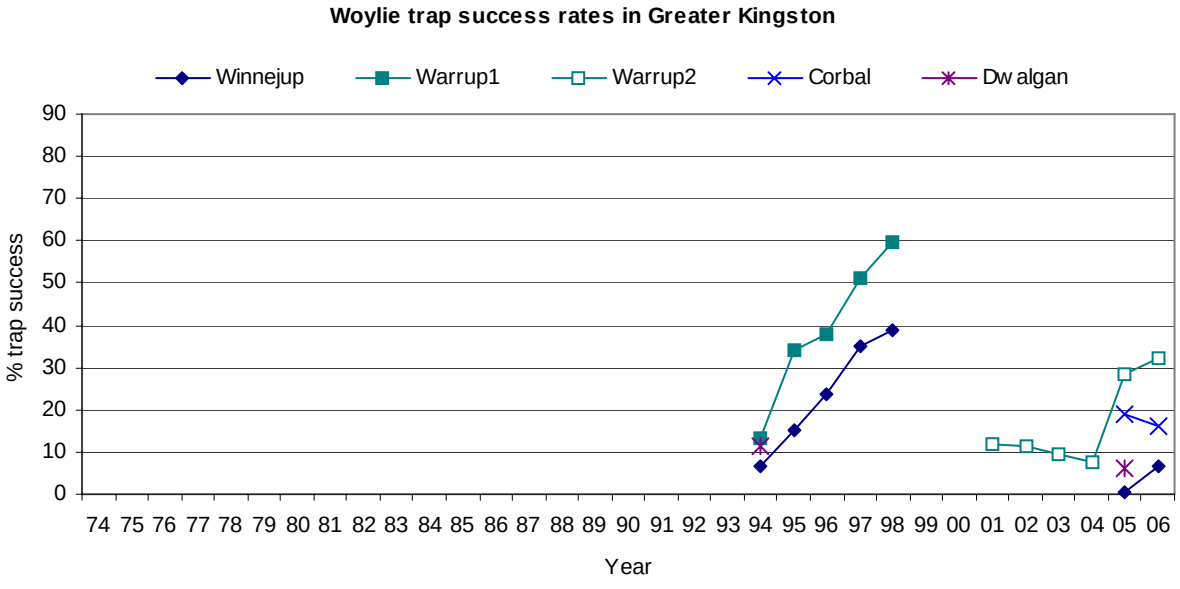


**Figure 6. The annual average percentage trap success rates of woylies in the Greater Kingston forests, Upper Warren Region, east of Manjimup.**

Note:
Transect names with the suffix 1 and 2 distinguish relatively similar transects within the same area with slightly different methodologies surveyed by different groups (e.g. slightly different transect locations, trapping frequency, etc).
Other data available for the area and from the Kingston study is not presented here due to differences in sampling methodology and confounding with timber harvesting activities making it inappropriate for direct comparison. Despite these differences, data from 1994-2000 and 2004/05 is consistent with the decline patterns observed elsewhere in the Upper Warren.

**Table 1. Summary of the changes in woylie captures along monitoring transects in the Upper Warren.**
Note:
The pre-decline average of % trap success is typically calculated on available data immediately prior to the commencement of decline on that particular transect and generally includes at least three consecutive years of data between 1999 and 2002.
** There has been a 93% median decline in woylies (86% average) throughout the Upper Warren region between 2002 and 2006.

| | | % Trap Success | | Currently |
|---|---|---|---|---|
| **Block** | **Area** | **Pre decline Average** | **2006** | **Extant** |
| Moopinup | Perup Central | 62 | 0 | **0%** |
| Yackelup | Perup Central | 56 | 0 | **0%** |
| Camelar | Perup Central | 43 | 0 | **0%** |
| Boyicup 2 | Perup South | 69 | 3 | **4%** |
| Chariup | Perup South | 62 | 6 | **10%** |
| Yendicup2 | Perup Central | 64 | 7 | **11%** |
| Winnejup | Gtr KTN | 33 | 7 | **20%** |
| Corbal | Gtr KTN | - | 16 | **-** |
| Warrup2 | Gtr KTN | 49 | 32 | **65%** |
| Balban | Perup North | 67 | 36 | **54%** |
| Keninup2 | Perup North | - | 51 | **-** |

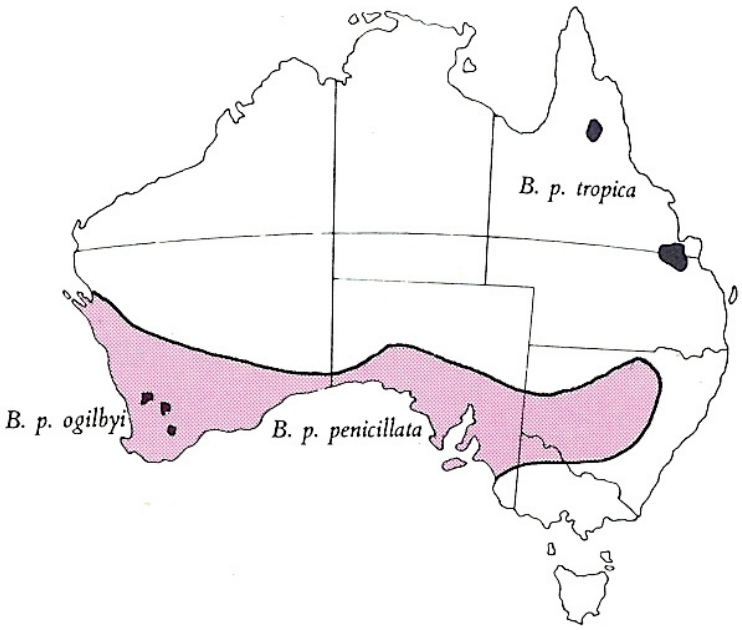


**Figure 7. The former distribution of the woylie at the time of European settlement (pink shaded area) and in the 1980's (solid black areas).** Source: Christensen (1991).
Note:
The three remnant populations of *B. p. ogilbyi* were located at Dryandra, Tutanning and Perup (Upper Warren). Woylie records from throughout central Australia (WA, NT, SA) are not included on this map (subspecies classification unassigned).

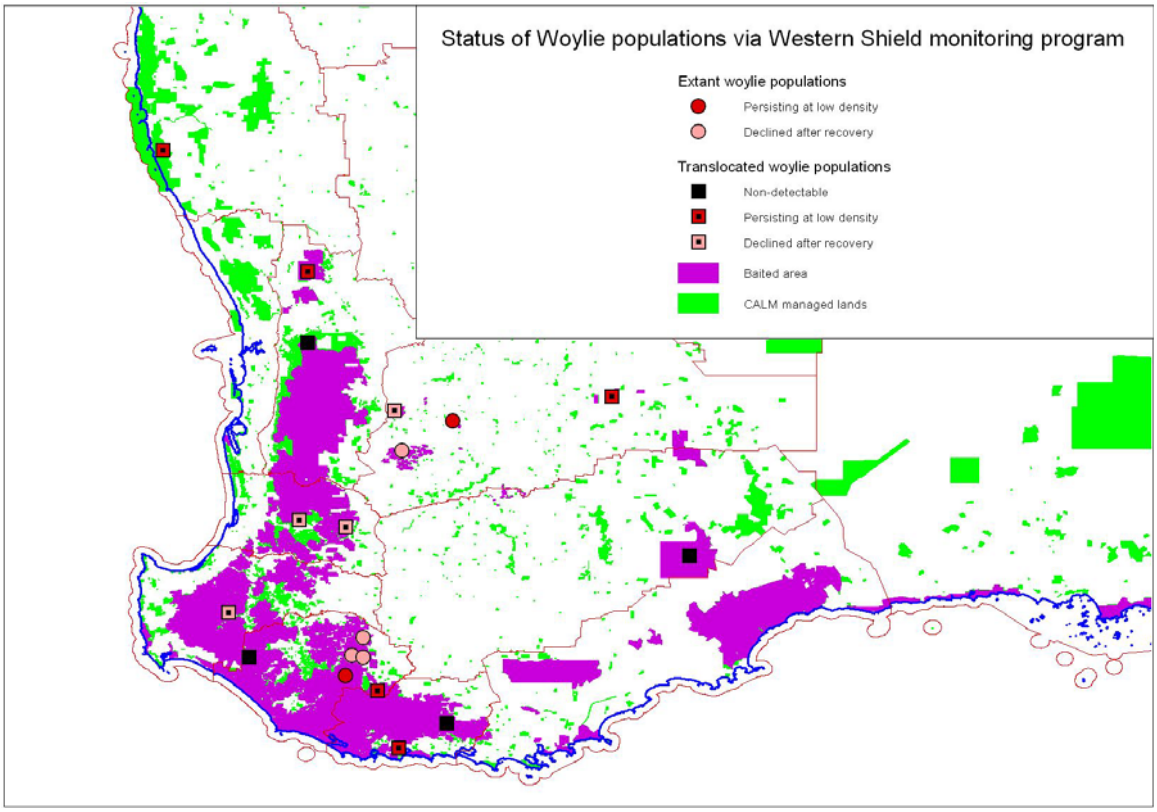


**Figure 8. The location and status of woylie populations involved in Western Shield (i.e. does not include all monitored woylie populations) .**

**Conservation and management implications**

The now substantial, rapid and extensive woylie decline throughout south-western Australia has a number of important biodiversity conservation and management implications including;

- The total abundance of woylies on CALM estate have returned to levels not seen for an estimated 20 years or more and constitute a nationally significant and major impact on this species. Without an appropriate management response the current trends bring to question the long-term viability of wild woylie populations in Western Australia.

- Woylies were delisted from State and Commonwealth threatened species lists in 1998. However, the conservation status of the woylie is currently being reviewed, with every expectation that it will qualify for an upgrade to at least the threatened "Vulnerable" category based on IUCN criteria.

- Previously the flagship for earlier successes, the recent woylie declines no longer achieve CALM Corporate and Western Shield biodiversity conservation objectives for this species.

- The reasons for the declines remain unknown and no recoveries of impacted populations have yet been observed. It is therefore difficult to provide a reliable extinction risk assessment and detailed advice as to what the most effective conservation and management responses should be for their long-term sustainable persistence.

- Given the limited success of translocations and reintroductions in the wild, it is unlikely that this strategy will help mitigate current circumstances and may well exacerbate the problem. A moratorium on woylie translocations is strongly recommended until the risks can be better assessed.

**Responses to date**

Since late October 2005, when the first indications of a woylie decline in the Perup were recognised and communicated to the Science Director, some of the key responses have included;

- The immediate reassignment of Dr Adrian Wayne to investigate early reports of woylie declines.

- The survey of 12 key transects throughout the Upper Warren region in October-December 2005 by Science and Donnelly District personnel to substantiate and assess the extent and magnitude of the declines.

- Communication in late 2005 to Regional and District Nature Conservation leaders and other key workers associated with woylie populations that;
  i) a pattern of recent, rapid and extensive declines of woylies was emerging and to be wary of the potential for the same to be happening elsewhere,
  ii) up-date and digitise any existing records of woylies and compile an inventory of current specimens and information in storage,
  iii) comply with Departmental disease hygiene protocols (Chapman *et al.* 2005),
  iv) any freshly dead or moribund woylies may be invaluable in identifying the cause(s) for declines and should be immediately be brought to the attention of Dr Adrian Wayne and be made available for pathology and/or necropsy.

- The identification and collation of existing available woylie data onto electronic databases to investigate
  i) the spatial and temporal patterns of the decline,
  ii) a preliminary assessment of the potential changes in demographic attributes of the woylie populations associated with the declines,
  iii) associations between woylie declines and climate, attributes of the fox baiting history and attributes of fire history.

- The convening of a Workshop (16 February 2006) attended by 32 relevant Science and Nature Conservation CALM personnel to;
  i) Provide an overview and understanding of the recent mammal declines in the southwest
  ii) Examine the potential cause(s) of these recent declines and associated evidence
  iii) Identify the priorities and strategies for a response to the recent declines.

- Establishment of a Woylie Decline Steering Group to co-ordinate and facilitate response activities including the development of a report and project proposal to Corporate Executive.

- The re-surveying of 11 key transects throughout the Upper Warren region in March-April 2006 to monitor the declines. More detailed and standardised data collection protocols were established and outlined in an Upper Warren Woylie Decline Monitoring Operations Handbook (Wayne et al. 2006) for this and future exercises. Results confirm that the declines are rapidly continuing with declines on some transects as great as 80% in the last 6 months.

- In collaboration with Murdoch University, extensive sampling of blood, faeces and ectoparasites during the March-April 2006 surveys are currently being analysed to screen animal health, identify parasites and diseases present in the populations in order to identify possible agents of decline.

**Diminishing opportunities and proposal outcomes**

The opportunities for identifying the cause(s) of decline are immeasurably greater while these declines are occurring. The reminder of 2006 remains the best and probably the last realistic opportunity to identify the cause(s) of the current woylie population crashes. The woylie populations in the Upper Warren region are the last remaining substantial wild populations with at least some areas still supporting moderate densities, albeit declining. Focussing on this region and optimising efforts immediately and within the next 6-12 months, is considered critical to the potential success in identifying the cause(s) of decline and to determining the appropriate responses required to facilitate the recovery of the species throughout south-western Australia.

Some of the key outcomes of the proposed woylie decline project include;

- Knowledge of causal factors responsible for recent woylie declines leading to more effective management and species conservation.

- Assessment of the effectiveness of current fox control programs, particularly in relation to introduced predator abundances, which is currently lacking.

- Identification of the significance of feral cat predation on woylie survival.

- An improved understanding of the ecology of woylies and their resource requirements.

- Establishment of baseline knowledge of disease and its impact on medium sized mammal populations.

- Guidelines for improved standards of CALM Corporate fauna monitoring protocols.

- Protocols for the diagnosis of declines of other fauna species.

- Best practice for the management of woylie (and other medium sized mammal) populations.

Woylie attributes including the potentially widespread and high population densities, the biological attributes (e.g. good reproductive potential and moderate lifespan), and the relative ease with which the woylie can be trapped and studied, provides an extremely rare opportunity to substantially improve knowledge and expertise in the diagnosis of declines. This will be immediately relevant locally as well as nationally and internationally, to the conservation of other declining species that are typically more rare and more logistically challenging to diagnose the cause(s) of declines.

## OPERATIONAL STRUCTURE

To manage this project a Steering Group comprising Science, Nature Conservation and Regional Service Division personnel has been established. Membership of the Steering Group is:

Brad Barton – Nature Conservation Leader, Warren Region (Chair)

Dr Adrian Wayne – Forest Fauna Ecology Research Scientist, Science Division

Keith Morris – Fauna Conservation Program Leader, Science Division

John Gillard –District Manager, Donnelly District

Jeff Richardson –Nature Conservation Leader, Narrogin District

Peter Orell – Western Shield Zoologist

Although distinctly different, this project is related to the broader study into reasons for declines of native mammals in south-western Australia and as such, will be included in the review process for the meso-predator project. This includes a review by an external panel of experts who report to the Executive Director and Director of Science.

In addition to the external panel, results of the proposed research will be reported to the Western Shield Operational Research Committee (WSORC). This committee was established to facilitate and coordinate the transfer of research findings relevant to fauna recovery into operations. The Directors of Nature Conservation, Regional Services and Science will also be kept informed of progress and outcomes.

## SUMMARY PROJECT OUTLINE

The principal aims for the proposed project are;

- To determine the causal factor(s) responsible for the recent woylie declines in the Upper Warren region of south-western Australia.
- To identify the management required to ameliorate these declines.
- To develop adequate mammal monitoring protocols that will enable future changes in population abundances to be quantified and explained.

Three major research components are planned that are mutually complementary and integral to the development of a comprehensive understanding of the causal agents of recent woylie declines. Given the complexity and notorious difficulty in diagnosing the causes of species declines, there will be multiple lines of investigation within a scientifically rigorous framework to confidently identify the problems in order to provide sound advice on the appropriate species conservation and management responses. The three major research components are;

1) Meta-analysis of existing data sets to quantify the characteristics of the woylie decline to provide circumstantial evidence that will aid in the identification of the potential causal agents of decline (co-ordinated by Science Division).

2) Broad-scale monitoring of the Upper Warren region – an enhancement and co-ordination of existing monitoring and research activities with the aims of providing i) regular information up-dates on population change and associated characteristics at the regional scale and, ii) a larger-scale support role to the more detailed population comparison study (co-ordinated by Donnelly District Nature Conservation Program).

3) Intensive Population Comparison study with a primary focus in the Upper Warren Region and an external reference site at Karakamia Wildlife Sanctuary (Australian Wildlife Conservancy). This study will be a detailed investigation for evidence relating to the putative causes of decline (co-ordinated by Fauna Conservation Program, Science Division).

This project proposal is distinctly different from, although complementary to, the meso-predator project, which focuses primarily on the role of predators in the declines of native mammals in south-western Australia. The investigation into the causes for the recent woylie declines differs in a number of important ways including;

- A primarily *species specific* focus on the woylie rather than an investigation on a suite of native species.

- The timing of the research will occur *while the declines are current*, rather than after declines have occurred and populations remain at low densities and/or populations have not recovered as otherwise expected in response to predator control.

- An investigation that addresses *all major potential agents of decline* (i.e. resources, predation, disease, human interference) rather than a focus on one factor - introduced predators.

## COLLABORATION OPPORTUNITIES

Collaborations and partnerships with external parties are regarded as critical to the success of this project. The development of a number of these is already underway;

Murdoch University

- Disease Reference Panel: principal liaison, Prof Andrew Thompson
- Existing research projects
  Toxoplasmosis in native wildlife – Nevi Parameswarran (PhD candidate)
  Endoparasites in native wildlife – Unaiza Parka (PhD Candidate)
  Ectoparasites and associated diseases in native wildlife – Yazid Abdad (PhD candidate)
  Trypanosoma (haemaparasite) in marsupials – Jill Austin (PhD candidate)
  Salmonella in Feral Pigs (ARC linkage project) – A/Prof Stan Fenwick and Dr Peter Adams
- Development of new research projects
  ARC Linkage Grant proposal – 'The nature, diversity and potential impact of infectious agents in Western Australian threatened mammals'
  Food resources and woylie densities – A/Prof Giles Hardy, A/Prof Barbara Wilson, Marie Murphy (PhD Candidate)
- Expert services – analyses such as necropsies and associated clinical pathology

Australian Wildlife Conservancy
  Karakamia
  ARC Linkage Partner

South West Catchment Council (SWCC)

Southern Forests Landcare
  Community Fox Control Program
  Predator surveys

Other working relationships with the proposed project already being developed include;

- Manjimup State Emergency Service
- Manjimup Aeroclub
- Manjimup TAFE – Certificate II Fauna Management Course

Other potential links and partnerships that could be further developed include;

- Dr Kris Warren, Murdoch University – conservation and wildlife disease
- Prof Ian Beveridge, University of Melbourne – parasites and parasitic diseases
- Relevant expertise in other Universities and Institutions
- Blackwood Environment Council
- Friends of Perup
- Friends of Kingston

## TIME FRAME AND MILESTONES

The meta-analysis component of this project will be completed within 3-4 months. The intensive population comparison study is planned to have a one-year field program (2006/07 financial year). The broad-scale monitoring of the Upper Warren will be sustained at a biannual frequency for 2006 and 2007. Both field programs will be responsive to new evidence as it comes to light. This project and its accumulated evidence will be reviewed externally as part of the meso-predator program in November 2006 and October 2007. There is a general expectation, however, that the increased monitoring effort should be sustained while population changes are rapid. After which monitoring should continue on a less frequent basis (i.e. annual or biennial) and/or resume to previous existing operational and research monitoring activity levels.

| | |
|---|---|
| April-May 2006 | Project proposal, design development and securing budget |
| June 2006 | Establish the Population Comparison Study field sites including the trapping grids, predator survey transects (i.e. sand pads), resources/vegetation plots and radio-tracking cohorts |
| July 2006 | Meta-analysis completed |
| August 2006 | Interim reporting to the Woylie Decline Steering Group |
| November 2006 | Review of progress to be reported to the meso-predator project external review group, Woylie Decline Steering Group and relevant Directors. |
| July 2007 | Completion of planned fieldwork for current program and assessment for the need for ongoing work by the Woylie Decline Steering Group. |
| October 2007 | Final report to be completed for consideration by the meso-predator project external review group, Woylie Decline Steering Group, relevant Directors and WSORC. |

## DETAIL OF PROJECT COMPONENTS

Relevant scientific literature repeatedly describes how notoriously difficult it is to determine the agent(s) of population or species decline (e.g. Caughley 1994;Caughley and Gunn 1996; Peery et al. 2004). Common challenges include;

i) Overcoming the complexity due to the likelihood of multiple factors being involved either simultaneously or sequentially.
ii) The need to separate independent effects to avoid the confounding between factors.
iii) Discriminating between causes, effects, and associations (coincidental or otherwise).
iv) Detecting reduced survival or productivity caused by environmental contaminants or disease is rarely straightforward.
v) The influence of habitat upon the decline of a species is particularly difficult to diagnose and that a safer preliminary hypothesis would conjecture that a species ends up, not in the habitat most favourable to it, but in the habitat least favourable to the agent of decline.
vi) The need to reduce some causal agents, such as habitat modification, down to the individual processes and specific effects (e.g. resource elements such as food and shelter).
vii) Avoiding the seduction of the obvious and the easy to measure. Not all agents are so conspicuous, which in no way lessens their importance.

The available evidence is subsequently compelling for scientific rigour being critical to the success of endeavours to identify the agents of a species' decline. Based on the 'declining population paradigm' and other scientific approaches recommended in the literature (e.g. Caughley 1994;Caughley and Gunn 1996; Peery et al. 2004), the framework to be used in this project is as follows

1) Confirm that the population has declined.
2) Determine the spatial, temporal and demographic characteristics of the observed decline.
3) Understand the species' ecology.
4) Identify all potential causes.
5) Use circumstantial evidence to help shortlist the potential causes.
6) Seek direct evidence – test putative causes.
7) Given the evidence, determine the most appropriate conservation and management responses within an active adaptive management framework.

While there is no obvious or substantiated cause(s) for the recent woylie declines it is as important to collect sufficient evidence to eliminate 'suspects' as it is to collate evidence the supports the likely role of other potential factors. Such a hypothetico-deductive approach is argued as the quickest and surest way to identifying an agent of decline (Caughley 1994). Based on these circumstances, there will be parallel lines of enquiry addressing numerous potential agents of decline, most of which can be broadly classified into four major groups;

1. Resources – including food depletion and consequences of climate change, fire management, etc.
2. Predation – including native and introduced species, and effectiveness of current control measures.
3. Disease – including known and novel agents (viral, haemaparasites, endoparasites, ectoparasites, bacterial diseases).
4. Direct human interference – e.g. negative consequences of trapping (over-harvesting for translocations, disrupted breeding success, reduced condition, injuries, increased stress and susceptibility to other mortality factors).

This project will have a specific focus on the Upper Warren region to concentrate existing resources in the one area where declines are currently occurring. This will improve the chances of success and eliminate the potential confounding of different factors being potentially at play elsewhere. Once the cause(s) of declines have been identified in the Upper Warren region and based on the evidence accumulated by other components of the meso-predator project, these specific and known causes can then be tested elsewhere to verify whether or not they apply in other specific cases.

**1a) META-ANALYSIS OF EXISTING AVAILABLE DATA**

Meta-analyses of existing medium-sized mammal data from past and present research and monitoring will be used to determine and characterise the attributes of population change. Relationships between the attributes of woylie declines with other factors will also be investigated (e.g. abundance of other mammals, climate, fire, fox control, etc). This will provide an indication of what mechanisms of change may/may not be responsible. Readily available datasets from throughout the southwest will be used.

*i) Population trends*

Two scales of enquiry;

- Upper Warren Region – 11 key transects
- South-western Australia – including all major established populations of woylies (i.e. Upper Warren, Batalling, Dryandra, Tutanning) and more recently translocated and minor populations with suitable data (e.g. Hills Forest, Lake Magenta, Julimar, Mt Lindsey, Boyagin, Centaur, etc)

Population density/abundance will be measured using;

i) Percentage trap success rates (%TS),
ii) Minimum number of individuals known to be alive (KTBA), and
iii) Mark-recapture population models.

The spatial (scale and patchiness) and temporal patterns (timing in relation to season and changed environmental conditions, rate of decline, etc) of population change will be examined in detail.

*ii) Demographic changes associated with population changes of woylies*

The characteristics of demographic change associated with changes in abundance will provide evidence of the causes and effects of population decline. This circumstantial evidence can be a powerful tool to help shortlist the most likely agents of decline. Specific demographic attributes that will be investigated will include;

- Condition
- Proportion of adult females breeding (i.e. a measure of breeding success)
- Population turnover
- Age demographics
- Longevity/Survivorship
- Sex ratios

*iii) Mammal guild population trends*

The population trends of other vertebrate species will provide evidence for and against various potential causal agents. Some of these can be related to woylies according to a number of biological/ecological categories or guilds;

- Competitors – e.g. koomal (common brushtail possum)(food)
- Terrestrial medium-sized mammals – e.g. Gilbert's potoroo, quenda
- Other macropods – e.g. western grey kangaroo, western brush wallaby, tammar wallaby
- Prey – e.g. ngwayir, wambenger, koomal, rabbits, quenda
- Predators – e.g. fox, cat, chuditch, wedgetail eagle, etc

Where data is readily available, a meta-analysis of the population trends of these guilds will be related to those of woylies.

*iv) Climate, direct human impacts and other possible meta-analyses*

Other possible meta-analyses that may be pursued depending on the results of earlier analyses and the suitability of available data include;

- Associations between population change and bioclimatic factors
- Direct human interference – e.g. negative consequences of trapping (disrupted breeding success, reduced condition, injuries, increased stress and susceptibility to other mortality factors)
- Associations between population change and attributes of the fire history (i.e. an extension and development of the preliminary investigation undertaken on Upper Warren data)
- Associations between population change and fox control.
- Demographic changes in koomal populations associated with woylie declines – of interest particularly if there is a significant relationship between woylie declines and koomal increases.

**WHO:** To be led by Matthew Williams/Amanda Mellican and principally supported by Dr Adrian Wayne, Peter Orell and other data custodians.

**WHEN:** To be started in May 2006 and completed by July 2006

**1b) POSSIBLE CAUSES**

- Develop preliminary lists of all potential causes (i.e. elaboration of lists started by Dr Adrian Wayne, contributions from the February Workshop and invited experts such as disease specialists from the Veterinary and Biological Sciences Schools, Murdoch University, see section 3e below)
- Assess the likelihood of potential causal agents by collating for each the supporting and refuting evidence. The sources of evidence will include the results from the meta-analyses, knowledge of the species' biology and ecology, other existing evidence and to some extent, expertise. Identify the critical information gaps and coarsely rank the causes to indicate which are the more likely factors.
- Where appropriate, these findings will be integrated into the data collection associated with the monitoring program and/or population comparison study to ensure that the appropriate evidence is being collected and that the most likely putative causes for woylie declines are being adequately addressed so as to enable more rigorous assessment.

**WHO:** Dr Adrian Wayne to initially develop, then the Southwest Woylie Decline Steering Group to review and maintain

**WHEN:** Ongoing review of the list and risk priorities

## 2) MONITORING OF MEDIUM-SIZED MAMMAL POPULATIONS

*Upper Warren*

Regular trapping will be used to monitor population change, principally abundance and demographics. Associated monitoring of key potential agents of population change will also generally be monitored where possible/necessary, including predators, food resources/vegetation health, climate and disease. This program builds on the monitoring and research activities conducted over the last 30 years to develop a longitudinal context to population changes (Table 2). The areas monitored are spatially distributed throughout the Upper Warren region to provide representative coverage of the known woylie population within the region. The monitoring complements the more detailed and intensive population comparison study (conducted on a subset of monitoring sites) by providing a more general and broader regional perspective to population changes.

Eleven key transects will be monitored biannually (March/April and October/November). Some of these transects are already routinely surveyed by existing District, Science and training programs (i.e. 13 of the 22 proposed annual surveys are additional to existing commitments) (Table 3). Building on existing monitoring, these activities will be expanded, standardised, centrally co-ordinated and their timing synchronised. As of October 2005 two of the 11 transects are additional to existing activities and serve to provide a more complete spatial assessment of woylie population changes - Winnejup (i.e. partial re-establishment of historical monitoring) and Corbal (a new transect).

**Table 2. Summary information of key monitoring transects across the Upper Warren region.**

Note. Transect names with the suffix '1' and '2' distinguish the original transect from a subsequent modification (generally a partial re-routing or subset of the original transect), respectively. Only the more recent transect version will be maintained. The original transects provide relevant historical context.

| | | | Survey History | |
|---|---|---|---|---|
| **Forest Block /** | | | | |
| **Transect Name** | **Area** | **Custodian** | **Period** | **# Surveys** |
| Balban | Perup North | Fauna Mgt Course/Science | 00-05 | 6 |
| Boyicup1 | Perup South | Science - Long-term | 74-99 | 57 |
| Boyicup2 | Perup South | District-WS | 98-05 | 9 |
| Camelar | Perup Central | Fauna Mgt Course/Science | 00-05 | 6 |
| Chariup | Perup South | District-Other | 98-05 | 8 |
| Corbal | Gtr KTN | Science/District | 05 | 1 |
| Keninup2 | Perup North | District-Other | 99-05 | 5 |
| Moopinup | Perup Central | District-WS | 99-05 | 8 |
| Warrup | Gtr KTN | Science / District-WS | 94-05 | 27 |
| Winnejup | Gtr KTN | Science - KTN study subset | 94-00, 05 | 22 |
| Yackelup | Perup Central | Science – Bushrangers | 00-05 | 12 |
| Yendicup1 | Perup Central | Science - Long-term | 75-99 | 54 |
| Yendicup2 | Perup Central | Science – Bushrangers | 00-05 | 12 |

Detailed demographic data that will be collected to provide associated evidence required to identify the cause(s) of decline includes age, sex, size and weight measures for condition indices, detailed breeding condition data including pouch condition, pouch young morphometrics, etc.

Associated information related to potential agents of decline will include;
Disease – blood, scats, ectoparasites, and possibly other samples if/when required
Resources – scats for dietary analysis, vegetation health surveys, etc

Where possible and appropriate, components of this project will be linked with the population comparison study. Some components potentially could be suitable for student projects, e.g. dietary analyses, laboratory based disease screening of field samples, etc.

**WHO:** Co-ordinated by the Donnelly District Nature Conservation Program and conducted by Donnelly District and Science personnel.

| | | |
|---|---|---|
| Project Leader | Ian Wilson | |
| Principal Field Personnel | District<br>Science | Dave Butcher, Zoe Clarke, Julia Northin, Brian Whittred<br>Graeme Liddelow, John Rooney, Chris Vellios, Bruce Ward,<br>Colin Ward, Adrian Wayne |

Volunteers – to assist when appropriate and available, especially to augment fieldwork

**Table 3. Assigned responsibilities for key Upper Warren transect monitoring**

Note: * = proposed additional surveys to pre-existing programs

| | **March /April** | **Oct/Nov** |
|---|---|---|
| **Balban** | *Science | SAC |
| **Boyicup 2** | District | *District |
| **Camelar** | *Science | SAC |
| **Chariup** | *District | *District |
| **Corbal** | *Science/District | *Science/District |
| **Keninup2** | *District | *District |
| **Moopinup** | District | *District |
| **Warrup 2** | District | *District |
| **Winnejup** | *Science | *Science |
| **Yackelup** | Science | Science |
| **Yendicup 2** | Science | Science |

**WHEN:** Ongoing and with biannual reviewing and reporting. Anticipated to continue at the current scale for at least two years. Ultimately this program will be down-scaled and subsumed into pre-existing district and research monitoring programs.

*Other monitoring outside the Upper Warren region*

Existing trapping monitoring activities involving woylie populations elsewhere throughout the southwest have the potential to be aligned and integrated into the monitoring and research activities undertaken in the Upper Warren region. This will occur directly with other components of the meso-predator project (i.e. Dryandra, Northern Jarrah Forest, Lake Magenta and Mt Gibson). There are no current plans to extend this research into other areas but it may be considered as new information comes to light. Improvements to monitoring protocols developed as part of this study will be incorporated into other relevant CALM-Corporate monitoring programs via the Woylie Decline Steering Group and the current review of monitoring protocols being undertaken by the WSORC.

**WHO:** The Woylie Decline Steering Group will facilitate other monitoring outside the Upper Warren region. District and Science Division personnel local to the study area will be responsible when and where applicable.

**IF/WHEN:** Undetermined

**3) POPULATION COMPARISON STUDY**

This is a more detailed and focused study designed to complement data collected from the broad-scale regional monitoring program (above). There will be a particular emphasis in the Upper Warren region where moderate woylie densities still exist and declines are current. The five sites in the Upper Warren region will be associated with a subset of the 11 key monitoring transects and provide replicated representation of current population states across the region:

- Declined populations now at low densities: Boyicup and Winnejup
- Currently declining and/or support the remnant moderate density populations: Keninup, Warrup and Balban
- Outlier (Reference) Site at Karakamia – a fenced (i.e. closed population), high density and stable population.

The study sites will be plot-based. Activities on each plot will include;

1. Trapping every 2 months to collect more detailed information including; fauna abundances and woylie demographics, diet and disease screening.
2. Radio-tracking to monitor survivorship and mortality events.
3. Predator activity/abundance primarily based on sand pad surveys.
4. Food resource availability and vegetation health.

Where possible and appropriate, components of this project will be linked with the broad-scale regional monitoring program. Some components potentially could be suitable for student projects, e.g. resource availability, dietary analyses, laboratory based disease screening of field samples, etc

**WHO:** Managed as a Research Project by Science Division, Fauna Conservation Program

Project Leader Adrian Wayne
Principal Technical Staff Graeme Liddelow, John Rooney, Chris Vellios, Bruce Ward, Colin Ward
Donnelly District – Trapping: Two people for nine weeks per annum, Predator surveys: Two people for 11 weeks per annum plus some assistance from crews and district plant to set up the sand-pad transects
University Students – several opportunities within this project could be integrated in to existing student projects and/or constitute complete student projects in their own right. Three Murdoch University PhD students have, or will shortly be commencing, studies into toxoplasmosis, endoparasites and ectoparasites as part of a proposed ARC Linkage program with CALM. There are also opportunities for Honours and post-graduate projects to commence examining the availability of food resources, the interactions of native predators and woylies, and detailed ecological studies.
Volunteers – to assist when appropriate and available, especially to augment fieldwork
Resources for Karakamia to be finalised in liaison with AWC

**WHEN:**

Initially the study will be conducted for a minimum of 12 months, beginning July 2006. The project will be responsive to any new evidence that emerges on an ongoing basis.

An interim project review and report will be completed by November 2006 and a final report by October 2007.

**COMPONENT DETAILS OF POPULATION COMPARISON STUDY**

**3a) Population densities and Demographics**

Trapping will collect detailed information including;

- Population abundance estimates based on KTBA and Mark-Recapture models.
- Demographics e.g. female fecundity, pouch young sex ratios, pouch young growth rates and survivorship through to adulthood, adult condition, adult sex ratios, fluctuating asymmetry, etc
- Diet from scat samples
- Disease and health screening – blood-parasites, endoparasites, ectoparasites, immune responses, etc

Five Upper Warren sites (2 x declined, 3 x declining populations) and one outlier reference at Karakamia.
One cage-trapping grid (plot) per site.
Each grid is 200 m x 200 m (i.e. 4 ha) with 25 cage traps spaced 50 m apart in an array of 5 x 5 lines.

Each site is trapped every 8 weeks (i.e. approximately half the duration of the woylie breeding cycle) and where possible simultaneously with other grids (at least within the same fortnight).

**WHO:** Colin Ward and Chris Vellios as deputy, to co-ordinate the field program and data management. All Science and some District personnel associated with the project will be involved in this component.

**3b) Survivorship and Mortality**

Survivorship comparisons between populations will be examined by;

a) Population turnover based on density and demographics trapping data (i.e. the relative incidence of new animals and the rate of loss of known animals).

b) The survivorship of radio-collared cohorts. i.e. a minimum sample of 12 adults (6 male, 6 females) at each site.

Mortality and the possible causes of death will be examined by;

a) Sustained and frequent (daily during weekdays where possible) monitoring of cohorts collared with mortality sensitive radio-transmitters for the 11-12 month period that the radio-collars remain operational. Monitoring will be done by plane will occur when personnel are not otherwise in the field.

b) Quantifiable area searches for animal remains and associated evidence of mortality (e.g. prey and predator signs). Potential involvement of the SES as a search and rescue training exercise.

c) All dead or moribund animals found during the study (i.e. trapping, area surveys, mortality radio-telemetry) will be closely examined to determine factors contributing to mortality/illness. Where possible and appropriate and particularly for fresh carcasses, specimens will be sent to Murdoch University for full pathology testing (see study component 3e below).

**WHO:** Colin Ward and Bruce Ward as deputy, to co-ordinate the field program and data management. All Science staff associated with the project will be involved in this component.

**3c) Relative activity / abundance of predators**

Multiple survey methods will be used including sandpads, remote cameras, and possibly DNA analysis (from scats/hair).

Sandpads: 10-20 km transects with sandpads at 500m intervals, 1 m wide spanning the full width of tracks (5-6m) (bias towards tracks rarely used by vehicles for operational/maintenance reasons). (i.e. consistent with the Dryandra meso-predator project) Transects will be replicated twice at each of the five Upper Warren sites and once at Karakamia. Transects will sample both forest edge (adjacent to cleared land) and core locations. The distance between transects will be greater than 5 kilometres. Where appropriate the transects will incorporate existing sandpad (Kingston and Perup) design and infrastructure where possible. Pads will be alternately passive (i.e. without any form of attractant) and active with a lure (audio, 'pongo' - primarily to attract feral cats).

The timing of surveys will be tied into the fox-baiting program (surveys to be done either side of fox baiting), resulting in a total of 8 surveys between July 2006 and June 2007. Transects will be run simultaneously. Transects will initially be run for 10 consecutive days with the intention of subsequent survey lengths to be informed by the initial results but approximating 4 consecutive nights each.

The Allen index (Engeman et al. 1998; Engeman 2005) will be used as a base measure of relative abundance.

Remote cameras: These will be set up as required and identified by activities from sand pad monitoring to assist in the species/individual identification of animals detected on the sand pads. The cameras will also be used opportunistically amongst the radio-collared cohorts to determine predator activity.

Nest/Den/Scat surveys: Wedgetail eagle nest sites and other predator dens will be surveyed and mapped specifically around each of the study areas and more generally throughout the Upper Warren Region. Carcasses of prey (including woylies) and predator scats will also be opportunistically examined to determine likely predators involved and their diet.

**WHO:** John Rooney to co-ordinate the field program and data management. Graeme Liddelow, Brian Whittred, Bruce Ward, plus another District person will be the principal field team.

**3d) Resources**

Changes in the abundance, access and/or suitability of resources may be a contributing factor to the recent decline of woylies. Resources essential for individuals and populations alike include;

- Water
- Food
- Shelter
- Reproductive mates
- Space (e.g. territories)

Of these, food is considered the most likely potential factor associated with woylie declines given that water is sourced from their diet and shelters are constructed by woylies within small moderately dense shrubs (i.e. anecdotally no recent and major changes in vegetation structure or floristics have been detected).

There will be four main components of an investigation into resources as a potential causal factor into the recent decline of woylies. The status and densities of woylie populations will be compared with;

1) Diet based on the compositional analysis of scat samples collected during associated trapping activities.

2) Hypogeal fungi species presence/absence, possibly abundance (data dependent), based on truffle surveys.

3) Vegetation health, structure and floristics based on rapid vegetation surveys.

4) Woylie digging densities and food associations.

*Dietary analyses*

A total of 171 scat samples for dietary analysis were collected from the 11 key monitoring transects during the Upper Warren trapping program in March/April 2006. The species of fungi spores (and other components if distinguishable) will be identified and quantified in the scats sampled to date and investigated to determine if there are any significant relationships to the status of their respective woylie populations. The findings from this initial investigation will be used to determine whether further enquiry of this nature is merited.

This component may be suitable as a collaborative and/or student project depending on the availability and timing of suitable expertise.

*Truffles Pilot Study (May/June 2006)*

The principle aims of the truffle pilot study are;

1) Conduct a preliminary assessment of whether there are any relationships in the species of hypogeal fungi with woylie abundances and population trends.

2) Assess the feasibility and sampling requirements required to more rigorously test whether there are any significant differences in the hypogeal fungi food resources related to woylie abundances and trends

A brief summary of the pilot study design is as follows;

Each of the five intensive study areas will be examined (i.e. the two declined now low abundance sites (Boyicup, Winnejup) and the three declining sites with moderate abundance (Keninup, Warrup, Balban)

Truffle survey plots will be arrayed in threes according to landscape position (valley, midslope, ridge). A total of 9-12 plots will be sampled per site (i.e. 3-4 plots per landscape position). Valley plots will be randomly situated within candidate areas and then the midslope and ridge sites will be located immediately upslope of the valley plot. Fire history will be considered in the sampling design. Each plot is 20 m x 50 m and searched for 100 person minutes by 4-5 people (i.e. 20-25 minutes per plot) resulting in 25-40% of the plot disturbed.

**WHO:** Chris Vellios to co-ordinate the field program and data management. All Science staff associated with the project will be involved in this component. Diet analysis by Richard Robinson and/or University collaboration (e.g. A/Prof Barbara Wilson, student project)

**3e) Disease**

The possible disease agents potentially responsible for marsupial population declines (either in isolation or in concert with other factors) are extensive and can be grouped as;

i) viral

ii) bacterial disease

iii) haemaparasites

iv) endoparasites

v) ectoparasites

vi) toxic

vii) nutritional

Objectives:

1) Identify parasites and other micro-organisms and evaluate their potential role in woylie declines.

2) Use expertise to prioritise which known and unknown diseases may be associated with woylie declines.

3) Examine indirect evidence (e.g. demographic changes) that may help to determine whether a disease in general or a specific disease may be responsible for recent woylie declines.

4) Assess the prevalence and potential for specific high-risk disease agents to be a causal factor in the decline of woylies.

Strategies:

Given the paucity of information on diseases and their pathogenicity in native mammals in south-western Australia and the increasingly limiting opportunities to identify the cause(s) while the declines are underway, extensive sampling for disease agents were conducted as part of the March/April 2006 trapping for the Upper Warren monitoring program. Preliminary counts of the samples taken are as follows;

| Sample Type | Label Prefix | Woylie | Koomal | Chuditch | Other | Grand Total |
|---|---|---|---|---|---|---|
| Blood - haematology | Be | 129 | | | | 129 |
| Blood - Toxoplasmosis serology | Bst | 146 | | | | 146 |
| Blood - Reference serum | Bsr | 135 | | | | 135 |
| Faeces - Diet | Fd | 171 | 218 | 14 | 8 | 411 |
| Faeces - Salmonella | Fs | 140 | 62 | 10 | 9 | 221 |
| Faeces - Endoparasites | Fe | 132 | 171 | 13 | 9 | 325 |
| Ectoparasites | C | 164 | 91 | 2 | 6 | 263 |

These samples are being analysed in collaboration with or the contracting of expertise primarily at Murdoch University;

i) Routine haematology will screen for general indicators of animal health and haemaparasites (Phil Clark, Head of Pathology).
ii) *Toxoplasma* will be specifically tested for in woylies (Nevi Parameswarran, PhD Student),

iii) *Salmonella* will be screened for in woylies, koomal, chuditch and other vertebrates (PathCentre via Peter Adams).
iv) Endoparasites - Initially, only a subset (150 samples) of the faecal samples dedicated for endoparasite investigation will be analysed (Unaiza Parka, PhD Student).
v) Ectoparasites will be identified to species and screened for associated diseases such as *Ricketsia* and other potentially pathogenic diseases (Yazid Abdad, PhD Student).

Collectively this information will provide a baseline of information on the disease agents present in woylie and other medium-sized mammal populations. Furthermore it will serve to identify and quantify the prevalence of potentially pathogenic disease agents in Upper Warren populations.

Based on the findings from these initial analyses, further investigations into potential pathogenic disease agents will be expected. The reference blood serum and other samples taken in March/April 2006 that were not immediately analysed will be stored indefinitely or until new information presents sufficient cause to undertake further analysis and/or specific tests.

Other work in this area will include;

- Development of a health profile that provides base-line data for clinically healthy animals in apparently stable populations
  a) Collate existing information for a reference for what is 'normal' pathology and parasite loads for target species PIOR to the decline
  b) Use existing samples / specimens to generate new data (e.g. frozen whole specimens, blood, tissue and scat samples) in CALM districts, Universities, WA Museum, etc
  c) Collect new samples for specific and targeted investigation.

- Development of a comprehensive list of wildlife diseases and an expertise-based risk assessment of their potential as a causal agent in the decline of woylies in south-western Australia (i.e. part of study component 1b above). Based on existing knowledge and expert opinion, the purpose of this exercise is two-fold;
  1) Identification of all known potential diseases so that we are aware of all possibilities
  2) A preliminary prioritisation based (high, medium, low) on their pathenogenicity and likelihood to be a contributing factor to a woylie population crash.

- Establish fauna health and disease monitoring protocols to be used as part of the trapping program of the population comparison study and the Upper Warren monitoring program. These protocols will also be available for use at other woylie populations and can form the basis of a future corporate-wide system (needed for ongoing fauna conservation and management).

- All dead or moribund animals found during the study (i.e. trapping, area surveys, mortality radio-telemetry) will be closely examined to determine factors contributing to mortality/illness. Where possible and appropriate and particularly for fresh carcasses will be sent to Murdoch University for full pathology testing.

- Post-mortem examination to include gross examination, collection of tissues in formalin for light microscopy (such tissues remain archived and can be used for subsequent detection of suspected agent's DNA (by PCR, in situ hybridisation etc) and proteins (by immunohistochemistry), tissues will be fresh frozen (for potential mineral or toxicological analyses), and samples for parasitology will be obtained. Tissues for electron microscopy may be taken at the discretion of the pathologist. Such post-mortem examinations provide immediate results from gross and light microscopy, but also build an archive of other tissues that can later be used for testing when a candidate agent is proposed.

- Integration with a proposed ARC Linkage project currently being drafted (i.e. timing dependent) on 'The nature, diversity and potential impact of infectious agents in Western Australian threatened mammals'.

- The potential remains for further development / collaboration with, i) existing, and ii) new student and other research programs at Murdoch University.
  Note: Student and staff input is available by way of either independent study contracts (ISC), which are the shortest type of project, or by Honours, Master, PhD or post-doctorate projects. Existing projects include investigations into wildlife disease in species as diverse as oysters

and bandicoots (including viral and protozoan causes), and the diagnostic techniques and skills are broadly transferable to other species and other disease agents.

Further details of future investigations into pathogenic diseases will be determined in consultation with disease experts at Murdoch University and influenced by the results from the March/April samples.

**WHO:** Co-ordinated by Adrian Wayne in liaison with Murdoch University collaborators and proposed ARC project.
Various analyses will be conducted by Murdoch University collaborators and potentially within the proposed ARC project.

## DATA ANALYSIS, EVALUATION AND REPORT WRITING STEPS

Data analysis and report writing will be co-ordinated by Dr Adrian Wayne. The Science Division biometricians (Matthew Williams and Amanda Mellican) will conduct the more complex analyses and statistically modelling. Report milestones include;

November 2006 Review of progress to be reported to the meso-predator project external review group, Woylie Decline Steering Group and relevant Directors.

October 2007 Final report to be completed for consideration by the meso-predator project external review group, Woylie Decline Steering Group, relevant Directors and WSORC.

A number of co-authored manuscripts will be prepared for scientific peer review and publication.

## MAJOR PROJECT RISKS AND OPPORTUNITY COSTS

Major factors that could determine the success or failure of achieving the desired outcomes of the woylie decline project include;

- The likely limited time-frame to undertake the research while the declines are still occurring and before the last remaining wild and indigenous populations with moderate densities have declined to low or very low densities – when the chances of success are immeasurably greater (i.e. it is expected that this opportunity will be lost by the end of 2006/early 2007).

- The need for sufficient resources to undertake a timely and efficient investigation. The availability of sufficient personnel with the appropriate skills will be particularly challenging. The collaboration with Murdoch University students and researchers will be especially important to address some of these shortfalls. The involvement of volunteers to assist with the fieldwork will also address some of these demands. An adequate operating budget to facilitate the project will also be necessary.

- The possibility that the factors associated with the woylie declines is too complex to unravel with the limited time and resources available. This risk is best minimised with a multiple scale approach with multiple lines of enquiry working in a complementary, co-ordinated and simultaneous manner. No one component or line of enquiry in the proposed project is likely to be sufficient to satisfactorily identify the cause(s) of woylie decline.

While this proposed project should be regarded as an urgent and high priority it will naturally incur an opportunity cost by which resources committed to this project would otherwise achieve alternative Departmental objectives during 2006 and 2007. These include;

Forest Fauna Ecology Research Team (Dr Adrian Wayne, Colin Ward, Chris Vellios, John Rooney)
A) Analysis and publication program originally planned would be scaled down from 80% to 10% FTE. Previously planned publications that would be deferred include;

1) *Koomal and ngwayir population trends from spotlight monitoring over time.* Examines the extent and significance of the decline of ngwayir and corresponding population trends of koomal. Speculates on what the causes of the decline may be. Part of the 'Kingston Project'.

2) *The effects of logging on the survivorship of ngwayir.* Part of the 'Kingston Project', based on the Wayne et al. 2000 report.

3) *The responses of medium-sized mammals to logging in the jarrah forest.* The population responses of the koomal, woylie, quenda and chuditch to logging over an 10 year period (1995 - 2005). Part of the 'Kingston Project'.

4) *The responses of medium-sized mammals to prescribed burning in the jarrah forest.* Longitudinal population trends and abundance differences between autumn, spring and unburnt (control) jarrah forest by medium-sized mammals (i.e. woylie, koomal, quenda, and chuditch). i.e. Batalling study (1992-2000).

5) *The responses of small terrestrial vertebrates to prescribed burning in the jarrah forest.* i.e. Batalling study (1992-2000).

6) *Koomal abundance in relation to anthropogenic factors at the local and landscape scales.* i.e. Possum Ecology study (2001-2005).

7) *Ngwayir abundance in relation to environmental factors at the local and landscape scales.* i.e. Possum Ecology study (2001-2005).

8) *Koomal abundance in relation to environmental factors at the local and landscape scales.* i.e. Possum Ecology study (2001-2005).

B) Research into mammalian declines and fire in the Kimberley region would either be down scaled or delayed. Previously planned reconnaissance in the 2006 dry season in preparation for field research commencing in 2007 in consultation with Norm McKenzie and Tony Start.

Fire and Desert Research Team (Dr Neil Burrows, Graeme Liddelow, Bruce Ward)

Planned publications that would be deferred include;

1) Camel Survey of the Eastern Pilbara Region of Western Australia

2) Recovery of Forest Ecosystems following a Wildfire in Nuyts Wilderness S.W. Western Australia

3) Rapid Survey Results on Distribution of Quokka's in Forest Regions of S.W. Western Australia

4) Results of Long Term Monitoring of Woylies in the Perup Nature Reserve

5) Mulga Regeneration following Fire in the Western Desert Area of Western Australia

6) Fire Effects on Hummock Grasslands in the Western Desert Area of Western Australia

7) Fire ecology of plants in the Gibson Desert Nature Reserve

Within the Donnelly District

Nature Conservation Program

- Operational flora searches (heavy impact Oct/Nov)
- Water monitoring in Lake Muir/Unicup Recovery Catchment

Other programs

- Prescribed burning (see page 28)
- Priority works for crews and machine availability in May/June 2006

# RESOURCE REQUIREMENTS

**Personnel**

*Existing:*

Personnel resources currently committed to existing programs in the Upper Warren region that are proposed to be co-ordinated and integrated into the investigation into woylie declines.

Science Division: Perup Long-term Monitoring / Bushranger Eco-education experience

| | **Staff (FTE)** |
|---|---|
| **Technical** | G. Liddelow (0.03)<br>B. Ward (0.03) |
| **Total salary budget including 42% overheads** | **$4516** |

Donnelly District: Western Shield and other district fauna monitoring (fieldwork component only)

| | |
|---|---|
| **District Personnel** | 2 personnel x 4 monitoring sessions |
| **Total payroll budget including 42% overheads** | **$9600** |

Species and Communities Unit: Mammal cage-trapping fieldwork component of the Fauna Management Course only

| | |
|---|---|
| **SAC Staff** | 2 staff x 1 week |
| **Total salary budget including 42% overheads** | **$4090** |

*Additional:*

Science Division:

| | 2005/06 | 2006/07 | 2007/08 |
|---|---|---|---|
| **Scientist (FTE)** | A. Wayne (0.70)<br>R. Robinson (0.01)<br>M. Williams (0.10) | A. Wayne (0.70)<br>R. Robinson (0.10)<br>M. Williams (0.10) | A. Wayne (0.20) |
| **Technical (FTE)** | C. Ward (0.50)<br>C. Vellios (0.50)<br>J. Rooney (0.05)<br>G. Liddelow (0.05)<br>B. Ward (0.05) | C. Ward (0.80)<br>C. Vellios (0.80)<br>J. Rooney (0.70)<br>G. Liddelow (0.50)<br>B. Ward (0.50)<br>A. Mellican (0.10) | C. Ward (0.20)<br>C. Vellios (0.20) |
| **Total salary budget including 42% overheads** | **$150,184** | **$ 325,213** | **$45,164** |

Donnelly District:

Additional Donnelly District resources will be required to successfully implement this project in 2006/07.

| **Additional Activities** | **Additional Resources during 2006/2007** | **Payroll** |
|---|---|---|
| Population Monitoring | 2 people x 5 days x 8 sessions + 25 man-days input and coordination | $25,140 |
| Population Comparison | 2 people x 5 days x 9 sessions | $21,600 |
| Sand Plot Establishment | 4 people x 15 days x 2 weeks | $14,400 |
| Sand Plot Monitoring | 2 people x 5 days x 7 sessions + 2 people x 11 days x 1 session | $23,400 |
| **Total** | | **$84,540** |

Donnelly District has the capacity to supply experienced competent personnel to undertake this work and this is the preferred option to capitalise on local knowledge of the area and ownership of the project and project outcomes.

However, this will have serious consequences for existing works programs particularly fire management. There will be considerable conflict for key District personnel needing to complete priority project work and assist with the prescribed burn program. This can be resolved by resources being assigned from neighbouring districts on a daily basis to assist with prescribed burning in Donnelly District. To be successful this approach will need to be supported and endorsed by the Regional Manager and Director Regional Services.

**Indicative Operating Budget**

*Existing:*

Operating budgets currently committed to existing monitoring programs in the Upper Warren region that are proposed to be co-ordinated and integrated into the investigation into woylie declines.

| **Current monitoring activities** | **Existing budgets** |
|---|---|
| Science – Perup long-term monitoring | $3,000 |
| District – Western Shield and other monitoring | $3,500 |
| SAC – Fauna Management Course | $1,110 |

*Additional*

| **Project Components** | **2005/06** | **2006/07** | **2007/08** |
|---|---|---|---|
| 1) Meta-analysis and possible causes | 3,693 | 7,961 | |
| 2) Biannual monitoring | 10,457 | 16,169 | * |
| 3a) Population densities and Demographics | 4,618 | 27,480 | |
| 3b) Survivorship and Mortality | 22,091 | 75,150 | |
| 3c) Predator prevalence and activity | 0 | 40,640 | |
| 3d) Resources | 2,500 | 10,000 | |
| 3e) Disease | 15,813 | 20,000 | |
| General Science Operating | 10,828 | 29,200 | 40,000 |
| | | | |
| **Total Additional Indicative Operating Budget** | **$70,000** | **$226,600** | **$40,000*** |

*dependent on the status of woylie populations and the project outcomes during 2006/07

**Total Additional Indicative Budget**

i.e. not including existing resources allocated to pre-existing monitoring programs that will be incorporated into the project.

| | **2005/06** | **2006/07** | **2007/08** |
|---|---|---|---|
| Salaries – Science | 150,184 | 325,213 | 45,164 |
| Payroll – District | | 84,540 | * |
| Operating Budget | 70,000 | 226,600 | 40,000* |
| External Funds (ARC) | | (?) | (?) |
| External Payroll funds (SWCC) | | (25,000?) | (25,000?) |
| **TOTAL** | **220,184** | **636,353** | **85,164*** |

*dependent on the status of woylie populations and the project outcomes during 2006/07

SWCC - CALM has submitted as a priority, a proposal for an additional 0.5 FTE based in Manjimup to assist in the facilitation of fauna conservation programs. This application is still being considered by SWCC as part of the next two-year funding agreements.

ARC Linkage Grant – The proposed ARC project, 'The nature, diversity and potential impact of infectious agents in Western Australian threatened mammals', will be closely associated with the disease components of the woylie decline investigations. Some part of the ARC funds dedicated to this project ($186,000 annual cash funds within a total annual budget of $474,803) will therefore be potentially available to offset some of the costs of the latter. CALM's contribution to the ARC will be $40,000 plus an in-kind contribution of $136,200.

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