

**A proposal for translocation of the western ringtail
possum, *Pseudocheirus occidentalis*, an arboreal
marsupial endemic to the south-west of Western
Australia**

February 2005

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Summary

This translocation proposal seeks approval for a series of translocations of the western ringtail possum, *Pseudocheirus occidentalis*. The possums proposed for translocation are those which:

- (i) will be displaced as a result of developments approved by local government and relevant State Government agencies and where such developments will result in habitat fragmentation and/or habitat destruction. These translocations will only be carried out where:
 - (a) in the opinion of staff from the Department of Conservation and Land Management (CALM), there is no practicable alternative to translocation and no better conservation outcome can be achieved;
 - (b) the proponent of the development has been given formal approval from CALM to have the possums relocated;
 - (c) the proponent has agreed to meet the full cost incurred by CALM for the relocation and has agreed to contribute to the costs for monitoring at the translocation release site;
 - (d) the development proponent has sought and been given translocation approval from the Commonwealth of Australia, consistent with the Environmental Protection and Biodiversity Conservation Act (EPBC Act), or where the Commonwealth has deemed such approval is not required; or
- (ii) have been held and/or rehabilitated by wildlife carers and are considered suitable for release, as determined by the health screening and health monitoring protocols outlined in this proposal.

The translocations should be seen a combination of re-stocking (of previous translocation release sites) and re-introductions, as per IUCN criteria and definitions (IUCN, 1987). All translocations are proposed as experimental translocations, as previous translocations of the western ringtail possum are yet to demonstrate translocation success. The major objectives of the translocations are to determine whether the western ringtail possum can be successfully translocated and, if so, to determine the conditions required to achieve translocation success.

The proposed translocation release sites are initially at Leschenault Peninsula Conservation Park and Martin's Tank (within Yalgorup National Park). These translocations have commenced under interim approval and have been dependent on funds obtained from the proponents of developments which result in western ringtail possum habitat destruction and/or loss. Monitoring has focussed on survivorship, reproductive success, habitat use and home range of the translocated possums and will also incorporate assessment of the extent and importance of competition between the western ringtail possum and the common brushtail possum, *Trichosurus vulpecula*. In the absence of continuity of funds, monitoring will cease at 30 June 2005 and the fate of released possum will be unknown.

Additional funding has been sought from CALM and the Commonwealth's Natural Resource Management (NRM) program to enable translocations and monitoring to be expanded to sites at White Hill, Preston Beach and Crampton Nature Reserve. White Hill and Preston Beach are both within Yalgorup National Park and are both former translocation release sites baited for fox control. Crampton Nature Reserve is proposed as an unbaited (control) site. If the funding application is successful, monitoring will be expanded to these additional sites and will focus on determining survivorship probability and causes of mortality, reproductive success, dispersal patterns of young, home range and habitat use. Monitoring will also assess the relative importance of fox control/fox predation, cat abundance/cat predation, predation by the suite of native predators, prey switching, habitat variables and competition with the

common brushtail possum. A seven year time frame is proposed for completion of this work, commencing July 2005.

Similarly, and in conjunction with Murdoch University, the University of Sydney and the University of Wales-Bangor, additional funding has been sought through the Australian Research Council (ARC) for an ARC Linkage program. If successful, the ARC Linkage program will support a PhD student to undertake health/disease monitoring research. The PhD program will focus on health and disease monitoring of extant, naturally occurring populations of the western ringtail possum and the common brushtail possum and will also examine the importance of disease and health issues to translocation success for animals taken directly from the wild (from development sites) and animals released ex wildlife carers. The proposed locations for monitoring extant populations of the western ringtail possum and the common brushtail possum are a reserve vested in the Shire of Capel and at Tuart Forest National Park (and surrounding state forest, Ludlow) where both possum species occur sympatrically. An additional naturally occurring population of the western ringtail possum will be monitored at Locke Nature Reserve. Monitoring of these naturally occurring populations will provide base-line information on the health/disease status of both possum species, survivorship and habitat use information, the extent of competition between the western ringtail possum and the common brushtail possum and population trends of the two species. The data collected will enable population modeling to assess the probability of persistence of both species.

This translocation proposal should be seen as complementary to a concurrent proposal which is seeking funds to examine the spatial distribution, abundance, demographics, population genetics of the western ringtail possum and the effect of habitat and population fragmentation. The concurrent proposal will enable populations and habitat of high conservation value to be identified. Consequently, planning decisions relating to development applications can be based on a better understanding of the issues important to western ringtail possum conservation. Specifically, this will enable CALM to provide a more informed response to local government, other WA State Government agency requests and requests by the Commonwealth (through the Department of Environment and Heritage, DEH) on development proposals which have the potential to modify and/or destroy western ringtail possum habitat and fragment populations.

The translocation proposal incorporates the constructive comments received from two referees, Dr Per Christensen and an unknown referee.

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1. Background

1.1 Distribution and conservation status

At the time of European settlement, the western ringtail possum, *Pseudocheirus occidentalis*, had a distribution which encompassed the south-west of Western Australia and extended from north of Jurien, to the south-west of Western Australia and east to the Esperance Plain (de Tores, unpublished). As recently as the 1970s the distribution included Wheatbelt areas near Pingelly (de Tores, unpublished; Jones *et al.*, 1994). Although there are recent unconfirmed reports of western ringtail possum presence from the Pingelly area, from Sawyers Valley/Mundaring and from the Darling Scarp near Jarrahdale, the distribution is now thought to have contracted to the south-west corner of Western Australia, with the most northerly confirmed record of occurrence (exclusive of translocated populations) in jarrah/marri forest and peppermint riverine habitat northeast of Harvey (de Tores, unpublished).

Additional unconfirmed records of western ringtail possum presence have been reported from the Geraldton area (Peter Mawson pers. comm.). These reports are currently subject to investigation and, if confirmed, represent a significant extension, or more specifically, represent significant outliers to the known distribution of the western ringtail possum.

The recent review of distribution and conservation status (de Tores, unpublished) found the western ringtail possum met the IUCN (World Conservation Union) criteria (IUCN, 2001) for listing as a threatened species in the sub-category "Vulnerable". If presence of the western ringtail possum is confirmed at the above reported locations, it will provide significant outliers to the population, but is unlikely to change the species' conservation status.

1.2 History of previous western ringtail possum translocations

Despite being listed as a "threatened" species, the western ringtail possum is locally common in the Busselton area of south-west Western Australia. Orphaned, injured and "nuisance" western ringtail possums are regularly brought into care and nurtured and/or rehabilitated by wildlife carers. Historically, when the wildlife carers decided these possums were suitable for release, the animals were "provided" to the Department of Conservation and Land Management (CALM) and released as part of a translocation and monitoring program. Many were not "provided" to CALM and were released, and continue to be released, in an *ad-hoc* un-monitored manner. The latter has not been sanctioned by CALM. The pre-release health and disease status and subsequent fate of these released animals are unknown.

In the Busselton area in particular, local and State Government approved developments have resulted in fragmentation and removal/destruction of western ringtail possum habitat. Resident populations of western ringtail possums are regularly displaced as a result of this habitat fragmentation and habitat loss. If unchecked, this habitat fragmentation will present a major threat to the western ringtail possum.

Existing known threats to the species include (de Tores, unpublished; Wayne *et al.*, 2000):

- population fragmentation through urbanisation and development in the Busselton, Bunbury and Albany areas;
- predation from introduced predators;
- increased predation in the presence of timber harvesting operations; and
- climate change.

Translocation has been adopted as a management strategy to mitigate the effects from habitat clearing. However, results from translocation have been equivocal. Translocations of the western ringtail possum have been carried out by CALM since 1991. A total of 381 western ringtail possums was translocated to four release sites in the period 1991 to 2001.

Of these, 106 rehabilitated possums, ex wildlife carers, were released at Leschenault Peninsula Conservation Park in the period from 1991 to 1997; 142 were sourced directly from the wild (development sites, where habitat was destroyed), and released at Yalgorup National Park (two sites) in the period 1995 to 2001; and 133 were rehabilitated possums, ex wildlife carers, released at Lane Poole Reserve/Keats forest Block in the period 1996 to 1999 (various unpublished data and de Tores *et al.*, 1998; de Tores and Rosier, unpublished; de Tores *et al.*, unpublished-a; de Tores *et al.*, unpublished-b). The total number of translocated possums is thought to represent only a relatively small proportion of the number of western ringtail

possums relocated, as many more rehabilitated ringtails have been released by wildlife carers as part of unsanctioned and un-monitored translocations.

All CALM sanctioned translocations were to release sites baited for fox control (dried meat baits impregnated with the toxin sodium monofluoroacetate, or 1080). All sites were monitored as funds permitted.

Each release site has shown some level of translocation success. However, the full criteria for translocation success have not been met at any site. Recent monitoring results from the primary release site, Leschenault Peninsula Conservation Park, confirmed this population declined to a level where extensive survey effort was required to confirm western ringtail possum presence (de Tores *et al.*, 2004b).

Changes to the 1080 baiting regime, specifically lapses in the baiting effort, a reduction in the number of baits delivered and a change to burying the baits, was proposed as the most parsimonious explanation for the decline at Leschenault (de Tores *et al.*, 2004b; de Tores *et al.*, unpublished-b). However, fauna declines are unlikely to be the result of a single dimensional causal factor, such as predation (de Tores, unpublished) and this no doubt also applies to translocation failure. Alternative hypotheses proposed as possible causes for the translocation failure at Leschenault include competition with the common brushtail possum, *Trichosurus vulpecula*, predation by cats and/or chuditch and/or pythons, drought, unsuitable habitat, wildlife health related issues, presence of disease (toxoplasmosis has been confirmed in the ringtail population at Yalgorup) and prey switching (rabbit control has been conducted concurrently with fox control at Leschenault and has resulted in an observed, but unquantified, decline in rabbit abundance. With this decline there is the possibility of prey switching by the suite of introduced and native predators and the potential for increased levels of predation on the western ringtail possum) (de Tores *et al.*, unpublished-b).

Post-hoc analyses using DISTANCE sampling techniques (Buckland *et al.*, 2001; Thomas *et al.*, 2002) of data from spotlight transects at Leschenault (1996 - 1998 and 2002) and Yalgorup (2002) identified increases in brushtail possum and western ringtail possum density at Leschenault in 1996-1998, and an additional, but small increase in density in brushtail possums in the period 1998-2002 (the period when the western ringtail possum declined at Leschenault) (de Tores and Rosier, unpublished; de Tores *et al.*, unpublished-b). Further analyses also indicated partitioning of the nocturnal foraging habitat by the two species (de Tores and Rosier, unpublished; de Tores *et al.*, unpublished-b). These results combined, suggested competition with the brushtail possum alone was unlikely to have been responsible for the western ringtail possum decline at Leschenault (de Tores *et al.*, 2004b).

Additional translocations of displaced western ringtail possums have taken place in 2004. These translocations have been necessitated by the requirement to relocate western ringtail possums displaced by developments which have removed western ringtail possum habitat. The releases were at Leschenault Peninsula Conservation Park (where monthly baiting was re-instated) and an unbaited control site established within Yalgorup National Park.

A subset of 20 of the 68 western ringtail possums released at Leschenault has been radio-collared and monitored. Interim results have demonstrated a higher rate of predation-caused mortality at the baited site, with five mortality events attributed to predation by pythons, five attributed to predation by cats, one attributed to predation by a fox/cat? and one attributed to predation by fox. Sixteen of the 17 released ringtail possums at the unbaited Yalgorup site have been radio-collared and there have been only two predation events, one attributed to a raptor and one to a fox.

1.3 Disease/wildlife health

Disease is often overlooked as a potential agent of population decline (Caughley and Gunn, 1996) and infectious diseases can result in significant declines of wildlife at the local population level and at the species level (Caughley and Gunn, 1996; Daszak and Cunningham, 1999; Spielman, 2001). Disease poses an additional threat to wildlife populations already at risk from threatening processes and in some situations may be the final factor responsible for driving a species to extinction.

In particular, introduced diseases can have a detrimental effect on naïve wildlife populations when trans-species infections occur from infected reservoir hosts. Wildlife species known to have suffered significant population declines associated with infectious diseases include African buffalos (*Syncerus caffer*), black-footed ferrets, *Mustela nigripes*, (canine distemper virus); the heath hen, *Tymphanuchus cupido cupido* (by blackhead), the Indian wild ass, *Equus hemionus khur* (by surra and African horse sickness), amphibian species

(chytridiomycosis); lions, *Pantera Leo*, (canine distemper virus); and African wild dogs, *Lycaon pictus*, (rabies, canine distemper virus) (Caughley and Gunn, 1996; Daszak and Cunningham, 1999; Daszak *et al.*, 2000).

There are potentially significant disease risks associated with wildlife translocation programs. Woodford and Rossiter (1994) outlined the disease risks which should be considered by conservation managers when undertaking a translocation project. The risks for each translocation project will vary depending on the type of animal and epidemiological situations at the founding source location and release destination (Woodford and Rossiter, 1994). Capture, transport and quarantine are stressful events for wild animals and stress in such animals can result in immunosuppression, increased susceptibility to infection and recrudescence of latent disease (Woodford and Rossiter, 1994).

There are two aspects of disease transmission which must be considered for translocation projects. Conservation managers must ensure the wildlife species being translocated, especially those originating from captivity, do not introduce novel pathogens to naïve populations of wildlife at the release site (Warren *et al.*, 2003; Woodford and Rossiter, 1994). Conversely, they also need to be aware that resident native and introduced animals inhabiting the release site may carry pathogens to which the released animals have had no previous exposure. Infection with such pathogens could adversely affect the survival of the released animals (Woodford and Rossiter, 1994).

1.4 Issues

The ongoing requirement to clear land for housing and industry in the greater Busselton area will continue to result in habitat loss and displacement of resident populations of the western ringtail possum. There will be a continued need for land use planners and wildlife managers to address the conservation management issues associated with this habitat loss. Although translocation has been identified as a possible management option for displaced and rehabilitated possums, translocations are yet to be shown to result in sustainable populations at the release sites.

Monitoring of translocations to date has been opportunistic (i.e. as funds permitted) and has lacked a strategic approach whereby the suite of factors potentially limiting translocation success can be objectively assessed. Although there are sufficient published data to suggest the western ringtail possum is highly susceptible to predation by foxes (see for example Augee *et al.*, 1996), the importance of other factors in terms of translocation success has not been determined. Specifically:

- (1) There are no base-line data on the disease status of western ringtail possum populations in the wild. During previous translocation procedures the pre-release health status was not assessed. There was no identification or investigation of any disease conditions resulting from holding rehabilitated possums "in care" for short or extended periods. There has been no comparison of survivorship and long-term health status of rehabilitated possums and possums translocated directly from the wild.
- (2) Toxoplasmosis was identified on post-mortem examination of a ringtail possum recruited to the translocated population at Yalgorup National Park. The animal showed neurological signs following routine capture for radio collar replacement. The possum was not released due to its clinical condition and was taken into captivity for care. It failed to respond or show any evidence of recovery. It was subsequently euthanased and the presence of Toxoplasmosis confirmed. The prevalence of toxoplasmosis in ringtail possums in Yalgorup National Park and the other release sites remains unknown. The prevalence of toxoplasmosis in feral cat populations at each of the release sites is unknown.
- (3) The influence of the suite of site specific habitat factors has not been assessed.
- (4) The effect of competition, should it exist, between the western ringtail possum and the common brushtail has not been rigorously assessed.
- (5) An episodic event of predation of western ringtail possums by pythons, *Morelia spilota imbricata*, has now been confirmed at the Leschenault Peninsula release site. It is unclear if this episodic event is a result of increased python abundance, learned behaviour, or seasonal predation patterns. Similarly, it is not known if on-going predation by pythons, should it occur, will jeopardise translocation success, or if these effects can be ameliorated by the timing of translocation releases.
- (6) The potential for cat populations to increase in the presence of fox control (meso-predator release) has not been assessed. Anecdotal accounts have reported such

increases, however, no unequivocal data are available to support this assertion. Even if such changes in cat abundance do occur, these changes cannot be assumed to equate with an increase in the net level of predation of the translocated species, or other *in-situ* species.

- (7) There are no data available from this study, or other translocation studies, to differentiate between individual animals responsible for predation events. The frequency of predation events of western ringtail possums at the Leschenault Peninsula release site since January 2004, combined with the spatial pattern of the retrieved carcasses and the nature of the predation events (i.e. predation attributed to a cat) suggests four of the five mortality events attributed to predation by cats, may be the result of predation by one cat. If this is the case, it provides managers with a very different long-term problem from that posed by an increased rate of predation resulting from an increase in cat abundance.
- (8) Wildlife carer records for the ten year period 1994 to 2003 revealed an average of 123 western ringtail possums per year had been handled by one carer alone. Only a small proportion of these animals has been passed on to CALM for release as part of the formal release programs at Leschenault, Yalgorup and Lane Poole Reserve. This suggests there is a very large number of ringtails “passing through” the wildlife carer network and released in unsanctioned translocations. The fate of these animals is unknown. The conservation value of releasing animals, post rehabilitation and/or post being held in care for other reasons, can only be assessed if releases are monitored.
- (9) The genetic structure of wild populations of the western ringtail possum is unknown. Specifically, there is no information on mating systems, population sizes, gene flow and the effect of population and habitat fragmentation. Similarly, the genetic structure of the founding stock used for translocations and the genetic structure of the establishing populations at translocation release sites are not known.

2. The translocation

2.1 General

The release and monitoring program is proposed to build on the results from previous translocations to Leschenault Peninsula Conservation Park and Yalgorup National Park (de Tores *et al.*, 2004b). Translocation releases and monitoring re-commenced in 2004. These translocations were sanctioned under interim approval from the Department of Conservation and Land Management and were deemed necessary as a result of habitat destruction from developments in the Busselton area.

Eighty two western ringtail possums were relocated from three development sites in the period 13 January to 17 July 2004, with an additional three rehabilitated ringtails, ex wildlife carers, released in August 2004. Capture, relocation and monitoring of these displaced and rehabilitated ringtails has been undertaken by Paul de Tores (CALM, Science Division), Jennifer Jackson (CALM, Science Division, employed since January 2004 on a casual basis) and Ian Bertram (a Masters student from the University of Glasgow, Scotland, based at CALM’s Wildlife Research Centre, Woodvale for the period July 2004 to June 2005). The continuity and intensity of monitoring has again been determined by the amount of funds available from developers.

Translocations and longer-term monitoring are now proposed through an integrated program structured in an active adaptive management framework, whereby monitoring (performance evaluation in a research context) is used to trigger changes to management (Possingham, 2001). If sufficiently funded, monitoring will address the issues of mesopredator release and intraguild predation. Mesopredator release is defined as an increase in the abundance of subordinate predators following the removal of a dominant predator which previously held the subordinate species in check (Soule *et al.*, 1988). Such an occurrence may constitute one link in a larger trophic cascade. Intraguild predation is a combination of competition and predation and is the killing of one species by another species where both species use similar, often limiting, resources (Polis *et al.*, 1989). It is different from “classical predation” as the act of intraguild predation reduces potential exploitation competition (Polis *et al.*, 1989).

The proposed translocation program is innovative as it advocates development and use of novel “contact” telemetry for monitoring of predator and prey species. The use of contact telemetry will also enable examination of the issues of mesopredator release and intraguild predation. Contact telemetry utilises a technology whereby a data logger is incorporated into the radio-tag circuitry. The data logger records when two tags (radio-collars) come in contact with, or are within close proximity of, each other and records the identity of the two tags (i.e.

the two individual animals) in contact. The data logger also records the time of the contact event. For example, when a western ringtail possum (wrpl) is in contact with a radio-tagged cat (cat1), the contact event is recorded and the data is downloaded when the tag is subsequently recovered. The data recorded by the data logger of "wrpl's" tag include the specific ID of "cat1" and the exact timing of the contact event. The corresponding information is recorded by the data logger in "cat1's" tag. Adoption of this technology will enable collection of detailed information on intraguild predation (i.e. it will enable detection of predation of cats by foxes, should it occur), on inter-specific competition (i.e. it will enable detection of cats and foxes coming into close proximity, similarly it will enable detection of ringtails and brushtails coming into close proximity) and will allow identification of the species and the individual responsible for each predation event.

The technology is currently advanced to a state where contact circuitry can be incorporated into collars of a weight suitable for fitting to foxes and cats. However, pen/aviary enclosure trials are required to ensure the technology can be used on animals as small as western ringtail possums. Ethics Committee approval has recently been given to trial these collars on western ringtail possums and common brushtail possums. These trials will also enable assessment and adjustment of the "contact" distance, i.e. the distance between the collars required to activate "contact" mode. The contact telemetry collars proposed for trial do not currently incorporate mortality circuitry. Further development is required to re-instate mortality circuitry, without the collars becoming too heavy for use on the western ringtail possum. Similarly, the option of incorporating the time of activating mortality mode into the data logger is being examined.

Development work is also being carried out by the collar manufacturers to determine whether contact telemetry can be downloaded remotely from satellite collars. If this is able to be achieved, cats and foxes will be fitted with satellite collars incorporating contact circuitry. The use of satellite telemetry will not only provide a more reliable data collection mechanism for contact events involving foxes and cats, but will provide a more cost effective mechanism for collection of fox and cat location records. The accepted alternatives (triangulation from various ground locations and/or use of towers) are inherently difficult logistically and require an extensive commitment of field time with a lower level of precision and reliability.

The satellite telemetry data on fox and cat movement will also complement the mesopredator release research proposed at a landscape level (de Tores *et al.*, 2004a). This work proposes to use satellite telemetry to examine meso-predator release issues at large-scale field sites in the Rangelands and Northern Agricultural Region, the South Coast Region, Wheatbelt and the northern jarrah forest of Western Australia. Specifically, the work will examine the extent of cat movements in the presence and absence of fox control. The research will examine, *inter alia*, whether the pattern of use of the landscape by cats changes when fox control is implemented over large areas. This has ramifications for CALM's Western Shield program, specifically for translocation programs planned for large tracts of land where fox baiting has been/will be implemented. The western ringtail possum translocation research will complement this large scale meso-predator release research by examining the same issues at a smaller scale, i.e. at smaller habitat patches in the presence and absence of fox control. These smaller patches are representative of many of CALM's translocation release sites in the south-west of Western Australia.

The western ringtail possum translocation program also proposes to introduce a system whereby wildlife carers are required to notify the Department of Conservation and Land Management within 72 hours of a western ringtail possum being taken into care. A similar system is in place for several other species (Peter Mawson, pers. comm.). Under this proposal, wildlife carers will be required to ensure all western ringtail possums suitable for release (as determined by health screening protocols outlined in this proposal) are released in accordance with the translocation and monitoring protocols of this program and only at sites identified in this proposal.

It is further proposed to ensure all proponents of development proposals are aware of their requirement to seek approval from the Federal Environment Minister where the proposed development "*has, will have, or is likely to have a significant impact on a matter of national environmental significance*" (Environmental Protection and Biodiversity Conservation Act, 1999 – EPBC Act). The EPBC Act defines "*matters of national environmental significance*" to include proposals which may have an impact on listed threatened species. Translocations will only be undertaken where the development proponent has sought and been given translocation approval from the Commonwealth of Australia, consistent with the EPBC Act, or where the Commonwealth has deemed such approval is not required.

2.2 Aims

The major aim of the western ringtail possum translocation research is to determine whether translocation is a viable management option for displaced and rehabilitated possums, and if so, determine the conditions under which translocation is successful. Specific aims are to:

- use conventional mortality radio-telemetry procedures and novel “contact” telemetry procedures to monitor the survivorship of a sub-set of translocated western ringtail possums at the primary 1080 baited translocation release site, Leschenault Peninsula Conservation Park, and at the recently established unbaited control site, Martin’s Tank (within Yalgorup National Park). The data from monitoring at these sites will enable comparison of survivorship between a baited and unbaited site and will also enable population modeling to determine whether the probability of survivorship at translocation sites is sufficient to allow the translocated population(s) to increase and be sustained;
- assess the abundance of introduced and native predators, and through the development and use of novel “contact” radio-telemetry and satellite telemetry procedures, assess the importance of fox and cat predation to translocation success;
- determine whether competition exists between translocated populations of western ringtail possum and resident populations of the common brushtail possum and assess the importance of this competition, if it exists, to translocation success;
- derive population estimates for, or indices of abundance to, the suite of alternative prey species and assess the importance of the presence of alternative prey species to translocation success;
- assess the importance of site specific habitat variables to translocation success;
- assess the pre-release and post-release health status of western ringtail possums and correlate the health status with post-release survivorship;
- determine the prevalence of specific diseases (toxoplasmosis, leptospirosis and chlamydia) in wild western ringtail possum populations as well as western ringtail possums undergoing rehabilitation;
- identify disease risks associated with translocation of ringtail possums and determine the role disease plays in terms of survivorship, reproductive success and overall translocation outcomes;
- assess the prevalence of toxoplasmosis in the feral cat population at the release sites;
- assess the long-term health status of the western ringtail possum at translocation release sites and compare this with the health status of wild-caught ringtails (ex development sites) and naturally occurring populations; and
- ensure collection of genetic material (ear tissue biopsy) for the complementary program (de Tores and Spencer, 2004) which is proposed to examine the genetic structure of translocated and wild populations of the western ringtail possum. That program proposes, *inter alia*, to:
 - ❖ assess whether western ringtail possum populations across the species entire range, historically constituted a panmictic or alternative population structure, e.g. source/sink or metapopulation(s) and if this/these structures are still functional;
 - ❖ quantify whether species with a narrow ecological niche (i.e. the western ringtail possum) show a more profound genetic effect of fragmentation than species considered more generalists (e.g. the common brushtail possum);
 - ❖ determine whether the geographically separated populations are genetically fragmented;
 - ❖ determine whether there has been a loss of genetic diversity as a result of habitat and population fragmentation;
 - ❖ assess the extent of inbreeding and determine if this was a potential contributing factor to the failure of the translocation at Leschenault;
 - ❖ assessing the extent of inbreeding at all other translocation release sites where genetic material is available; and
 - ❖ determine (through simulation modeling) if population augmentation through ongoing translocations is a requirement for long-term persistence of translocated populations.

2.3 Methodology and analyses

2.3.1 The sites

The experimental design incorporates unbaited (control) translocation release sites and sites baited for fox control through the use of 1080 dried meat baits. The baited sites are Leschenault Peninsula Conservation Park, Preston Beach (Yalgorup National Park) and White Hill (Yalgorup National Park). The unbaited control sites are Martin's Tank (Yalgorup National Park) and Crampton Nature Reserve. Two possible alternatives to Crampton Nature Reserve (Guthrie Forest Block and Lyons Proposed National Park) will also be considered. Final site selection will be determined post site inspection, discussion and negotiation with relevant CALM specialist, regional and district staff.

The number of sites used will be determined by the level of funding secured (see Section 2.3.3 Funding and priority for monitoring, below). Initial monitoring emphasis will be at Leschenault Peninsula Conservation Park (vehicle based monthly delivery of 1080 dried meat baits) and the Martin's Tank (unbaited). The White Hill and Preston Beach sites are both baited for fox control (vehicle based monthly delivery of 1080 dried meat baits) and have previously been used as western ringtail possum release sites. Crampton Nature Reserve (and the possible alternatives) will remain unbaited. Crampton Nature Reserve has no previous history of western ringtail possum releases and has a vegetation structure and floristic composition comparable to the White Hill release site. There are no records of western ringtail possum presence at Crampton Nature Reserve. The reserve will be re-surveyed prior to the first release to "confirm absence", or more accurately, to provide additional support for the absence of western ringtail possums at this site.

Extant populations of the western ringtail possum will also be monitored at Reserve 23000 4583 in Capel Shire, Tuart Forest National Park (inclusive of adjoining state forest) and at Locke Nature Reserve. Both species occur sympatrically at the Capel reserve, where the habitat is representative of western ringtail possum habitat at the northern extremity of the species range. Peppermint (*Agonis flexuosa*) is present but not dominant. Both species also occur sympatrically within the Tuart Forest National Park and adjoining state forest (Ludlow), which support mature stands of tuart (*Eucalyptus gomphocephala*) and a peppermint understorey. The status of the ringtail and brushtail populations has recently been identified (Barbara Jones, pers. comm.) as requiring investigation at these sites. Locke Nature Reserve supports a high density population of the western ringtail possum in high quality (large areas of continuous interlocking canopy) peppermint habitat. Table 1 list the sites, land tenure of each site, site descriptions and level of baiting at each site. Figure 1 shows the location of all sites.

The Yalgorup National Park translocation release sites are all within areas quarantined from burning programs and there are no planned burns for Leschenault Peninsula Conservation Park. Similarly, there are no planned burns for the Capel reserve sites. Confirmation of use of Tuart Forest National Park and Locke Nature Reserve will be subject to negotiations for exclusion of fire and discussions with CALM regional and specialist staff.

2.3.2 Re- introduction or re- stocking

Habitat at all proposed translocation release sites is considered suitable, as determined by vegetation structure and floristics which is comparable to that at locations supporting extant populations of the western ringtail possum. All sites are within the species' former geographic distribution and pre-release survey supported the belief that none of the translocation release sites supported a western ringtail possum population prior to the releases at Leschenault (1991) and Yalgorup (1995). However, there is an absence of historical records of western ringtail possum presence at these sites and former presence is only inferred.

The translocation is therefore considered to be a "re-introduction" at Martin's Tank and Crampton Nature Reserve, as per the IUCN definition (IUCN, 1987) where re-introduction is defined as: "... the intentional movement of an organism into a part of its native range from which it has disappeared or become extirpated in historic times as a result of human activities or natural catastrophe". Translocation is considered to be a "re-stocking" (i.e. re-stocking of previous translocation release sites) at Leschenault, Preston Beach and White Hill as per the IUCN definition (IUCN, 1987) where "re-stocking" is defined as "... the movement of numbers of plants or animals of a species with the intention of building up the number of individuals of that species in an original habitat".

2.3.3 Funding and priority for monitoring

Funding will be sought from the proponent of every development proposal where it is deemed necessary to relocate western ringtail possums. The minimum level of funding sought will be sufficient to cover the full cost for CALM to capture the resident population of western ringtail possums from the development site, relocate these possums to the translocation release sites and contribute to the cost of monitoring for the first 12 months post relocation. A model for determining these costs (de Tores, 2004) has been used since January 2004 and will be reviewed annually.

Additional funds have been sought from CALM through a Cabinet Submission as part of a proposal to expand Western Shield (de Tores *et al.*, 2004a), through the Departmental annual budget process and through the Commonwealth's Natural Resource Management (NRM) program. This funding has been sought to enable translocations and monitoring to be extended to White Hill, Preston Beach and Crampton Nature Reserve. Similarly, and in conjunction with Murdoch University, the University of Sydney and the University of Wales-Bangor, additional funding has been sought through the Australian Research Council (ARC) for an ARC Linkage program. If successful, the ARC Linkage program will support a PhD student to undertake the health/disease monitoring research and examine survivorship and habitat use of naturally populations at the Capel reserve, Tuart Forest National Park and Locke Nature Reserve.

Subject to receiving funding as indicated below, the priority and duration of each component of the program is identified below, as is the research focus:

- (i) Monitoring at Leschenault Peninsula Conservation Park and Martin's Tank will focus on determining survivorship probability and causes of mortality, in particular, predation induced mortality for translocated western ringtail possums and resident populations of the common brushtail possum. Monitoring will assess reproductive success, dispersal patterns of young, home range and habitat use (see Section 2.4 *Criteria for success and failure* for specific detail). Monitoring will also address the importance of predation by pythons and competition with the common brushtail possum. Continuity of monitoring is subject to continued funding from proponents of approved development projects where possums are displaced. A seven year time frame is proposed for completion of this work, commencing July 2005. In the absence of funding beyond 30 June 2005, the existing interim monitoring will cease and the fate of released possum will be unknown.
- (ii) The proposed expanded monitoring at Leschenault Peninsula Conservation Park, White Hill, Preston Beach, Martin's Tank and Crampton Nature Reserve will continue to focus on determining survivorship probability and causes of mortality, reproductive success, dispersal patterns of young, home range and habitat use. Monitoring will also assess the relative importance of fox control/fox predation, cat abundance/cat predation, predation by the suite of native predators, prey switching, habitat variables and competition with the common brushtail possum. The expanded number of sites and expanded monitoring is subject to continued funding from proponents of approved development projects from sites where possums are displaced and additional funding from CALM and/or the NRM program. A seven year time frame is proposed for completion of this work, commencing July 2005. In the absence of this funding, monitoring will be restricted to that identified in (i) above.
- (iii) Subject to the outcome of the ARC Linkage application and funds sought from CALM and/or the Forest Products Commission (FPC), monitoring will determine the importance of wildlife health / wildlife disease issues for ringtail and brushtail possums at the two sites where they occur sympatrically (Capel and Tuart Forest / Ludlow) and for ringtails only at Locke. The wildlife health / wildlife disease data will be supplemented by sampling ringtails displaced from development sites. Monitoring will also examine wildlife health/disease issues of ringtails ex wildlife carers (pre and post release sampling of animals from carers and animals ex development sites). Abundance estimates will be derived for ringtails and brushtails (Capel and Tuart Forest / Ludlow) and ringtails only (Locke). Changes in population size, should it occur, will be quantified. The extent of interaction/competition between brushtails and ringtails will be examined, as will survivorship, home range and habitat use for both species. Modeling will determine the probability of persistence of both species at the naturally occurring sites. A four year time frame is proposed for completion of this work, commencing July 2005. In the absence of this funding, monitoring will be restricted to disease health issues only (if ARC funds only are received) or will otherwise be restricted to that outlined in (i) above.

Table 1: The proposed monitoring sites for two arboreal possum species, *Pseudocheirus occidentalis* and *Trichosurus vulpecula*. Also listed is the land tenure of each site, the presence/absence of 1080 baiting for fox control and the presence/absence of the two possum species. The translocation sites are identified as either a re-stocking site or a re-introduction site.

Site	Tenure	Presence of 1080 baiting, description of site and baiting regime and area baited	The possum species present
Translocation sites - re-stocking			
Leschenault Peninsula Conservation Park Crown Reserve 42470	Conservation Park, with central sections currently freehold land and proposed as Conservation Park	Baited – nominally 1100 ha baited by vehicle delivery at 4 weekly intervals. Baits are buried however, subject to a risk analysis, the baiting regime is proposed to change to tethering of unbaited baits. The site is surrounded by water all bar the northern 600m wide isthmus, which presents the only possible point for re-invasion by foxes	<i>Pseudocheirus occidentalis</i> <i>Trichosurus vulpecula</i>
Preston Beach (Yalgorup National Park) Crown Reserve 22057	National Park	Baited area of approximately 573 ha baited by vehicle delivery at 4 weekly intervals. Baits surface laid and un-tethered. The site is bounded by Lake Preston and similar unbaited vegetation. The closest agricultural land is 1.2km from the centre of the release site.	<i>Pseudocheirus occidentalis</i> <i>Trichosurus vulpecula</i>
White Hill (Yalgorup National Park) Crown Reserve 12189	National Park	Baited area of approximately 551 ha baited by vehicle delivery at 4 weekly intervals. Baits are surface laid, un-tethered. The site is bounded by fenced private property (Sarich property, previously baited, currently unbaited) which is partially parkland cleared, partially used for horticultural and recreation purposes and also supports high quality peppermint habitat. Also bounded by unbaited coastal heath and unbaited low jarrah / marri / casuarina / peppermint. The closest agricultural land (Sarich property) abuts the release site.	<i>Pseudocheirus occidentalis</i> <i>Trichosurus vulpecula</i>
Translocation sites - re-introduction			
Martin's Tank (Yalgorup National Park) Crown Reserve 11710	National Park	Unbaited. Nominally 490 ha. The site is bounded by Lake Clifton and Martins Tank Lake, peppermint / tuart forest and coastal heath. The closest agricultural land is approximately 750m from the centre of the release site. This agricultural land and other areas of agricultural land within 1 km of the release site are "in-holdings" within the Park	<i>Trichosurus vulpecula</i> Translocations of <i>Pseudocheirus occidentalis</i> began January 2004
Crampton Nature Reserve Crown Reserve 24472	Nature Reserve	Unbaited. Approximately 37 ha. The site is bounded by a jarrah / marri / banksia woodland buffering Myalup Pine Plantation (eastern side of reserve) and agricultural land on the remaining three sides. A major road (Old Coast Road) separates the site from agricultural land on the western boundary.	<i>Trichosurus vulpecula</i> Translocations of <i>Pseudocheirus occidentalis</i> proposed from July 2005.

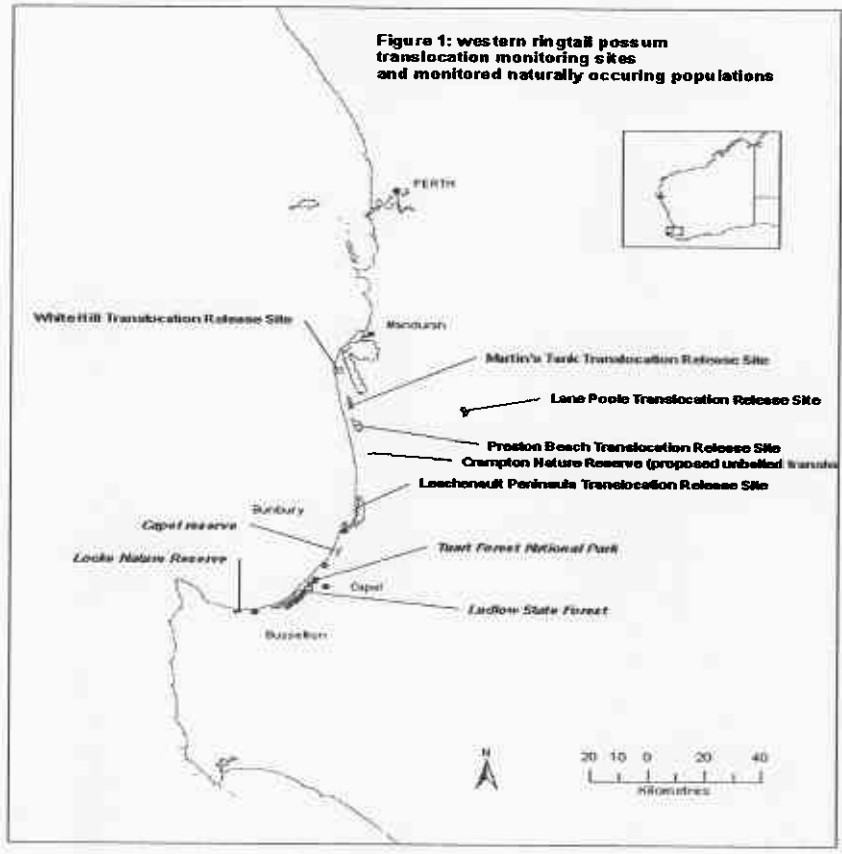
Table 1: (... continued) The proposed monitoring sites for two arboreal possum species, *Pseudocheirus occidentalis* and *Trichosurus vulpecula*. Also listed is the land tenure of each site, the presence/absence of 1080 baiting for fox control and the presence/absence of the two possum species. The translocation sites are identified as either a re-stocking site or a re-introduction site.

Extant naturally occurring populations (non-translocation) monitoring sites		
Capel reserve (comprised of Reserve 23000 and Reserve 28836)	Crown Reserve, vested in Local Government	Unbaited. Approximately 141 ha. The site is bounded by parkland cleared, special rural (hobby farm), large residential lots and agricultural land. The parkland cleared and special rural lots support jarrah / marri / banksia woodland. A major road (Bussell Highway) separates the site from partially cleared special rural lots / large residential lots with minimal clearing on the eastern boundary
Locke Nature Reserve	Nature Reserve	Unbaited. Total reserve area is approximately 200ha, of which approximately 20 percent (approx 40ha) is high quality peppermint (continuous canopy). The site is bounded by parkland cleared and completely cleared agricultural land (on three sides) and a major road (Caves Road) separates the site from partially cleared special rural lots with minimal clearing on the fourth (northern) boundary.
Tuart Forest National Park and surrounding state forest (Ludlow)	National Park State Forest	History of intermittent baiting at Tuart Forest National Park. The area is approximately 1100ha. Unclear history of baiting at Ludlow State Forest. The area is approximately 890ha. The site is predominately tall tuart forest with a peppermint understorey in the national park, extending to parts of Ludlow, however much of Ludlow is pine plantation, currently scheduled for harvesting.

Pseudocheirus occidentalis
Trichosurus vulpecula

Pseudocheirus occidentalis

Pseudocheirus occidentalis
Trichosurus vulpecula



2.3.4 Sample size

The number of western ringtail possums released will be determined by the number of rehabilitated possums, ex wildlife carers, deemed suitable for release and by the number of possums requiring relocation from development sites. On the basis of the number of animals previously displaced by developments in the Bunbury and Busselton area and on the number of animals released ex wildlife carers (either through previously approved translocation programs or as part of unsanctioned and unmonitored releases carried out by wildlife carers) the total number of animals translocated may reach 300 to 400 over the three to four year period of the ARC Linkage supported proposal. The number of ringtails requiring release may be up to twice this over the proposed seven year time frame of the proposal seeking NRM / additional CALM funding support.

The timing of translocation releases will largely be determined by the timing of site clearing at development sites. Consequently, timing of releases will be subject to negotiation between CALM and development proponents. The timing of release of animals held by wildlife carers will attempt to minimise the length of time animals are held in care.

A sub-set (sample size) of 10-12 western ringtail possums from the total number released will be radio-collared and monitored at each translocation release site. This sample size will be maintained by augmenting the radio-collared sample size where possible (see section on monitoring). All radio-collared and released western ringtail possums ex-wildlife carers will be screened as part of the pre-release health/disease monitoring. Similarly, all radio-collared and released western ringtail possums relocated from development sites will be screened as part of the pre-release health/disease monitoring.

A comparable sample size of brushtail possums will be radio-collared and monitored at each release site, at the Capel reserve site and at Tuart Forest National Park / Ludlow.

2.3.5 Animal handling, monitoring and data analyses

Interim monitoring

Interim monitoring will be undertaken by the existing personnel (de Tores, Jackson and Bertram), currently funded through CALM committed funds and funding received from developers. Monitoring will continue to examine survivorship, reproductive success, habitat use, home range and causes of predation induced mortality, inclusive of the importance of predation by pythons and competition with the common brushtail possum (see below). Subject to progress in development of "contact" telemetry and liaison with radio-telemetry manufacturers, developmental aspects of contact telemetry will be initiated/trialed.

Monitoring of pythons will focus on pythons caught through detected predation events on western ringtail possums or when opportunistically sighted and caught. Each python will be implanted with a temperature sensitive radio tag and monitored to assess the extent of python predation on western ringtail possums (see below). Additional searches for pythons may be required to ensure the monitored sample is not biased to over-represent pythons known to be predators of one or both possum species. A sample size of 10-12 pythons is anticipated at Leschenault. The sample size of monitored pythons at Martin's Tank (the unbaited site) will be determined by opportunistic sighting and capture success and frequency of known mortality events attributable to python predation.

Longer term monitoring - possum capture, handling, survivorship, home range and habitat use analyses and competition between the two possum species

Subject to the outcome of funding applications submitted through CALM and the NRM program, monitoring will continue to be carried out at Leschenault and Martin's Tank and will be expanded to include the three additional translocation release sites – White Hill (Yalgorup National Park), Preston Beach (Yalgorup National Park) and Crampton Nature Reserve.

Capture of brushtail possums will also be extended to all sites. Capture of brushtail possums for radio-collaring and abundance estimates will be through standard wire cage trapping techniques, with seasonal trapping sessions and supplementary trapping as required to maintain the radio-collared sample size. Targeted trapping of un-collared brushtail possums observed during nocturnal monitoring of the radio-collared sample is also envisaged.

A range of techniques will be used for capture of western ringtail possums from development sites, with darting (de Tores *et al.*, unpublished-c) the preferred capture technique. Other capture techniques will include opportunistic capture during the day (hand capture of possums from dreys and rest sites), use of extendable poles/shepherd's crooks during diurnal and nocturnal searches of development sites (shepherding animals to the outer foliage where they can be taken by hand or shaken to the ground), and, in collaboration with contractors engaged

by developers, cherry pickers will be used to access dreys to enable high branches to be lowered (chain sawed) and/or animals to be taken directly from high dreys/rest sites.

Standard morphometric data will be collected when each animal (both possum species) is initially fitted with a radio collar and when subsequently re-collared. Data will also be collected on reproductive status (pouch condition, presence and sex of young). Animals will be anaesthetised (Isoflurane gas inhalation anaesthesia or use of the injectible anaesthetic, Zoletil) for all radio-collaring and re-collaring procedures.

An ear tissue biopsy will be collected from each possum (both species) for subsequent genetic analyses.

Radio-telemetry will use “contact” telemetry technology if it can be developed and adopted for use on the two possum species. If this technology cannot be adopted for use on possums, “mortality” telemetry will be used to ensure earliest possible detection of mortality events.

Western ringtail possum survivorship analyses will use the known fate model in Program MARK (White, 2001) which incorporates the option for staggered entry. Survivorship modeling will adopt the Information-Theoretic approach (Burnham and Anderson, 2002) and will assess a suite of *a-priori* candidate models to select the best approximating model to determine western ringtail possum survivorship. Variables in the set of *a-priori* candidate models will include presence or absence of 1080 baiting, the number of known con-specifics, introduced predator abundance, native predator species abundance (or indices to these abundances), disease status, prey species abundance (inclusive of brushtail possum and the suite of alternative native and introduced species prey abundance) and site specific habitat variables. Alternative Program MARK survivorship models which use a combination of radio-telemetry and trapping data will be investigated for brushtail possum survivorship modeling.

Monitoring to determine habitat use and the extent of competition between the two arboreal possum species will require collection of nocturnal foraging location records and diurnal rest site/drey/hollow use records. Location records will be recorded at sub-metre accuracy (differential GPS) and will record a suite of “location-type-specific” data. For example, tree hollow use will record the tree species, tree height, tree form, diameter at breast height over bark (dbhob), whether the tree is dead or living, the highest order of dead wood, the angle of lean of the tree, the presence of scratch marks, the number of contacts with neighbouring trees/vegetation, the number and type of hollows present, the height at entry of the hollow being used, the type of hollow used, the hollow orientation, hollow aspect, hollow shape and whether the hollow is in dead or living timber. An equivalent and relevant suite of data will be recorded for location records in grass trees, fallen logs, dreys (constructed nest sites), rest sites (diurnal location records where there is no evidence of construction of a drey and no use of shelter such as tree hollows, fallen logs or grass trees) and for nocturnal foraging records.

Home range analyses will be based on the GPS location records and will use Ranges6 home range analyses (Kenward *et al.*, 2003), or equivalent, to assess home range size and the extent of home range overlap. Analyses will enable comparison between the baited and unbaited sites and comparison with the data from the sympatric wild populations of ringtails and brushtails from the Capel reserve site and Tuart Forest National Park / Ludlow.

Ranges6 and GIS (ArcGIS) analyses will assess habitat preferences through use of the Jacob’s Index (Kenward *et al.*, 2003) to determine whether habitat preference/avoidance is detectable and to determine the extent of habitat partitioning and/or the extent of competition between the two possum species. Habitat partitioning will also be assessed by analyses of spotlight transect data (Buckland *et al.*, 2001). Spotlight data will also be used to derive estimates of western ringtail possum density and abundance at all release sites and at the naturally occurring extant populations (Capel reserve site, Tuart Forest National Park / Ludlow and Locke Nature Reserve). Density estimates will be derived through DISTANCE Sampling and model selection protocols (Burnham and Anderson, 2002; Thomas *et al.*, 2002) and will assess the importance of differences in detection probabilities between and within sites and between and within the two possum species.

If contact telemetry can be employed, additional data will be available on contact/proximity events. This will enable individual predators to be identified when a fox or cat predation event has occurred. Therefore, it will be possible to differentiate whether one individual or several individual predators are responsible for multiple predation events.

If contact telemetry is employed, data will also be available on intra and inter specific possum contacts and will assist in the interpretation of the extent of habitat partitioning and competition between the two possum species. The number of intra-specific and inter-specific contact events will also be used as a variable in survivorship modeling.

Introduced predator abundance estimates and predator-predator interactions

Cat and fox abundance will be assessed through development and refinement of existing techniques, including trapping (Victor Soft-Catch traps), sandplotting and use of the olfactory attractant, Synthetic Fermented Egg (SFE), and photographic points / camera trap surveys (Karanth and Nichols, 2002).

Foxes and cats will be anaesthetised upon capture. The monitored sample size of radio-collared foxes and cats will be determined by existing densities and the effectiveness of trapping. A sample size of up to 10–12 foxes and 10–12 cats is envisaged at each translocation release site. A higher “turn-over” (as a result of 1080 baiting deaths) is envisaged at Leschenault and other baited sites. Subject to the development of the ability to remotely download “contact” data from satellite collars (see section 2.1), the monitored sample of radio-collared foxes and cats will be fitted with satellite collars. This will enable analyses of the extent of intra and inter specific interactions, inclusive of predator-predator predation events (intra guild predation).

Pythons

Monitoring will require periodic recapture of each implanted python to allow recovery/retrieval of regurgitate and purged intestinal contents. Pythons will be routinely caught and encouraged to regurgitate or purge intestinal contents, as per protocols/techniques outlined by Webb and Shine (1998), Arnold (1993) and Miller and Mushinsky (1990). This will enable the suite of prey species present to be identified. The frequency with which western ringtail possums and common brushtail possums occur as prey items will be determined. Incidental data will also be collected on python survivorship, habitat use, activity patterns and home range.

Disease/health monitoring

Subject to the outcome of the ARC Linkage application, collection and analyses of base-line data will allow assessment of the general health status and prevalence of specific infectious diseases in wild and translocated possum populations. Health monitoring of resident brushtail and predator species populations at the translocation release sites will also be carried out to identify any diseases which could pose a risk to naïve ringtail possums proposed for release into these areas. All rehabilitated ringtail possums radio-collared prior to release will have pre-release and post-release health monitoring.

Pre-release and post-release health monitoring and disease screening of ringtail and brushtail possums will involve the following diagnostic testing:

- routine haematology and biochemistry analyses;
- urinalysis;
- faecal parasitology examination;
- microbiology of cloacal swabs;
- Leptospirosis testing;
- Chlamydia testing;
- Toxoplasmosis; and
- post-mortem and histopathology examination of deceased animals.

Pre-release health checks will be conducted approximately two weeks prior to the planned release of ringtail possums held by wildlife carers. This will enable the health status of “rehabilitated” and other ringtail possums held by carers to be determined and will identify whether these possums have been exposed to novel pathogens in captivity. The health status and disease testing results will determine whether these possums are suitable candidates for release. Post-release health monitoring will be conducted when the radio-collars are changed (at approximately 4 to 6 monthly intervals for adults). Post-mortem and histopathology examinations will be conducted on all radio-collared possums known to have died and where carcasses were recovered and on all ringtail possums known to have died in care.

All sample collection for health screening will be carried out when each animal is anaesthetised. Anaesthesia will be through the use of the injectable anaesthetic agent Zoletil or through the use of Isoflurane gas inhalation. Once anaesthetised, the animals will be weighed and given a physical examination. A blood sample will be collected from the lateral tail veins. The volume of blood collected will be based on the animal’s weight and will be less than the volume which can safely be collected (10% of blood volume – estimated blood volume for small mammals is 50ml/kg). Blood will be collected for haematology and biochemistry analyses, toxoplasmosis and leptospirosis testing. Abdominal palpation will determine whether the bladder is distended with urine and urine will be manually expressed to collect a sample for urinalysis. The cloaca will be swabbed for microbiology culture. Conjunctival, cloacal and pharyngeal swabs will be collected and stored frozen for

Chamydophila testing at Queensland University of Technology. The duration of anaesthesia will be approximately 15 minutes. This will allow time for physical examination, application of a radio collar and sample collection.

Review of the literature relating to diseases of predator populations (feral cats, foxes and pythons) known to occur at the western ringtail possum translocation release sites suggests toxoplasmosis is the primary infectious disease posing a risk to the translocated ringtail possums. However, if other disease conditions are identified in possums and these diseases are associated with transmission from resident populations of predators, then investigations will be undertaken to determine the prevalence of the particular disease in the relevant predator species. Cats are the definitive host for toxoplasmosis (Lenghaus *et al.*, 1990) and the prevalence of toxoplasmosis in the feral cat population at the release sites remains unknown. When feral cats are anaesthetised for radio-collaring, blood samples will be collected and samples subsequently screened for toxoplasma infection.

2.4 Criteria for success and failure

Long-term translocation success will be achieved and demonstrated if:

1. the probability of survivorship and population modeling predict the translocated populations will be sustained and/or increase; **and**
2. populations are shown to be sustained and/or increase over the seven year monitored timeframe and over a period of longer-term annual monitoring; **and**
3. genetic variability of the established populations is comparable with naturally occurring self sustaining populations (i.e. there has been no loss of genetic diversity at translocation sites) and it has been clearly determined there is no on-going requirement for population augmentation through further translocations.

Several short-term, intermediate and longer-term milestones/outcomes will need to be met to realise the above criteria. Specifically, population monitoring will need to demonstrate:

- released individual western ringtail possums survive for sufficient time to build and establish regular use of dreys, and/or establish regular use of tree hollows and a suite of diurnal rest sites;
- home range, habitat use and dispersal patterns are consistent with those expected from the literature and unpublished studies for the western ringtail possum. Anticipated patterns include extensive overlap of female home range, a lesser degree of overlap of male home range, female young remaining within, or close to, the natal home range and male young dispersing from the natal home range. Any variations to these patterns will need to be investigated;
- home range and habitat use patterns are consistent with those expected for possum species occurring sympatrically and competition with the brushtail possum is not limiting translocation success of the western ringtail possum;
- reproductive success, with a sex ratio for the young produced comparable to that reported in the literature and unpublished reports;
- young survive to sexual maturity and in turn produce young;
- breeding is not restricted to a few dominant individuals and genetic variability has been maintained;
- disease and wildlife health issues are not limiting translocation success;
- a sustainable level of predation from native and introduced predators; and
- a pattern of sustained or increasing western ringtail possum population density.

Translocations will be deemed to have failed where:

1. population modeling predicts translocated populations will not be sustained; **and**
2. this prediction is supported by subsequent survivorship analyses and population estimates; **and**
3. there are no negatively correlated explanatory variables in the best approximating model to describe survivorship, or negatively correlated explanatory variables cannot be addressed through management intervention.

In circumstances where negatively correlated explanatory variables can be addressed by management intervention (for example, delivery of a novel method of feral cat control), this management intervention will be implemented in an active adaptive management framework.

2.5 Personnel

Proposed personnel are:

- Paul de Tores (project leader and PhD co-supervisor, CALM Science Division, Wildlife Research Centre, Woodvale);
- continued employment of Jennifer Jackson (developers and or external funds) (CALM Science Division, Wildlife Research Centre, Woodvale);
- CALM / NRM supported technical officer;
- Ian Bertram, Masters student from the University of Glasgow, Scotland (based at CALM's Wildlife Research Centre, Woodvale for the period July 2004 to June 2005);
- ARC Linkage supported PhD student (commencing July 2005);
- PhD program co-supervisor, Dr Kris Warren and specialist veterinary support from Professor Ralph Swan and statistical support Dr Ian Robertson (Murdoch University);
- Murdoch funding supported veterinary graduate, Dr Karon Eastley (BJ Lawrence Scholarship until September / October 2005);
- PhD co-supervisors, Professor Chris Dickman (University of Sydney) and Dr Dorian Moro (University of Wales-Bangor);
- specialist cat control and cat ecological research input from Dr Dave Algar and cat research technical expertise from Mike Onus, Neil Hamilton and John Angus (CALM Science Division, Wildlife Research Centre, Woodvale);
- specialist python ecology research input from Dr Dave Pearson (CALM Science Division, Wildlife Research Centre, Woodvale);
- specialist regional support (wildlife carer liaison) from Warwick Roe (CALM, Regional Wildlife Officer, South-West Region, Bunbury);
- specialist volunteer program support (wildlife carer liaison) from Marg Buckland (CALM, Parks and Visitor Services Division, Community Involvement, Kensington); and
- operational support for Frank Colyer, (CALM, Wellington District, Collie) to maintain 1080 baiting programs at Leschenault Peninsula Conservation Park and Mark Humble (CALM, Perth Hills District, Dwellingup), Steve Dutton and Murray Banks (CALM, Swan Region, Mandurah) for logistic support and maintenance of baiting programs at Yalgorup National Park.

2.6 Animal ethics approval

The project has been approved CALM's Animal Ethics Committee, approval number 149/2003 and subsequent renewals

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