CHAPTER 8 INTERIM / PRELIMINARY RECOMMENDATIONS

Adrian Wayne

Department of Environment and Conservation

Abstract

While the Woylie Conservation Research Project (WCRP) is ongoing, some interim and preliminary recommendations for research, fauna monitoring, conservation management and project management can be outlined. The principal research framework includes;

1. Phase 1 completion and synthesis
2. Key putative agents of decline
   a) Disease - Toxoplasma, Trypanosoma, Supporting (diagnostic) evidence (field, clinical, pathology, epidemiology), Other infectious agents (including priority risks), and Dependent follow-up (e.g. synergistic effects)
   b) Predator control experiment (Active Adaptive Management)
   c) Resources
   d) Stressors
3. Species recovery
   a) Conservation genetics
   b) Small population paradigm – limiting factors and risks
   c) Population viability analysis
4. Research management (statistical analyses support, reviews, symposium and workshop, data and information management)

A six-month plan for the completion of the current commitments to the WCRP is summarised.

Fauna monitoring recommendations include;

- Suggested programs for Upper Warren and elsewhere
- Improved monitoring protocols (surveillance versus ecological monitoring; target species, predators, other covariates; and trigger points, reporting and response protocols)

Interim and preliminary conservation management recommendations include;

- Conservation status reviews
- Recovery planning
- Improved efficiency to the current fox-control program
- Data and information management improvements

Project management considerations include adopting the appropriate framework for an ongoing program (as distinct from the rapid response approach of phase 1), consider the sustainability of the project (personnel to meet workload, resources, etc), support and funding, communication, data and information management, media and public engagement and the value of external and internal reviews.

DRAFT

Introduction

As originally planned, phase 1 of the Woylie Conservation Research Project (WCRP) is expected to conclude on 30 June 2008. The intent is that the work achieved in this initial phase will inform what should happen next. The second phase of the woylie conservation response should be distinct from the first in three important ways;

1. The project management should shift from the rapid (emergency) response model to an ongoing program model
2. Research focus shift from investigative to scientific testing
3. Response emphasis should begin to shift from research toward management

While the WCRP is ongoing, a framework of interim and preliminary recommendations has been provided to stimulate further development and facilitate the maintenance of momentum into phase 2. These considerations are broadly classified as

1. Research
2. Fauna monitoring
3. Conservation management
4. Project management

Figure 8.1 provides a higher-order outline for the Woylie Conservation Phase 2 framework.

8.1. Research recommendations

Based on the available evidence and the leading hypothesis of the cause(s) of the woylie declines (Section 7.3), a framework for future research is grouped into four major themes;

1. Phase 1 completion and synthesis
2. Key putative agents of decline
   a) Disease
      -Toxoplasma
      -Trypanosoma
      -Supporting (diagnostic) evidence (field, clinical, pathology, epidemiology)
      -Other infectious agents (including priority risks)
      -Dependent follow-up (e.g. synergistic effects)
   b) Predator control experiment (Active Adaptive Management)
   c) Resources
   d) Stressors
3. Species recovery
   a) Conservation genetics
   b) Small population paradigm – limiting factors and risks
   c) Population viability analysis
4. Research management

DRAFT

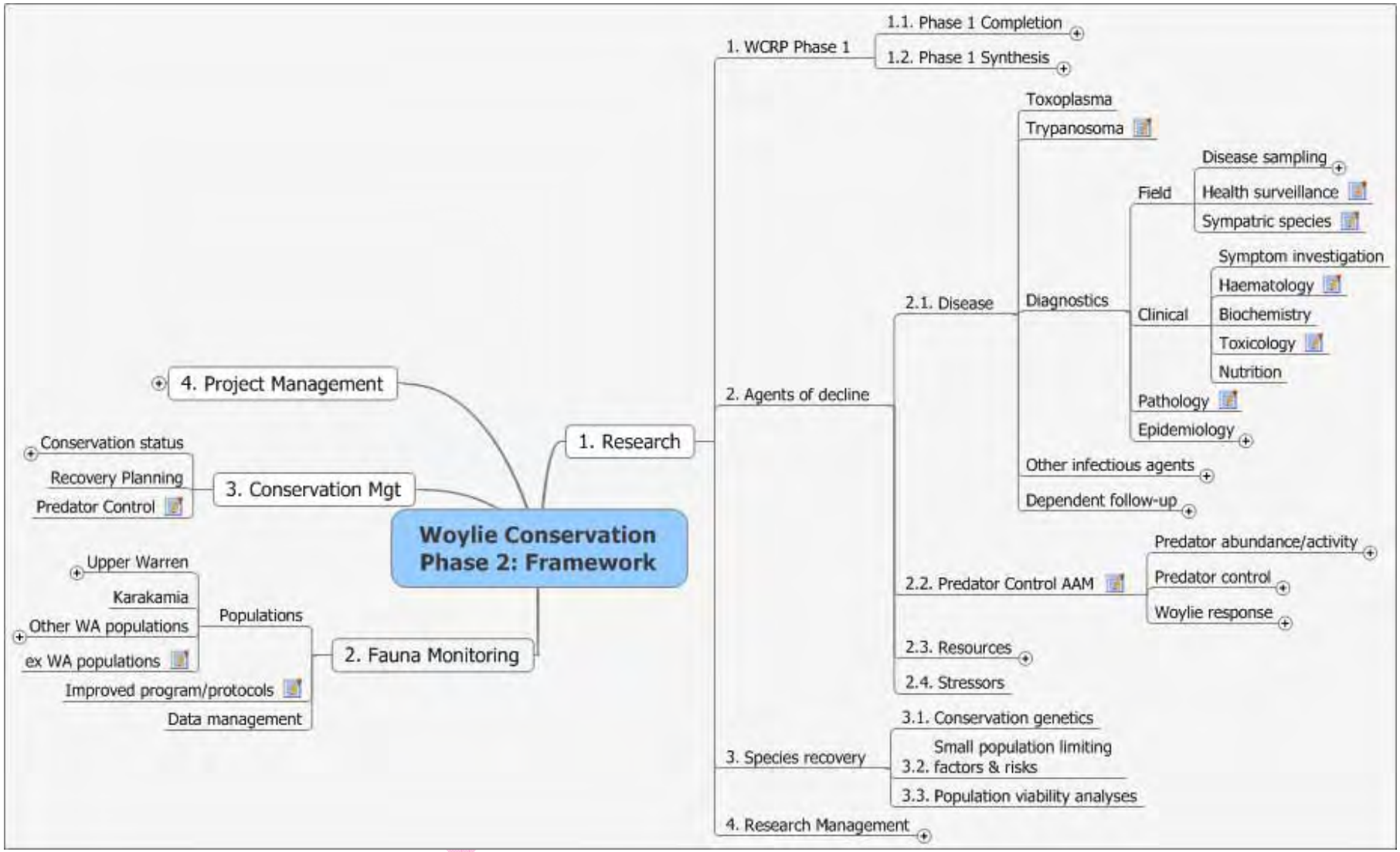

Figure 8.1. Draft framework for the development of Phase 2 of the woylie conservation response plan.

Shifting focus for new research

Research to date has focused on finding associative evidence related to recent woylie declines. While this has been the most efficient preliminary strategy available to determine what primary factors may be involved they provide relatively weak inference. This is because associations may be either *related* or *co-incidental* to the declines. Furthermore, it is necessary to discriminate between related associations that are a *cause* of the declines from those that are an *effect* (i.e. a consequence or response to woylie declines). In so doing, the next phase of research should serve to progress the woylie decline diagnosis framework (*sensu lato* 'declining population paradigm'; Caughley, 1994; Caughley and Gunn, 1996; Peery *et al.,* 2004) by concluding steps 1-5 and shifting focus onto step 6 and 7;

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.

Scientific experimental testing is highly recommended as the next stage in determining the factors associated with the recent woylie declines. Such an approach provides the scientific rigor necessary to test the nature and role of the putative factors that have been identified by association with woylie declines. Scientifically testing these associations is a particularly critical next stage given the potential risks of undertaking management and conservation responses based on untested hypotheses derived from associative evidence. The extinction of the California Condor in the wild in the 1980s, is an example where conservation and management efforts based on untested theories unwittingly facilitated their decline (Caughley, 1994).

An active adaptive management framework (*sensu* Walters and Holling, 1990 and Lee, 1999) is recommended as the scientific framework to test putative agents of decline wherever possible and appropriate. This 'learn by doing' approach helps address the need to respond to the declines in a timely manner and to optimise the conservation prospects for the species (e.g. minimise loss of genetic diversity, limit vulnerability to declining populations to local extinction, facilitate rapid recovery, etc). Such an approach can also serve to minimise the risks of pursuing actions that unintentionally have adverse affects.

Flexibility and responsiveness to new and emerging evidence remains a necessarily important provision given the nature and complexity of the situation.

8.1.1. Limited continuation of elements of WCRP phase 1

8.1.1.1. Phase 1 - Completion of existing work-in-progress

The collection of primary data in the field was predominantly concluded by August 2007 for all components of the project with the exception of a reduced-level of on-going Upper Warren Fauna Monitoring, resources PhD research, and the opportunistic collection of some samples for ongoing disease investigations (discussed more below). The emphasis since then has been to process and analyse the available samples and data.

The continued processing and analyses of data is expected to provide substantial and important information necessary for diagnosing the woylie declines. This continued work includes;

Meta-analysis

- Spatial and temporal characterization of the Upper Warren declines

DRAFT

- Population change associations with other species needs resolution for koomal, quenda and large reptiles and investigation of the more cryptic ngwayir, wambenger and possibly numbat.
- Consideration of expanding the meta-analysis (population trends, demographics, other associations, etc) to include analysis and comparison with other woylie populations (e.g. Batalling, Dryandra, Tutanning, and South Australian populations).
- A more comprehensive analysis of climatic associations with the woylie declines.

Survivorship and mortality (PCS)

- Complete comparative disease and health profiles of radio-collared woylies that died/survived.
- Complete evidence processing of forensic material and necropsies collected from woylie mortalities
- Complete evidence processing of material collected from the woylie 'search and rescue' exercise. Consider another community-based exercise.

Peer-reviewed publications

The population comparison study components and disease investigations should complete the analyses of existing data currently underway, and publish the works directly into the peer-reviewed literature. A publications plan and register of all material derived from the project and its collaborative association is being maintained and is available to all WCRP collaborators. It is expected that manuscript submissions will begin before mid-2008.

Incomplete or outstanding / Low priority work

Meta-analysis elements that remain incomplete but lower priority include;

- Demographic analysis of population turnover and individual longevity
- Fire associations with woylie declines

Population comparison study elements that remain incomplete but lower priority include;

- Demographic analysis of population turnover and individual longevity
- Wedge-tailed eagle predator abundance and nest surveys
- Dietary analysis of predator scats collected during the sandpad surveys
- Analysis of historical sandpad survey data from the Kingston Study and Perup Bushrangers program
- Resources pilot study analysis

8.1.1.2. Phase 1 - Synthesis of existing evidence

Once the analyses of the various components have been sufficiently advanced, it will be necessary to undertake a comprehensive synthesis of the available information. A critically necessary progression in the development of the evidence is relating and linking the multiple datasets available to identify associations with individuals/populations at different stages of decline.

Key datasets include;

- Survival and mortality radio-collared cohorts
- Trapping data from PCS sites
- Upper Warren monitoring transects
- WA and SA populations

Key data types include;

- Disease incidence/prevalence
- Clinical indicators - haematology, biochemistry, etc

DRAFT

- Pathology - necropsies
- Field health examinations
- Biometric and trapping
- Predator activity

These lines of enquiry are related to the epidemiological investigations and the development of disease/health profiles discussed further below.

The synthesis of available information will include the consideration of developing systems models to assist understanding and communicating the likely interactions and complexities associated with the woylie declines.

8.1.1.3. Close monitoring and study of the last moderate-density woylie populations

Keninup, and to a lesser extent Warrup, constitute the last remaining wild woylie populations still persisting at moderate densities in Western Australia. There is every expectation that Keninup will undergo substantial and rapid declines during 2008. This is based on its close geographical association to the latest decline at Balban (81% decline in 12 months to July 2007 and continuing) and the pattern and characteristics of the declines observed throughout the region. This provides the best and possibly last opportunity to directly identify the cause(s) of woylie declines so that appropriate conservation and management can effectively promote the recovery and long-term viability of the species. The importance of this opportunity is particularly well emphasized by the immeasurably greater difficulty to identify these factors in low-density woylie populations and after the decline has occurred. The factors that keep a population low also may not be the same factors that cause the initial declines.

Continued close monitoring and study of the woylie populations at the Population Comparison Study (PCS) sites is highly recommended. This is especially so for Keninup, Warrup and Karakamia – which remains a particularly powerful comparative population. Comparative data from a population that has declined would also be necessary to assist in the diagnosis of the woylie declines.

8.1.2. Key putative agents of decline

The research framework for the key putative agents of decline are grouped into four themes;

a) Disease

b) Predator control experiment (Active Adaptive Management)

c) Resources

d) Stressors

8.1.2.1. Disease

Toxoplasma

- Spatial and temporal differences in *Toxoplasma* evidence in relation to woylie population declines. Sources of evidence include serology from blood samples, PCR and histopathology of available tissues from dead radio-collared woylies and necropsies.
- Epidemiological investigation to relate evidence of *Toxoplasma* infection with other available disease, health, demographic, and survival data, compared with individuals/populations not infected.
- Genetic characterization
- If the associative evidence for *Toxoplasma* having a role in the woylie declines is compelling, several more lines of enquiry should be pursued including; evidence of toxoplasmosis, possible synergisms (e.g. *Trypanosoma*), virulence testing, relative importance of the various transmission pathways (cat faeces, infected meat, vertical transmission), etc

DRAFT

Trypanosoma

- Spatial and temporal differences: comparison of binary PCR data (positive/negative) within (across time) and between (across space) populations. If there appears to be a link, or role, for trypanosomes then a more in-depth modelling analysis will be required for significant publication
- Genetic characterisation
- Epidemiological investigation to relate evidence of *Trypanosoma* infection with other available disease, health, demographic, and survival data, compared with individuals/populations not infected.
- Parasitemia (in association with QPCR if possible)
- Experimental infection - will provide the most compelling evidence for the pathogenic status of trypanosome infection. Could be expanded to include the concomitant effects of *Toxoplasma*.

Supporting (diagnostic) evidence

Field sampling and data collection includes;

- Disease sampling at PCS sites and Upper Warren fauna monitoring transects should continue (blood, scats, ectoparasites, DNA) for the development of the sample reference bank (i.e. capacity to retrospectively examine compelling new evidence) and to examine spatial/temporal differences in disease prevalence associated with declines.
- Disease sampling at PCS expansion sites (Batalling, Dryandra, Tutanning, etc?) to provide key discriminating associative evidence for the possible role of *Toxoplasma*, *Trypanosoma* and other possible infectious agents associated with the woylie declines.
- Ongoing field health surveillance of woylies and other fauna caught in the Upper Warren, other swWA and SA populations (i.e. primary means of detecting clinical symptoms that may provide critical breakthroughs to the diagnosis of woylie declines).
- Disease sampling of sympatric species by the associated ARC linkage project may provide useful leads.

Clinical activities providing supporting evidence includes;

- Clinical investigation of symptomatic evidence in sick or moribund animals
- Haematology
- Biochemistry
- Toxicology (e.g. sodium monofluoroacetate, alkaloids, and heavy metals)
- Nutrition

Pathology investigations, including detailed necropsies to maximise the capacity to identify and collect evidence that may be associated with the causes of woylie mortality and population declines.

Epidemiological investigations and characterisation of the decline would be particularly powerful tool to assist in the diagnosis of the woylie declines. Such an investigation may help to identify how and what diseases may be involved in the declines based on the evidence accumulated to date. Investigations could include;

- Comprehensive aggregation of all available data collected to date on the disease/health profiles of the survival and mortality radio-collared cohorts (died versus survived), PCS sites, and broader comparisons between other woylie populations.
- Research and synthesise all available disease and health information in the published literature and other available records relating to woylies and related species.
- Comparison between observed and predicted behaviours of key putative agents and mechanisms of decline
- Review the identification and risk assessment of potential disease agents in relation to woylie declines in an ongoing or at least annual basis.

DRAFT

Other infectious agents

- High priority / high risk infectious agents that have not yet been investigated include Macropod Herpesvirus, Orbivirus, Encephalomyocarditis virus, Chlamydiales bacteria, and the protozoan: *Neospora caninum*.
- Ectoparasites
- Bacteria
- Endoparasites
- Viruses
- Haemaparasites

Dependent follow-up

Dependent on anticipated and/or more compelling evidence, there are a number of investigations that may be considered as logical developments. These include;

- Synergistic effects – particularly between *Toxoplasma* and *Trypanosoma*
- Testing the role of associated diseases (transfection study)
- Arthropod vectors of associated diseases

Synergistic effects

Investigations into possible synergistic effects would commence once associative evidence of *Toxoplasma* and *Typanosoma* both being involved in the woylie declines has been established and/or if other potential synergistic effects are well founded.

Testing the role of disease – 'transfection' study

There is mounting evidence that woylies from different populations differ in the prevalence of *Toxoplasma* and *Trypanosoma*. Little is known about the mechanism of transmission of *Trypanosoma* and its potential for pathogenic effects on its woylie host. The aims of this project are therefore (1) to determine the role of arthropod vectors in trypanosome transmission; (2) to determine the extent to which trypanosome infections may adversely affect woylie health and/or condition and/or activity in a manner that may contribute to woylie population declines. Possible interactions with *Toxoplasma* and other key disease agents can also be investigated as part of these trials.

The primary principle of the experimental investigation is to co-house, in a controlled environment, woylie individuals from an affected population (Upper Warren) with naive individuals from a population unaffected by the recent declines. The ectoparasite loads would be removed from woylies in some of the concurrent trials to determine their role as vectors. Close and frequent observation of the animals by suitably trained individuals and supervision by veterinarians would monitor the health and behaviour of the animals. The ethical considerations and welfare of the animals involved will remain an utmost priority and will comply with all the necessary codes and requirements in the most appropriate manner.

The aim would be to conduct this research as a PhD student project and as a collaboration lead by Murdoch and involving DEC, possibly Perth Zoo and others. A/Prof Alan Lymbery and Prof. Andrew Thompson have had lead roles in the development of this project proposal. The plan is to begin the project in 2008, running for a minimum of two years. Enclosures would be required to accommodate the woylies involved and a not-for-profit community organisation has been engaged as prospective key collaborator in this capacity. Funding for the research is currently being sought.

Arthropod vectors to disease (student project)

Given the possible association of trypanosome infection with Upper Warren woylie declines there is a need to understand what vector(s) may be involved in transmission of this parasite. One possibility is the ectoparasite assemblage that live on woylies (fleas and ticks), but trypanosomes are commonly transmitted by biting flies of a number of species. Cyclical development can occur in the vector, either in the anterior of the insect with subsequent accumulation in mouthparts and salivary glands and

DRAFT

transmission by biting, or in the hindgut with passage by faeces resulting in contamination of mucous membranes or wounds.

The objective of this study would be the examination of collected or trapped vectors for presence of the trypanosomes.

a) Existing activity is already planned to examine ectoparasites removed from the animals (fleas, ticks, mites) for evidence of infection by trypanosomes and *Rickettsia* (i.e. Halina Burmej's PhD research).

b) The proposed additional activity is to:

- set insect traps in the Upper Warren and at Karakamia
- detect and sort species of biting flies that are trapped
- examine mouthparts/salivary glands and hindgut for presence of trypanosomes by direct microscopy and/or by PCR

This project has been identified by the Woylie Disease Reference Council (WDRC) as one of the priorities for new potential research and has been developed and championed by Dr Trevor Ellis and Dr Phil Nicholls. The project would be suitable for an Honours student project supported by a DEC field entomologist (e.g. Janet Farr) and parasitologists at Murdoch University. It will assist in determining the differences in incidence and prevalence of trypanosomes between woylie populations and could help to understand the epidemiology involved. The priority of this research would be elevated if additional evidence indicates that Trypanosomes or other vector-borne diseases potentially transmitted by biting flies are in some way related to recent woylie declines.

8.1.2.2. Experimental introduced predator control within an active adaptive management framework

The remnant woylie populations within the Upper Warren region are well-suited to experimentally testing the role of introduced predators in current woylie declines. Given the spatial distribution and status of woylie populations within the region, the approximately 50 km by 50 km area could be used as an unreplicated experimental trial in which part of the area is managed as a control (existing predator management) and the another portion as the treatment area (increased and sustained cat and fox control).

Summary points of the proposed experimental design

Control area (predator management unchanged):

Western and Southern portion of the Upper Warren region, including the Proposed National Park in the greater Kingston area and State Forest immediately south (Figure 8.2). This includes Warrup which supports one of the two last remaining moderate-density wild woylie populations. Both the Warrup and Winnejup (declined woylie population) areas have long-term medium-sized mammal data, and more recently, more detailed data associated with Upper Warren woylie monitoring and PCS sites (including woylie grids and predator sandpad networks). The area is also involved in ongoing research which would otherwise be disrupted if it were to be the treatment area (e.g. Kingston Study and FORESTCHECK).

Treatment area (intensive, aggressive and sustained cat and fox control):

Northeastern portion of the Upper Warren region, including all or most of the Perup Nature Reserve (Figure 8.2). This includes Keninup which supports the most substantial of the two last remaining moderate-density wild woylie populations as well as representative areas that have recently undergone >90% declines in woylies. The area also includes proposed reintroduction sites for bilby and boodie and constitutes important habitat for the indigenous populations of the threatened ngwayir and other threatened mammals that can be predated by cats and foxes.

DRAFT

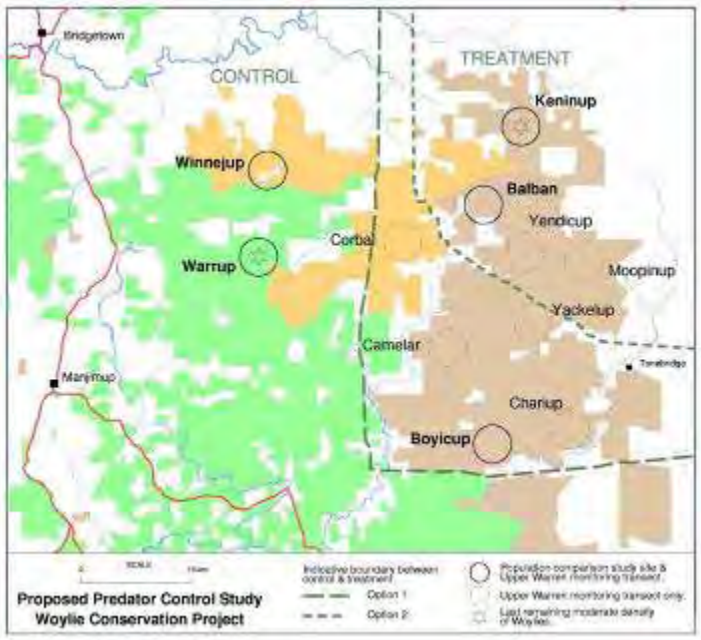

Figure 8.2. Proposed Predator Control study using an experimental and active adaptive management design that directly tests the role of predators (principally cats) in the current declines of woylies in the Upper Warren region.

Predator control:

Intensive and sustained cat control would use one of two approaches that both aim to maximise the reduction of feral cats in the treatment area and sustain them at these levels over time.

Option one: Cat control using methods that can directly quantify the number of cats removed (e.g. trapping, shooting, rapid-kill baiting).

Option two: Cat control using methods that do not directly quantify the number of cats removed (e.g. broadscale baiting).

Option one is the vastly preferred approach given that it more directly quantifies the reduction in cats, which can then be directly related to woylie responses. A substantial and significant additional benefit of this approach is the ability to calibrate and test the sensitivity of methods used to monitor predator activity and/or estimate predator densities within the southwestern Australian forests, which is notoriously difficult and problematic. The support and expertise of Dave Algar and others would necessarily be a collaborative component of this program. As well as being directly beneficial to woylie conservation efforts this study would also have broader benefits and relevance for predator control and monitoring across the State and elsewhere.

Predator monitoring:

Fox and cat activity and abundance would be regularly monitored before and during the study in both the control and treatment areas to quantify treatment effects and changes in predators over time. Predator control option one would enable the monitoring methods to be calibrated and their sensitivity quantified as discussed above. Monitoring methods would include;

- Sandpad surveys using the networks established as part of the WCRP. These will be used principally to measure activity and possibly abundance of cats and foxes, as well as native fauna.
- Hair traps for DNA mark-recapture abundance estimates (currently being developed and refined by Mesopredator research colleagues Paul de Tores and Nicky Marlow).

DRAFT

Woylie and other native fauna monitoring

Existing PCS (grids) and Upper Monitoring infrastructure (transects) will be used to quantify woylie and other native species responses to the increased predator control using a similar program as conducted in 2006/2007. This will include studying the responses to increased predator control by;

- Regular trapping on the PCS grids to study density and demographic responses.
- Radio-collared cohorts in the treatment and control areas will be used to quantify survival and mortality.
- Upper Warren Fauna Monitoring transects will provide landscape-scale responses.
- PCS grids and UW Fauna Monitoring transects will also quantify responses by other native species.

Other points for consideration

- This project will necessarily be a highly collaborative project providing mutually beneficial outcomes and accessing the expertise of mesopredator research colleagues, particularly in relation to predator control methods and hair traps for DNA mark-recapture abundance estimates.
- The project could provide a continuing leading example of a high level of co-operation between operational and research components within the Department. The operational components of the study (e.g. predator control and landscape-scale monitoring) would be well-suited to existing and new works managed by Regional Services and Nature Conservation Divisions. Science Division can provide scientific and specialist support.
- This project is well-suited to be incorporated into the suite of Departmental active adaptive management projects currently being established.
- The relatively high reproductive potential of woylies means that if predation is a key factor in the decline of woylies, population responses should be detectable within one to three years.
- The survival and mortality data generated from monitoring radio-collared cohorts should provide strong (partial) evidence within the first 12 months of intensive predator control
- Factors that cause the decline of a species may be different to those that then keep populations at low levels. Predation is likely to play an even more important role in the former. Therefore this project is expected to be a potentially key contributor to the optimisation of the recovery of the species, which will critically have substantial long-term conservation benefits (i.e. minimisation of genetic loss due to a large and protracted bottleneck).
- The greatest genetic diversity of woylies is expected to be at the remnant indigenous populations at Upper Warren, Dryandra and Tutanning, of which the latter is likely to be limited value given the relatively small population size and historical isolation. Conservation genetics research currently underway by Carlo Pacioni (Murdoch University) will quantify this in 2008.
- The proposed predator study is best suited for the Upper Warren region given the existing infrastructure in the field (e.g. transect, grids, sandpad networks) and office (e.g. Manjimup-based inter-divisional collaborations), the substantial foundation of existing data and information from >30 years research and monitoring activities, including the current WCRP, relative value of the population as one of the three remnant indigenous population (i.e. highest conservation value), and geographic attributes of the region (size, proximity to Departmental resources).

8.1.2.3. Resources

Resources investigations undertaken as part of Kerry Rhodda's PhD research should continue. As well as scientifically assessing whether or not food resources are associated with the woylie declines, this research will provide important ecological information directly relevant to the recovery and long-term conservation of the species.

DRAFT

Vegetation health, structure and floristic data from the resources pilot study and PCS sites remains to be analysed. Similarly the analysis of woylie digging densities and associations from the resources pilot study remain to be completed.

8.1.2.4. Stressors

Stressors that may trigger or contribute to the effects of key agents of decline include predation, ectoparasites, competition, nutrition, climate factors / extreme weather, disease reservoirs in sympatric species, concurrent infections, and high-density woylie populations. Researching and monitoring these and other possible stressors should be considered. The importance of understanding the potential stressors will increase as the compelling evidence for the key agents of decline accumulates.

8.1.3 Species recovery

As well as being relevant to the diagnosis of the causes of the woylie declines, some research is particularly important for facilitating rapid and appropriate species recovery. This includes;

8.1.3.1. Conservation Genetics

A good understanding of woylie population genetics is important for a number of reasons including; characterisation of the remaining genetic diversity, understanding the consequences of previous bottlenecks thus enabling predictions of the consequences of the current declines, and informing how best to facilitate the recovery of the species in a manner that will maximise the genetic diversity and hence maximise the long-term conservation potential of the species. This work is being conducted as part of a collaborative PhD research program by Carlo Pacioni.

8.1.3.2. Small population paradigm

Understanding the limiting factors and risks to small populations are particularly important given that they can be profoundly different to declining populations. This is therefore an important complement to the diagnosis of the causes of the woylie declines.

8.1.3.3. Population viability analyses

Population viability analyses will help characterise the nature of the declines, quantify the impact of the declines, assess the risk to populations and help instruct recovery plans and management to maximise woylie conservation prospects.

8.1.4 Research management

8.1.4.1. Statistical analyses

Conducting statistically rigorous and appropriate analyses remains a key limiting factor in the progress of many of the WCRP component investigations. This is due to the extensive competing demands of Adrian Wayne as the project manager and chief investigating officer and the absence of any other individuals with the appropriate skills to perform many of the necessary statistical analyses. This problem has now become increasingly important and critical to the project as the emphasis has now shifted to analysing and publishing the results to date. Involvement of a suitably-experienced biometrician would be singularly the most effective means of increasing the capability of the project to produce results in a timely manner. This will immeasurably benefit the diagnosis of the declines and improve the capacity to respond in a manner that maximises the conservation and recovery of the species. A workable solution to this situation is now one of the highest priorities for the progress of this project.

8.1.4.2. Project and research review

Potentially substantial gains could be had by inviting a critical review of the WCRP and its preliminary results (presented in this report). Such an exercise could help to identify what has been done well and what could be improved or reemphasised in terms of priorities. This would be particularly valuable

DRAFT

given the urgency for a rapid response to the situation and the vast amount of work that has been conducted by considerably limited resources (particularly people and expertise). It would also be timely to be conducted now so that it can contribute to the considerations of what happens next (i.e. priorities, strategies, etc). The project and research review would have several components;

1. General research approach and progress – conducted by the Mesopredator External Review Panel (Andrew Burbidge, Peter Jarman and David Choquenot).
2. Specific disease components – conducted by invited experts from the Australian Wildlife Health Network (AWHN) and the Australia Wildlife Disease Association (WDA).
3. Project Management – communication and comparison with analogous programs, e.g. Tasmanian Devil Facial Tumour program.
4. Self review – workshop(s) involving those directly involved in the WCRP.

8.1.4.3. Woylie symposium and strategic review

This is planned for the 14th and 15th February 2008. The Woylie Conservation Steering Group will convene the symposium and workshop. The purpose of the woylie symposium is to aggregate and communicate of all relevant woylie information currently available. The intended audience includes the large number of collaborators involved in parts of the WCRP and mesopredator research programs, fauna conservation managers, relevant experts not directly involved with the current programs but may have some capacity to contribute (including specific invitees), and associated and interested community groups and individuals. The symposium will also inform the subsequent workshop, which will be attended by invitees (principally researchers and managers directly relevant to woylie conservation and decline diagnosis). The purpose of the workshop will be to use the current information available to agree on the priorities and a strategic woylie conservation response plan (phase two). This will be further developed and presented as a proposal for consideration by key DEC Directors and/or Corporate Executive so that it can be assessed on its merits and within the context of other competing priorities.

8.1.4.4. Data and information management

Research and operational protocols

The WCRP Field Operations Handbook (Volume 3) outlines the methodology and protocols for the various components of the project. Components of this handbook are of value to other research and operational programs. Whole or parts of the handbook have been provided to colleagues and other workers and are being used in their current form or as a basis of protocols and procedures in other programs. While functional in their current form, some of the details necessarily change in order to be responsive to the changing circumstances and emerging information. If/when further decline diagnoses and/or monitoring are conducted using this handbook, a minor revision will be required beforehand. Consideration should also be given to managing the handbook in a manner that facilitates occasional or ongoing revision. For example, the latest version should be available electronically and readily accessible by a geographically dispersed and institutionally diverse target audience (e.g. web-based). Reformatting into a more user-friendly format would also be highly recommended. For example, 'Mindjet MindManager' software organises the information into a self-structured organisational chart that can be intuitively and easily navigated to rapidly access the target information. Accessing and reading the protocols can be done using free Mindjet software.

Improved data collection efficiency

The use of PDAs or similar hardware and software that can substantially increase the efficiency and quality of data collection and management should be given careful consideration if/when further work is conducted as part of this or similar work. The potential efficiency benefits alone from this are potentially substantial, particularly within the context of limited personnel resources. Given that this is a common problem across many programs within the Department, there would be substantial gains from a co-ordinated, cross-Department consideration and development of the use of these tools.

DRAFT

Database aggregation / centralisation

Substantial benefits have been gained by the creation of a single, centralised, aggregated database ('Manjimup Fauna File' (MFF)) containing fauna data from previously isolated programs operating within the same geographic area (Upper Warren). The value of the database is substantially greater that the sum of the isolated parts from which it was created, not least because the same fauna individuals now have a more comprehensive and integrated record of their history and association across separate programs. The analytical benefits of this in assisting in the diagnosis of the woylie decline, or any other fauna-related work is potentially invaluable. Such an approach to data management is also clearly more efficient and highly desirable for many reasons, despite the considerable effort required to aggregate the databases.

Ongoing maintenance of the MFF is necessary now that the substantial investment has been made to establish it and given the demonstrable benefits that have and will come from its ongoing use. This should include keeping the database up-to-date and continue efforts to validate the data to ensure a higher quality of data with a minimal error rate. Co-ordination and co-operation between the multiple contributors/users (i.e. Warren Region, Donnelly District, *Western Shield*, and various ongoing and historic research programs conducted by Science Division) is also necessary.

Future development of the database would also be beneficial. This should include the obligation by future work to use the MFF as the primary data management platform - using a centralised database at the outset is vastly more efficient than attempting to aggregate a separate database at some later date. Other developments could include, aggregation of the remaining datasets associated with the region (e.g. other Science Division databases, and work by external institutions such as UWA, Landcare groups and community groups, etc), and the expansion of the geographic area that is managed by the database (e.g. whole of Warren region).

The work on the Upper Warren data aggregation provides a model for what could happen more broadly across the Department. As such it has already assisted in efforts currently underway to improve the *Western Shield* database, 'Fauna File'. The Upper Warren example should continue to support and encourage efforts towards a more Department-wide integrated fauna data management system.

DRAFT

8.1.5. Summary of the short-term WCRP plan and future work preparation

The emphasis of the WCRP for the remainder of the 2007/2008 financial year will be the continuation of analyses and work toward the publication of the results to date, in keeping with the original plans and agreements for this project. The existing funding and formal commitments to the WCRP will conclude on 30th June 2008. The outcomes of the work-to-date will, however, inform what further responses may be committed to, also in keeping with the original strategy. However, in order to facilitate a timely and effective transition from the end of phase 1 and the start of phase two, planning is required well in advance of this milestone (hence the need to publish this progress report at this time). An efficient transition is particularly important given the significance and urgency of the issue and the substantial time-dependent opportunity costs associated with identifying and responding to the rapid species decline. In this context a plan for specifically addressing this transition is proposed;

Jan08	WCRP Progress Report – circulation to collaborators, DEC Directors, BCI, Director General, etc
Feb08	Project progress review General – Mesopredator Review Panel Disease – Wildlife Disease Association (WDA Australasia) / Australian Wildlife Health Network (AWHN) Project management Self review
Feb08	Woylie symposium and strategic review workshop - Publications should be forthcoming from herein
Mar08	Woylie conservation response plan (phase 2) continued development - including priorities, resource requirements, funding strategy. Incorporates reviewer and workshop contributions.
Mar/Apr08	Upper Warren Fauna Monitoring Re-instate predator sandpad monitoring (highly recommended)
May/Jun08	Secure support, funding and commitments to phase 2
Jul08	Commence phase 2 This may include predator control management/experiment, study of the last moderate-density woylie populations, and/or ongoing and emerging disease investigations.

DRAFT

8.2. Fauna monitoring

Fauna monitoring is directly involved in existing and recommended research and management activities. As such this section is relevant to research and management recommendation sections (above and below).

8.2.1. Woylie Populations

Upper Warren Fauna Monitoring

Continue the fauna monitoring program albeit on a less intensive basis. At the very least this should remain biannual for the last remaining moderate-density woylie populations (Keninup and Warrup). All other sites could resume to their pre-WCRP monitoring frequency but retain the standardized operational protocols (Volume 3) to ensure consistency and comparability (i.e. annual for most – some in spring, some in autumn, biannual for Yackelup and Yendicup) (Chapter 2 UW Fauna Monitoring). Careful consideration should be given to annually surveying those key Upper Warren transects that would not otherwise be surveyed on this basis (i.e. Chariup, Winnejup and Corbal) until either the cause of the declines is identified, the trajectory of the conservation risk to the species is improved and/or a robust recovery can be demonstrated. Changing the frequency of trapping needs to carefully consider the consequences and potential confounding resulting from changed capture probabilities based on trap-learning by woylies and other species.

Predator monitoring at the Upper Warren PCS sites should be re-activated in early 2008 as a matter of priority, particularly given the likelihood of cat predation being involved in the woylie declines. This is particularly critical covariate data to have concurrently available with the imminently-expected woylie declines at Keninup and possibly Warrup. This would also provide pre-treatment predator activity data necessary for the predator control experiment (AAM) and remains consistent with recommendations for more comprehensive ecological monitoring.

Karakamia Wildlife Sanctuary

The Karakamia (AWC) woylie population remains important for reasons including; assisting in the diagnosis of the woylie declines, remaining as the only high density/high productive woylie population unaffected by the recent declines in Western Australia, the relative security of the population, and as a source for translocations. It is therefore important that monitoring and health surveillance remains ongoing, and that it continues to serve through close collaboration with AWC as the most powerful comparative population available to provide associative evidence for the cause(s) of the woylie declines.

Other populations

The monitoring and health surveillance of other woylie populations in Western Australia and elsewhere remains necessary to develop an understanding of the magnitude and characteristics of the population changes across the species range.

8.2.2. Improved fauna monitoring

Type of monitoring

The vast majority of fauna monitoring conducted by the Department, including *Western Shield* is surveillance monitoring. 'Surveillance' monitoring provides information on the changes of the targeted measures over time (in this case generally native fauna abundance). It does not provide any capacity to associate or explain observed changes with factors that might be causal agents of these changes.

Ecological or informed monitoring includes collecting comparable covariate data that can be used to help explain changes in the targeted measures, such as threatened species abundances. This

DRAFT

additional information can help identify the mechanisms and characteristics of the change (e.g. changes in the rates of loss and recruitment, and population demographics, respectively) and provide associative data that can identify or eliminate the possible cause-effect relationships driving the observed changes.

In the case of the recent woylie declines, the surveillance monitoring was able to detect the changes in woylie abundances but provide limited or no data on the mechanics or associations that might help explain these declines. As a consequence there has been a significant and substantial lost opportunity in the ability to identify the cause(s) of the declines within a timely manner. The ability to rapidly mitigate these declines has been compromised and delayed.

Pragmatically, more informed monitoring is recommended in circumstances where it is considered there are sufficient conservation values and potential risks. For example, this may be merited for fauna populations of critically endangered, endangered or high conservation value and/or where there is reasonable chance or expectation that populations may change over time due to anticipated threatening process or stressors. Similarly areas that support a number of species of high conservation value and/or those subject to significant or multiple pressures should be considered for informed monitoring.

It is therefore recommended that fauna monitoring conducted by the Department be reviewed with respect to the value of improving the quality and type of monitoring undertaken in order to maximise the conservation and management outcomes and to increase the capacity to understand the ecology of these systems better. This remains relevant to many of the activities conducted by the department including species recovery plans, threatened ecological communities, *Western Shield* (predator control, translocations, and species conservation), management activities such as fire and timber harvesting (e.g. FORESTCHECK) and the effects of other factors such as introduced species (weeds and animals), disease (e.g. *Phytophthora cinnamomi*), recreation and climate change, etc.

The Upper Warren Fauna Monitoring protocols established as part of the WCRP provide a highly suitable model for consideration and development of more comprehensive and more informative fauna monitoring.

Target native species

Consider the collection of more detailed data from target species. This includes reproduction, health and condition and potentially reference samples for disease, particularly those that are relatively easy and cheap to collect and store (e.g. scats for endoparasites, ectoparasites, tissue for genetic research) as well as carefully considering the value of collecting other samples for monitoring, collaborative research and/or reference banking (e.g. blood for haemaparasites, haematology and/or biochemistry, and sera for parasites, viruses and other specific diseases.

Predators

As the situation with the woylie declines clearly demonstrates, it is not possible to associate the observed declines that occurred prior to the WCRP with possible changes in the abundance or activity of introduced predators such as the cat and fox. Furthermore, there is no direct means to verify that current predator control programs are effectively reducing targeted predators and not producing undesired responses such as the release of other problematic mesopredators. Without monitoring predators directly it is not possible to be responsive in a timely manner to any potential (foreseen or unforeseen) problems that may occur with predator control. Similarly without monitoring predators it is not possible to efficiently and effectively improve upon the current program. Monitoring of predators within an active adaptive management framework facilitates the capacity for ongoing improvement and the delivery of best-practice conservation and management as well as providing covariate data on a key known threatening process responsible for limiting and/or reducing native species such as the woylie and other threatened mammals.

Other covariates

Comparable covariate data to help explain changes in population of target species may include; diseases, resources, climate, competitors, prey, vegetation structure, health and floristics, etc.

DRAFT

Trigger points and reporting and response protocols

Irrespective of the type of monitoring conducted, in order to gain maximum value from the exercise it is critical to remain up-to-date with possible changes reflected in the data. This maximises the capacity to respond to new and emerging issues in a timely manner. There are several contemporary examples where monitoring data has detected substantial changes but have not elicited a timely and necessary response. In some cases this is a result of databases not being kept up-to-date with monitoring data collected in the field. In other cases the data has not been regularly interrogated. Worse still, in some cases substantial declines have been recognised but this information has not been investigated further or acted upon.

It is recommended that at the Departmental level, the revision or establishment of trigger points and associated reporting and response protocols be conducted. Trigger points (i.e. nominal quantifiable change thresholds) do not automatically necessitate an active response but should serve to alert the need to consider the available information more carefully before considering the need to respond further. In this context nominated trigger points do not need to be particularly precise and help to overcome many of the challenges associated with identifying appropriate thresholds including species specific considerations, and distinguishing 'natural' cycles and normal variation from something different. Data capabilities such as sensitivity measures of the data to detect change also need to be considered.

Obligatory annual reporting of fauna monitoring data would promote databases being kept up-to-date and can systematically address whether species have been observed declining. This could be associated with the annual reporting for Animal Ethics (whether or not the information was reviewed by the AEC or a separate body) given that it is a legitimate assessment of the justification of the fauna work being undertaken. Alternatively, it could be associated with the provision of Licences to take fauna, an expansion of the Science Division Annual Research Activity reporting across the Department or by some other means.

Concise protocols providing broad guiding principles and systems for managing cases when trigger points or problems are recognised would help to ensure that timely, efficient and appropriate responses to new information occur. These would outline who to report to, and who and how the new information should be considered in order to determine how best to respond.

DRAFT

8.3. Conservation management recommendations

8.3.1 Conservation status review

Completion of the review of the conservation status of the woylie considering all of the available data and information available to date is recommended. This review process should include State, Commonwealth and International programs where relevant. The development of effective recovery plans will be a natural and necessary progression if/when the change of conservation status decrees it.

8.3.2. Predator control

Improved efficiencies in the existing fox control program is highly recommended. This will help improve the efficacy of fox control with much of it incurring no or negligible additional costs to the current program. Reduced predation pressure on remnant woylies and other native fauna are clearly the key advantages of this. Operational improvements could include;

- reduce variability in the time intervals between baiting events from the current situation (1-9 months)
- strategic timing of baiting events to increase the efficacy of fox control, e.g. more closely associated with fox biology including when vixens support dependent young and seasonal peaks in dispersal
- clarify the effects of rainfall on bait efficacy and avoid baiting when conditions are likely to be problematic (e.g. heavy rainfall events forecast during or after baiting)
- routinely monitor predator activity/abundance in association with baiting activities within an active adaptive management framework to facilitate continued opportunities for improvement

Further detail is provided in the discussion of the PCS Predator section of this report (Section 4.4) and in this chapter above (‘Section 8.2.2). Some of these changes could be incorporated into the predator control experiment (AAM) discussed above.

8.3.3. Data and information management

Improvements to data and information management include;

- Consideration of the use of the ‘WCRP Operations Handbook’ as a basis for improvement to the protocols and procedures applicable to other programs.
- Keeping databases up-to-date and assessment of the data trends (facilitated by annual reporting obligations).
- Maintaining and developing the aggregated ‘Manjimup Fauna File’ (or equivalent) that functions as the central repository for all fauna data within a discrete geographic area. Progression toward a broader, perhaps single, Department-wide fauna database should be the ultimate aim.
- Improving data quality control through clear protocols and training, data-entry controls within the database, clear data crosschecking and validation procedures to identify and rectify errors.
- Improving data collection efficiency and quality by use of PDAs and software to record the raw data in the field.
- This is addressed in more detail in the ‘Research Recommendations’ section of this chapter (above) and the ‘improved fauna monitoring’ section (above)

DRAFT

8.4 Project management

Any continuation or development of the woylie conservation project will require a review of the project management. This is particularly important given the complexity of the project, the large number of people involved and the substantial 'collaborative capital' that has been established in phase 1. The appropriate project management framework will be dependent on the nature and extent of the support and priorities that are established for phase 2. Once this is clearer, careful consideration of the project management will be fundamentally important to the potential capacity of the project to function efficiently and effectively. Some general points for consideration include

- The WCRP Phase 1 project management framework more closely resembled a rapid (emergency) response model in which there was a high dependency on the generosity and goodwill of internal and external collaborators to contribute substantially (e.g. personnel, resources and intellectual property/expertise) in an informal manner. This has been the singularly most important factor in the success of the project to date. While flexibility remains important, fostering longer-term collaborations depends on ensuring and maintaining a satisfactory and fair balance on the currencies relevant to the collaborations and the mutualisms within in order to avoid over-exploitation.
- Project sustainability is fundamentally important to its success. Adequate personnel to meet the work loads and resources to manage the project in its own right are essential and in addition to those required to directly address the agreed research and management priorities.
- Adequate support and funding for phase 2 will be necessary as part of the woylie conservation response plan development.
- Excellent communication and data and information management between the many collaborating organisations and individuals is particularly important to the ongoing development of good collaborative relationships and project success.
- Media, public information and liaison, and engagement with interested community groups and individuals is particularly important to address adequately.
- Review processes (independent/external and internal) help ensure the project optimises its effectiveness and efficiency in a sustainable manner.

DRAFT

8.5. Species prognosis

Some brief notes on the consideration of the woylie declines within the context of the conservation outlook of the species and the capacity and relevance of the diagnosis efforts:

- The woylie has an excellent reproductive potential.
- The woylie has a proven record for a capacity to recover.
- The woylie is easily monitored (highly trappable).
- The woylie is not an intrinsically or evolutionary rare species (e.g. historic records report high densities).
- Manage the surviving remnant populations in a manner that facilitates their recovery (i.e. minimise manageable pressures (e.g. predation)), and the woylie's intrinsic capacities should be able to do the rest (i.e. species recovery should not in theory be as problematic as it is for other species).
- What keeps a population low may be different from what got them low in the first place – i.e. consider pragmatic indirect approaches – it may be more feasible/effective to manage declined populations rather than efforts to stop the declines.
- Understanding the causes of the declines is central to being able to make the best management decisions – this strategy is the most sound but is only practical if the research can provide reasonable answers within a reasonably short time frame.
- Understanding the cause(s) is necessary, whether or not the declines are 'natural' or due to factors that cannot be directly controlled. Irrespective of this, understanding the causes will have profound consequences on instructing how best to manage the species recovery and conservation in the short to long term. Even if the declines result from factors that may be considered impossible to address directly (e.g. inoculation for disease), there *will* be important and profound ways the risks and other related factors can be better managed that will i) improve the conservation of the species (e.g. quarantine and hygiene protocols (e.g. *Phytopthora*)), ii) determine the relative value of isolated and island populations, iii) the extent to which an emphasis is placed on the recovery of various populations, the establishment of new populations, etc.
- There is an increased vulnerability to population viability when numbers become extremely low (i.e. increased risk of local and species extinction).
- Rapid woylie population recovery is important to minimise genetic loss from bottlenecking etc, which will maximise the long-term conservation prospects
- Severe selective pressure has in all likelihood been imposed given the magnitude of the declines.
- Caution is needed when considering numbers of survivors without consideration of the genetic / longer-term conservation value (i.e. Dryandra, UW, Tutanning and translocated populations founded on large numbers / high genetic diversity) – i.e. there are some large populations with limited genetic/conservation value (e.g. some SA islands) that now constitute a substantial proportion of the survivors.
- The woylie declines provide an excellent model that will assist other species recoveries and decline diagnoses – probably the best marsupial available.
- National and International significance to decline diagnoses, species conservation and management, fauna monitoring, introduced predators and their control, wildlife disease and health surveillance, human health implications (zoonoses), and new and emerging diseases, etc.

DRAFT

8.6. References

Caughley, G. 1994. Directions in Conservation Biology. Journal of Animal Ecology **63**:215-244.

Lee, K. N. 1999. Appraising adaptive management. Conservation Ecology **3**:3.

Walters, C. J., and C. S. Holling. 1990. Large-scale management experiments and learning by doing. Ecology **71**:2060-2068.

Thylacinus cynocephalus, 'Head of a Male' by John Gould, in *The Mammals of Australia* 1863

Lest We Forget