WOODLAND RESERVE, WHITEMAN PARK - A CASE STUDY IN THE CONSERVATION VALUE OF POST-CARE ANIMALS

Dr Chris Rafferty[1] and Dr Carlo Pacioni[2]
1 Whiteman Park, Lot 99a Lord Street, Whiteman, Western Australia
Email chris.rafferty@planning.wa.gov.au

2 Murdoch Univerisity, School of Biomedical Sciences and Biotechnology, Murdoch, Western Australia
Email C.Pacioni@murdoch.edu.au

Woodland Reserve at Whiteman Park is a 50 hectare protected woodland on the Swan Coastal Plain. The Reserve, which aims to 'recreate the natural biodiversity of the region', is surrounded by a predator proof fence and fire suppression system. In early 2010, a small number of rehabilitated and captive raised woylies were introduced to the Reserve. These were deemed unsuitable to rejoin their wild counterparts and sent to the Reserve to trial how they would cope in a new habitat. After 15 months, further individuals of varied origin were introduced to supplement the initial colony, which was proving very successful. In just over two years, Woodland Reserve has established a colony which has potential to become an insurance population, contributing to the conservation and management of this critically endangered species. It also is a suitable release site for locally endemic, displaced post-care fauna due to its metropolitan location.

Aware that small, enclosed populations are exposed to a number of factors that may jeopardise their long-term viability, the Park enlisted the assistance of a geneticist to help formulate an adequate management plan for the resident woylies. Working towards 'acceptable' levels of genetic variability for macropods, it was found that careful selection of breeders may potentially maintain acceptable levels of genetic diversity for a period of ~10 years.

The results of genetic analysis support the current plan to increase the size of the Reserve from its current 50.5ha to 200ha in 2013. The planned expansion doubles the length of time at which the colony would maintain a heterozygosity (H_E) of at least 70% (which is generally considerate an acceptable level in macropods). In addition, the analysis suggests that the development of a program of regular supplementation of unrelated animals would result in further improvements in colony viability, which is a Reserve management priority over the next five years.

The Woodland Reserve project demonstrates that post-care fauna can contribute to both regional biodiversity and species conservation if managed correctly, despite the potential behavioural and physiological negative impact of captivity (e.g. imprinting). The key to their success, however, is prompt and effective management to reduce inbreeding. Adequate record keeping and resources to adequately house and prevent breeding will assist with these issues. Importantly, increased support from government conservation agencies for carers is vital to guide and support correct management of wildlife during the rehabilitation process.

Introduction

Whiteman Park receives rehabilitated woylies (*Bettongia penicillata*) from a number of sources throughout the state. The source populations of these woylies are not always

known and records of origins are limited. While the received woylies, and consequently the population being established, are not of primary conservation concern (i.e. there is no plan to release these animals back into the wild), it is a management intention of the Park to maintain a viable woylie population. As such, Woodland Reserve presents an optimal environment to test and validate management actions in order to maximise the conservation outcome of a semi-free range population of macropods.

Small, enclosed populations are exposed to a number of factors that may jeopardise their long-term viability and conservation value. These make them vulnerable to stochastic events, susceptibility to epidemics and loss of genetic diversity due to inbreeding and genetic drift. Adequate management plans can attenuate the effect of the latter. The development of a successful plan, however, depends on 1) the availability of accurate baseline data; 2) the establishment of clear and realistic objectives; and 3) the verification of planned achievements and implementation of corrective measures as required. This study dealt with points 1 and 2 by generating genetic data for the woylie population at Whiteman Park and calculating a number of genetic parameters, including measures of genetic diversity and individual relatedness. To further refine the development of a management plan, population viability analysis (PVA) was conducted to test different management options.

Methods

Woylies were trapped using standard wire traps. The weight, gender and reproductive status were recorded. Individuals were identified by implanting a microchip and ear tags. At the time of sampling, Whiteman Park (WMP) had received woylies from two sources; Chidlow Marsupial Hospital (Chidlow MH), believed to be from Karakamia Sanctuary stock; and Wellard, whose woylies were of unclear origin. Wellard stock was believed to be either from Dwellingup (a translocated population from Dryandra woodland) or Collie (a translocated population from Perup). The two different stocks were kept in two separate enclosures. Animals from Chidlow MH were housed in the Soft release enclosure (~1ha) and Wellard stock was housed in the Woodland reserve (~52ha). Details of molecular work and analysis are provided elsewhere (Pacioni 2011, Pacioni 2012, unpublished). Descriptive measures of population genetic diversity and relatedness for all captured animals were calculated and compared to data of other indigenous and translocated populations (Pacioni 2012, unpublished).

For analysis, carrying capacity was set to 15 woylies for the Soft release enclosure (note that WMP supplement food to woylies in this enclosure) and 70 woylies for the Woodland reserve. WMP plans to expand the Reserve adding 150ha (giving a total of ~200ha with an estimated carrying capacity of over 200 woylies). Three scenarios were formulated and population viability analysis (PVA)was used to examine the benefit of animal movement and/or introductions of new animals. These three scenarios were:

Scenario 1. The two sub-units (Chidlow MH and Wellard) were kept separate in the Soft release and Woodland enclosure respectively. For Wellard stock only, the effect of changes in K (carrying capacity) to reflect the hypothesis that woylies may use the whole Reserve after the first year (i.e. the area would increase from 52ha to 200ha) was also considered.

Scenario 2. Surplus animals from Chidlow MH (calculated as 30% of males and 5.8% of females) were moved, once a year, into the colony in Woodland reserve, which was initially established with Wellard stock.

Using the genetic data available, a third scenario was generated:

Scenario 3. A selection of breeders was used to give the Woodland reserve colony the best possible genetic make up (and at the same time, limit the co-presence of highly related individuals). Again, the effect of changes in K was also considered as described above.

Results

Each enclosure had a relatively low genetic variability. This was expected since only a few animals were actually caught in the wild and some of the founders of WMP colonies were offspring that were born at the rehabilitation centres. However, when combined together, the two colonies had a genetic diversity that was comparable to that commonly found in other macropods (Pope et al. 2000). Individual heterozygosity, however, ranged from 27.3% to 91.7%, suggesting a high level of inbreeding in some individuals.

On average, the relatedness of woylies within each colony was equivalent of half-siblingss or above, confirming the expected high level of inbreeding ($p <= 0.001$, Figure 1). The Hierarchical Cluster analysis showed a clear 'family' relationship with two major groups in each colony. In the Soft release enclosure, the paternity analysis identified with 95% confidence, the father of 12 of the 14 woylies that were born at WMP (Table 4). The data indicates that the (supposed) dominant male sired 64% of the offspring, with the other two candidates siring 21% and 7% of the offspring.

The selection of breeders based on the genetic data generated from this study (Scenario 3) proved to be an advantageous strategy. The genetic diversity of this theoretical colony resulted to be higher and more stable than what would be obtained under the Scenario 1 and 2. The increase of the size of the reserve would further slow down the rate of genetic loss due to genetic drift and supplementing 10 animals once a year would virtually stop the genetic decay of the colony. None of the scenarios analysed had a probability of extinction (PE) of more than 2%, except the Soft release colony under the Scenario 1 and Scenario 2 where PE was equal or more than 50%.

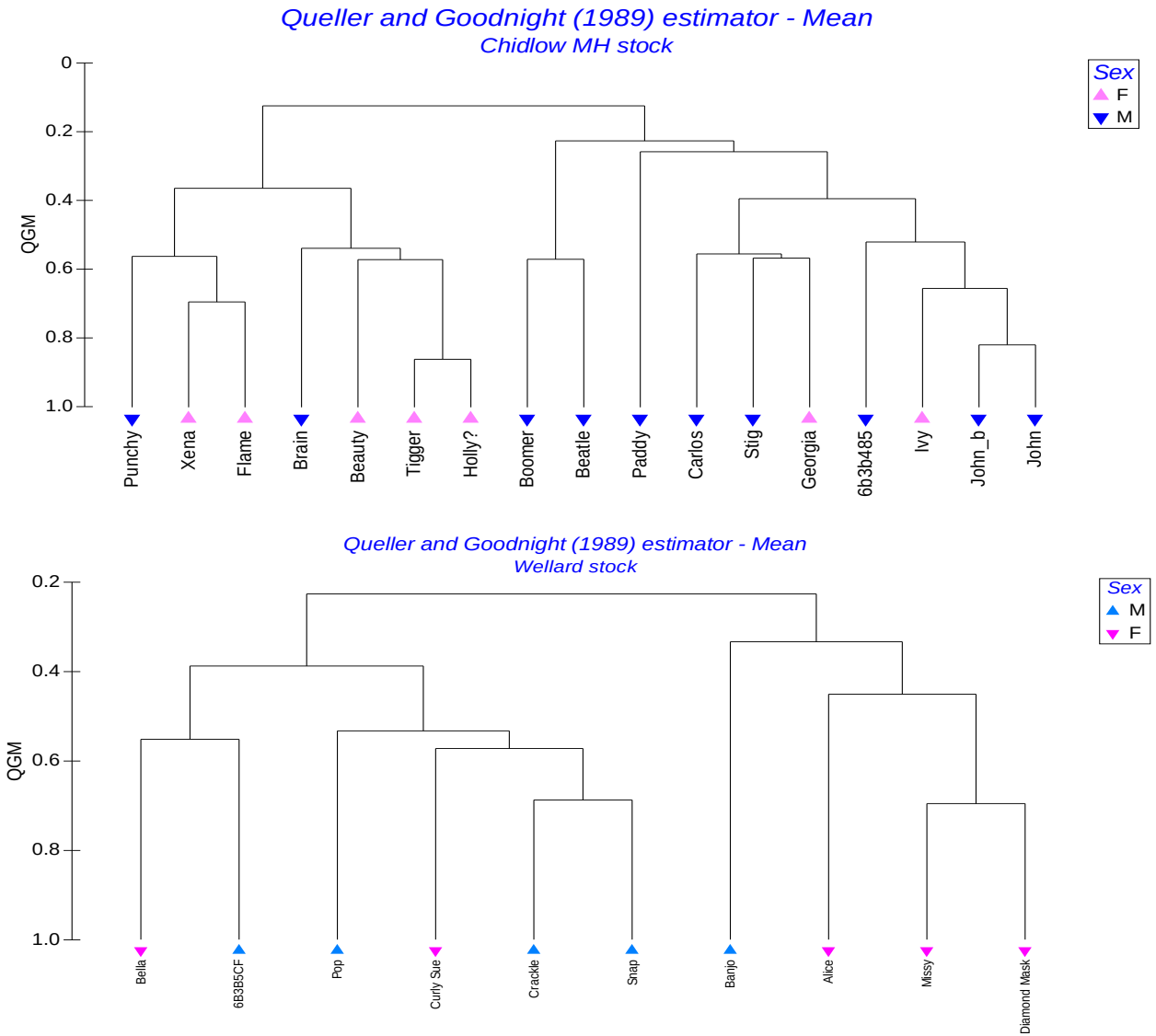

Figure 1 Hierarchical Cluster analysis of the pairwise QGM matrix within each colony (Nodes represent the mean between clades)

DISCUSSION

Genetic viability of a population is vital to guarantee the conservation value of the population, particularly when it is of limited size as occurring in a semi-free range or captive population. Management actions should aim to maintain genetic diversity at similar levels to wild populations.

The possibility of selectively moving animals between the two enclosures offers a clear benefit in terms of the genetic diversity of the colony and represents a recommended management action. In a way, the colony generated under Scenario 3 represents the 'net' benefit of having conducted this study. A H_E of ~70% is generally considered acceptable in macropods species (Pope et al. 2000) and considering this threshold, the only scenario where a woylie colony at WMP reached such a value is in Scenario 3. Increasing the size of the reserve available to the colony is, by all means, a well-founded investment. Under this scenario, the woylie colony almost doubles the time at which it is at a H_E>=70%. The combination of this action with the supplementation of additional individuals from external sources is a promising plan. Of course, due consideration needs to be given to potential risks associated with such practise (e.g. disease transmission).

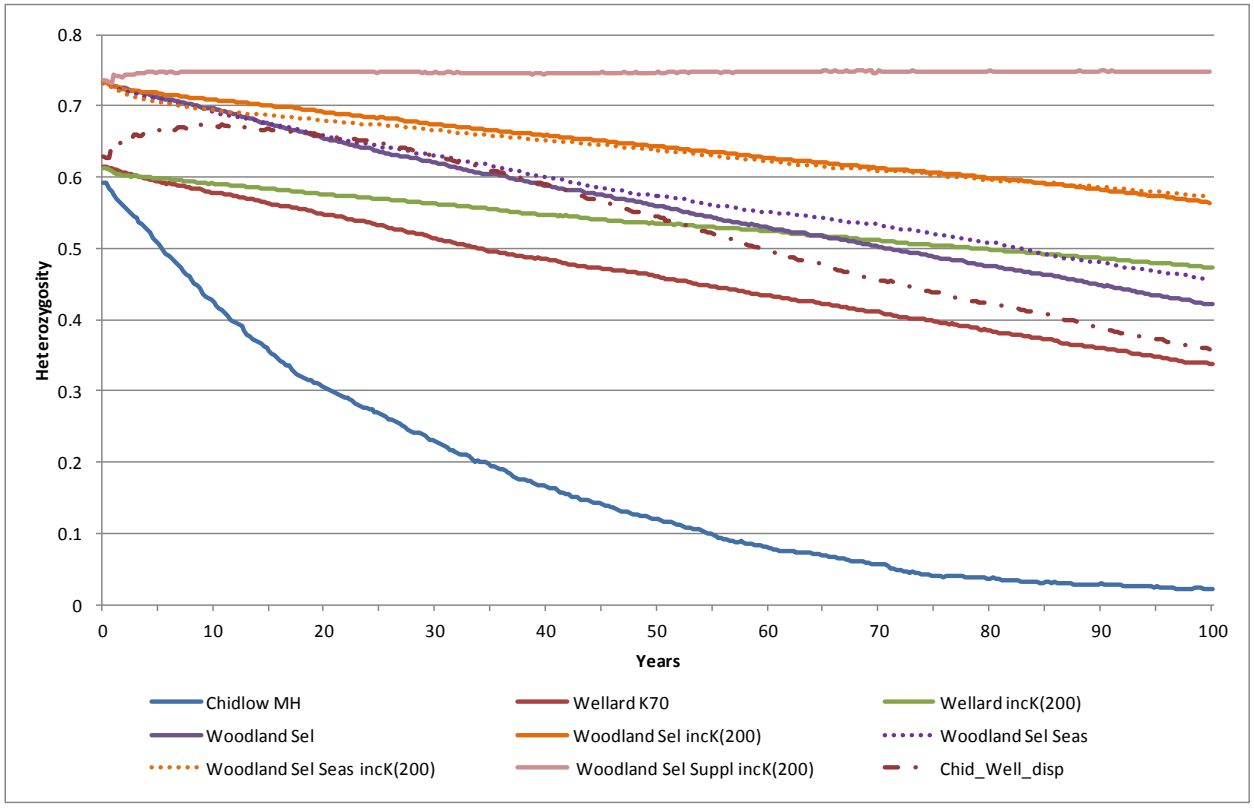

Figure 2 Trends of genetic diversity (measured as heterozygosity) over time in different PVA scenarios. Abbreviations listed in Table 1

Table 1 Abbreviations of PVA scenarios for Figure 2 and their brief description

Scenario	Description
Chidlow MH	Scenario 1 Chidlow MH stock
Wellard K70	Scenario 1 Wellard stock
Wellard incK(200)	Scenario 1 Wellard stock. K increases to 200 after the first year
Chid_Well_disp	Scenario 2
Woodland Sel	Scenario 3. Selection of breeders in the Woodland reserve
Woodland Sel incK(200)	Scenario 3. Selection of breeders in the Woodland reserve. K increases to 200 after the first year
Woodland Sel Seas	As for Woodland Sel, but reproduction is seasonal
Woodland Sel Seas incK(200)	As for Woodland Sel, but reproduction is seasonal and K increases to 200 after the first year
Woodland Sel Suppl	As for Woodland Sel, but the colony is supplemented with ten individuals once a year
Woodland Sel Suppl incK(200)	As for Woodland Sel, but the colony is supplemented with ten individuals once a year and K increases to 200 after the first year

The results indicates that the Soft release enclosure has a limited (if any) contribution to the conservation value of the woylie population at WMP, other than providing the initial founders of the colony in the Woodland reserve enclosure. In fact, the Soft release colony will lose quickly genetic diversity due to genetic drift and, in only five years, it will be genetically 'poor'. Additionally, the high density already reached in this enclosure poses a problem for WMP managers. When at high density, woylies, especially males, display an aggressive behaviour, which can result in some animals being wounded or the access to resources (e.g. food or suitable nesting sites) being restricted. These issues pose an ethical problem and may be challenging for the public. It is needed, therefore, some sort of control of numbers of woylies housed in this enclosure. While the educational value of this colony is recognised, neutering of all males in the Soft release enclosure is recommended. This would stop the increase of the size of the population and, at the same time, the genetic profile of the colony would still be available through the reproduction of females that can return to be active breeders if moved into an external enclosure with active males.

In conclusion, this study provided evidence that the WMP population, in the short term, can potentially have a conservation role for the species. Moreover, a carefully designed supplementation program should be integrated in the management strategy of this population. This would have a double effect: to extend the time at which the population would be genetically viable, and to contribute to the development of an effective supplementation protocols that could be transferable to other populations and possibly even

to other species. The study also highlights the importance of appropriate and prompt actions when managing post-care rare and endangered species - *quality* of individuals is just as, or even more so, important than *quantity* - this should be a consideration for all carers and conservation agencies.

Acknowledgements

We are grateful to the staff of Whiteman Park for their ongoing support of the project. Thanks to Professor Stephen Davies, Alison Dugand and Chidlow Marsupial Hospital for their assistant in the development of Woodland Reserve. Thanks also to Peter Spencer for facilitating access to the Wildlife Genetic Lab at Murdoch University and Malcolm Kennedy for comments on early draft of this report and Sarah Stevenson for assistance proofing the final draft.

References

Armstrong D, Jakob-Hoff R, and Seal US 2003. Animal movements and disease risk. IUCN/SSC Conservation Breeding Specialist Group, Apple Valley, MN.

Pacioni C 2010. The population and epidemiological dynamics associated with recent decline of woylies (Bettongia penicillata) in Australia. PhD thesis. Murdoch University.

Pacioni C. 2012. Unpublished. Integrating genetic data in the development of the management plan for the woylie population at Whiteman Park.

Pope LC, Estoup A, and Moritz C. 2000. Phylogeography and population structure of an ecotonal marsupial, *Bettongia tropica*, determined using mtDNA and microsatellites. Molecular Ecology **9**:2041-2053.

Queller DC, and Goodnight KF. 1989. Estimating relatedness using genetic markers. Evolution **43**:258-275.

DR CHRIS RAFFERTY AND DR CARLO PACIONI: Chris Rafferty has been the Land and Environment Team Leader at Whiteman Park since 2007. Having completed her double major in Zoology and Botany in 1998 at the University of WA, she returned to study macropods in her honours year. This research led to work in the Australian and Native Species Breeding areas at Perth Zoo. Upon receiving a post graduate scholarship, Chris completed her PhD on macropod herbivory in 2005. She then worked with the Botanic Gardens and Parks Authority and later in the arid zone of the north west as a Disturbance Ecologist.

Over the past three years, Chris has led the development of the Woodland Reserve project at Whiteman Park. As a wildlife carer for over fifteen years, Chris was excited by the prospect of developing the long planned feral proof Reserve. With the assistance of small team of highly dedicated environment staff and volunteers, the Reserve, officially opened in March 2010, now has a thriving population of the critically endangered woylie. The protected area is planned to quadruple in 2012, allowing for greater development of the Park's endangered species breeding program.

Carlo Pacioni is a research officer at the Department of Agriculture and Food, Western Australia (Vertebrate Pest Research Section). In addition, he is also actively involved in applied research for wildlife conservation with Murdoch University, where he holds a part-time research fellow position. As part of his PhD (Murdoch University, 2011), Carlo investigated several aspects of woylie ecology using molecular based approaches, conducted population viability analysis and health and disease investigations in woylie wild populations. He had previously completed the Master in Conservation Medicine at the same university.

Before arriving in Australia in 2005, he had completed his degree in Veterinary science at the University of Perugia (Italy) in 2000, volunteered in different Wildlife Rescue Centres in Spain, Argentina and Australia; completed several training at different Universities (UAB, Spain: Veterinary Hospital; LMU, Germany: Surgery Clinic) in internal medicine, neurology, surgery, radiology and exotic animal medicine and was the veterinarian Zoo of Saenz Peña (Complejo Ecologico Municipal Saenz Peña, CEMPS), Argentina.