

**A summary of research by Department of Environment and Conservation (DEC),  
Murdoch University and Curtin University on the western ringtail possum  
(*Pseudocheirus occidentalis*) on the southern Swan Coastal Plain and  
recommendations relevant to current research proposals**

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## **Disclaimer**

The comments and opinions expressed in this report represent those of the author and not necessarily those of the Western Australia Department of Environment and Conservation.

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The photograph on the front page – an adult male western ringtail possum at Tuart Forest National Park - was taken by Wendy Payne.

## **Summary and recommendations**

### **Distribution and genetics**

Presence only surveys have shown the distribution of the western ringtail possum on the southern Swan Coastal Plain to be different from that reported in the scientific literature. Populations have recently been reported from a range of locations from which there were no previously known records of occurrence. Many of these newly reported populations were from areas of remnant vegetation and are not contiguous with other habitat known to support western ringtail possum populations. The full extent of the species' occurrence on the southern Swan Coastal Plain and elsewhere is unknown (de Tores, in prep).

Genetic analysis (Wilson, 2009) from a sub-sample of populations from the southern Swan Coastal Plain has shown two discrete sub-populations, separated by only 30km, with no mixing or gene flow between populations. This is despite the absence of any physical barriers to population mixing.

Distribution mapping and the conservation importance of populations (in terms of genetics and demographics) is the fundamental starting point on which to base decisions on development proposals and other activities which have the potential to impact on the species. In the absence of the availability of this information to decision makers and developers alike, there has been inconsistency in the approval process, duplication of survey in some areas, absence of survey in others and considerable uncertainty for developers.

### **Recommendations**

1. A coordinated approach is recommended to identify and quantify the factors (variables) which determine western ringtail possum presence within the southern Swan Coastal Plain. Occupancy modelling (MacKenzie *et al.*, 2006) is recommended as the most appropriate method for this research.
2. Identification of populations of high conservation value (in terms of demographics and genetics) is recommended.
3. Tissue sampling for genetic analysis is recommended as mandatory in any further western ringtail possum population studies.

### **Survey and assessment of population parameters**

Survey of western ringtail possum populations on the southern Swan Coastal Plain has historically been *ad hoc* and undertaken as a "one-off", usually for the purpose of meeting assessment criteria for determining potential effects from proposed developments. These surveys have provided managers with little information other than crude estimates of the minimum number of individuals present at any given sampling session. The approaches adopted have been short term only, have no scientific basis, are unrepeatable, make no allowance for detection heterogeneity and provide little or no indication of the level of uncertainty and/or variability associated with the estimates. Once reported, these unjustified techniques are then enshrined as reliable and cited as justification for further use of the same techniques in subsequent surveys.

Similarly, reporting of habitat use and population parameters for environmental assessment purposes are simplistically derived and analysed, are not scientifically based and make limited or no use of the most basic techniques generally accepted and widely used in wildlife studies.

Despite the large number of *ad hoc* surveys undertaken in the southern Swan Coastal Plain, there has been minimal collaboration or coordination and, other than providing information on presence, has resulted in no value-adding to existing knowledge. There are current opportunities for coordination and collaboration in population studies of the western ringtail possum. Such coordination would be cost effective for proponents of individual developments, would assist approval and decision making agencies and would provide biodiversity conservation benefits.

### **Recommendations**

4. A coordinated and longer term approach to western ringtail possum studies of habitat use, home range, competition (see below) and long term effects from habitat fragmentation is recommended, specifically:
  - 4.1 Routine use of more rigorous sampling methodology (e.g. Distance) (Buckland *et al.*, 2005; Buckland *et al.*, 2001) is recommended for future surveys to ensure agencies responsible for development approvals, and other decision making agencies, are provided with reliable information on which to base these decisions.

- 4.2 Population estimates based on drey and/or scat counts are unlikely to provide accurate, reliable or repeatable estimates. A cautious approach is recommended if inference is drawn from such estimates.
- 4.3 Use of standard wildlife monitoring and analytical techniques such as radio-telemetry is recommended when assessing habitat use and survivorship. Analysis of radio-telemetry data through the kernel density estimation method (or equivalent) is recommended when deriving estimates of home range and home range overlap.

### **Translocation**

Translocation of western ringtail possums displaced from development sites and those held by wildlife carers and deemed suitable for release has met with qualified success. Low density populations appear to have become established at three locations within Yalgorup National Park (Clarke, in prep; de Tores *et al.*, 2008). Translocation to Leschenault Peninsula Conservation Park has shown a high loss to predation by feral cats (*Felis catus*) and the south-west carpet python (*Morelia spilota imbricata*) (Clarke, in prep; Clarke *et al.*, 2009; de Tores, 2008; de Tores *et al.*, 2005a; de Tores *et al.*, 2005b). A health screening program (Clarke *et al.*, 2009) has indicated survivorship is a function of white blood cell counts and common brushtail possum (*Trichosurus vulpecula*) population size at translocation release sites. However, evidence of competition between the two arboreal possum species is equivocal and may be confounded by the phenomenon of habitat partitioning (Grimm and de Tores, 2009). Use of nest boxes, albeit from a small sample size and over one season only, was found to provide no benefit to translocated western ringtail possums.

Development proponents have recently advocated alternatives to translocation. These alternatives include a “do nothing” approach and a “shepherding” approach whereby individual animals are shepherded away from vegetation at the time of clearing. This may lead to unsustainably high population density in the retained habitat and/or forced dispersal of resident individuals from the retained vegetation.

Unsanctioned release of western ringtail possums by wildlife carers and others has continued and the release locations and fate of these released possums is unknown. Such translocations contravene the regulations of the Western Australian Wildlife Conservation Act, 1950 and the Western Australian Animal Welfare Act, 2002.

### **Recommendations**

5. A coordinated approach to translocation is recommended whereby:
  - 5.1 monitoring is maintained (resurrected) at the Yalgorup National Park and Leschenault Peninsula Conservation Park release sites;
  - 5.2 the effectiveness of a range of cat control techniques is assessed at the primary translocation release site (Leschenault Peninsula Conservation Park) and the biodiversity conservation outcomes of integrated fox and cat control is assessed;
  - 5.3 the effect of competition / habitat partitioning (between the western ringtail possum and common brushtail possum) on translocation outcomes is assessed;
  - 5.4 the short and long term conservation value of alternatives to translocation are rigorously assessed prior to being recommended as a strategy for dealing with western ringtail possums within habitat proposed for clearing;
  - 5.5 continued involvement of wildlife carers in formal, sanctioned translocations is encouraged; and
  - 5.6 closer scrutiny is given to the reporting and compliance requirements for wildlife carers.
6. It is recommended the western ringtail possum be listed as a “notifiable” species, in accordance with the Western Australia Wildlife Conservation Act 1950 and Regulations of the Act.

### **The physiology of the western ringtail possum – evaporative water loss and the implications of climate change predictions**

Findings from research on the metabolic and hygric physiology of the western ringtail possum (Yin, 2006) supported the anecdotal reports of the species’ limited ability to cope with high ambient temperatures. In a captive environment and for a small sample size, evaporative water loss increased to what was considered biologically significant at ambient temperatures above 32.5°C.

### **Recommendation**

7. Climate change modelling is recommended to assess the potential effects to distribution and conservation status of the western ringtail possum.

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## **A summary of research by Department of Environment and Conservation (DEC), Murdoch University and Curtin University on the western ringtail possum (*Pseudocheirus occidentalis*) and recommendations relevant to current research proposals**

A series of collaborative research programs on the western ringtail possum has made progress in the following areas:

### **1 Distribution**

A review of the distribution of the western ringtail possum has shown the species' current geographic range to be considerably different from, and more expansive than, previously published accounts (Fig 1). However, this should be interpreted cautiously and does not necessarily reflect an expansion of the species range, nor does it represent a recovery of the species. It more likely represents an increase in knowledge of the species' distribution (de Tores, 2008; de Tores, in prep). The known distribution now includes multiple discrete locations, dispersed through a range of habitat types in the greater Bunbury region. Populations have also been confirmed from the Binningup / Myalup area and individual records confirmed north of Myalup and in the vicinity of translocation release sites north and south of Park Ridge (Fig 2). Many of the previously unknown records of occurrence from the Bunbury, Collie and Binningup areas in particular are from remnant habitat patches with little opportunity for improving or restoring habitat connectivity.

The extent of gene flow between populations is largely unknown. The Binningup / Myalup populations, including the population from the Southern Seawater Desalination Project are of considerable interest given the genetic findings (see below).

There are several unconfirmed reports of western ringtail possum presence as far north as Mandurah.

The presence of western ringtail possum populations at sites more widely distributed than was previously known on the Swan Coastal Plain has highlighted the need for broadscale survey to identify the full extent of the range/distribution of the western ringtail possum in the Busselton and Bunbury areas, especially the area between Bunbury and Binningup and north of Binningup.

By necessity, the survey approach to date has been *ad hoc* and driven by the need to meet the survey requirements of individual development/project proposals. This has resulted in a considerable amount of valuable information and has confirmed many new records of occurrence for the western ringtail possum. However, it has not provided information on population size, affinities between populations (gene flow/mixing of populations) of the factors/variables (biotic and abiotic) which determine presence and persistence of populations. All of which is required for effective conservation management. The estimates of population size presented in various reports (see for example 360 Environmental, 2008; Jones *et al.*, 2007) cannot be justified. There is also gross inconsistency within and between reports (including reports on the same areas from the same studies by the same consultants), and making this even worse, each report is used as a justification for use of the technique in subsequent studies.

Distribution mapping and the conservation importance of populations (in terms of genetics and demographics) is the fundamental starting point on which to base decisions on development proposals and other activities which have the potential to impact on the species. In the absence of the availability of this information to decision makers and developers alike, there has been inconsistency in the approval process, duplication of survey in some areas, absence of survey in others and considerable uncertainty for developers.

A coordinated approach is recommended to identify and quantify the factors (variables) which determine western ringtail possum presence within the southern Swan Coastal Plain. Occupancy modelling (MacKenzie *et al.*, 2006) is recommended as the most appropriate method for this research. Occupancy modelling is based on a Kullback-Leibler / information-theoretic approach (Burnham and Anderson, 2001; Burnham and Anderson, 2002), with the fundamental premise that reliable inference on population presence and persistence relies on estimation of detection probabilities. The only caution with use of the principles is that detection probabilities are likely to change over time, location and species (MacKenzie *et al.*, 2006). In the case of the western ringtail possum, occupancy modelling would require repeated survey (over different seasons) of the remnant vegetation patches within the southern Swan Coastal Plain.

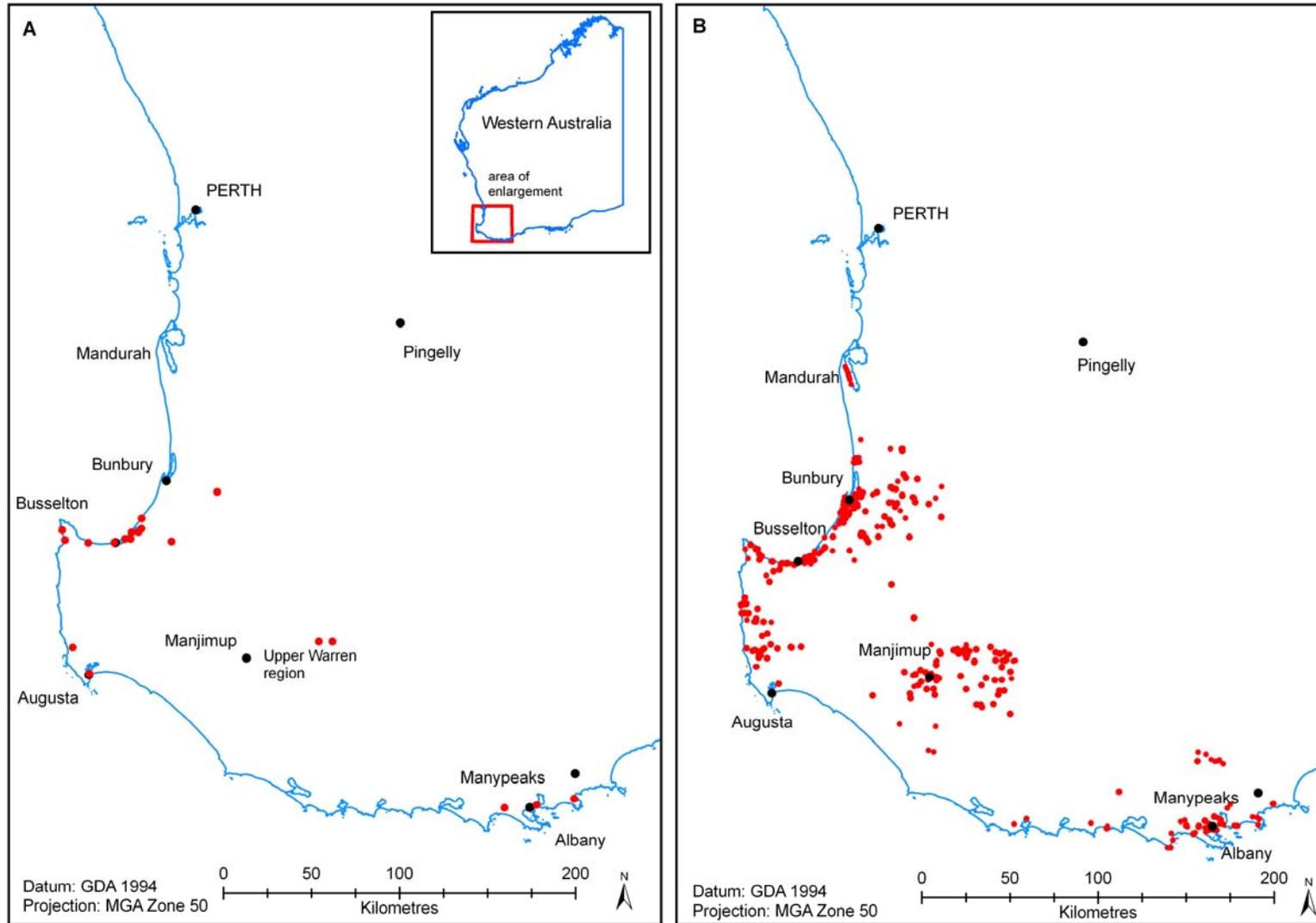


Figure 1: Known location records for the western ringtail possum at:  
 A - 1994. Source: Jones *et al.* (1994); and  
 B - 2009. Source: de Tores (in prep).

## 2 Genetics

Funding was recently provided through the Commonwealth Department of Environment, Water, Heritage and the Arts (DEWHA, formerly DEH) to undertake a pilot study to identify western ringtail possum populations of high conservation significance (in terms of genetics and demographics). Microsatellite markers were developed (Wilson, 2009; Wilson *et al.*, 2009) for the genetic component of this work. The demographic component assessed the practicality and feasibility of using Distance sampling (Buckland *et al.*, 2005; Buckland *et al.*, 2001) to derive robust estimates of western ringtail possum population size and is summarised in Section 3, below and reported by de Tores and Elscot (in prep).

Development of the microsatellite markers enabled assessment of the genetic structure of western ringtail possum populations. From the samples analysed, three discrete subpopulations were identified – one from the Upper Warren region and two (Busselton and Gelorup/Dalyellup) from the southern Swan Coastal Plain. Despite no geographic barriers to gene flow and only 30km separating the Busselton and Gelorup/Dalyellup populations, these populations are genetically discrete – *i.e.* there is no mixing/gene flow between these populations.

The genetic analysis has also shown the Upper Warren population (Fig. 1) to have greater genetic diversity than the swan coastal plain populations (Wilson, 2009). These results suggest the anecdotally enshrined views attributing highest conservation value to the Busselton populations may not be warranted.

This, combined with recent knowledge of the current distribution, has major implications for western ringtail possum management. The affinity (extent of historic and contemporary gene flow) between populations within the greater Bunbury region is not known. The Bunbury populations may show affinities with each other, with the Gelorup/Dalyellup populations or the Busselton population(s), or with none of these populations. The latter would suggest populations from the greater Bunbury area represent another genetically discrete population.

Similarly, the extent of historic and contemporary gene flow between populations from the greater Bunbury region and populations from Binningup is not known. Therefore the Binningup / Myalup population(s) may also represent another genetically discrete population.

Confounding this further, the source of the Binningup population, and of the unconfirmed populations near Mandurah (if they occur) (Fig. 2), warrants some examination. One or all of these may have been established as a result of dispersal from translocation release sites and/or dispersal from unsanctioned translocations. Unsanctioned and unmonitored translocations have been undertaken by wildlife carers from the Busselton area. Wildlife carers have revealed some of these release sites, but not all.

The Binningup population has been reported as a “closed population” (360 Environmental, 2008). It is unclear what is meant by this. The term “closed population” in a mark-recapture context means during the period of survey there are no births or deaths and there is no immigration or emigration. In a genetic context the term would suggest there is no gene flow between this population and other populations. If the latter was intended, there is no evidence to support this. The rationale presented advocating a “closed population”, and emphatically stating the population is not sourced from translocation or other sites, is based entirely on a lack of detection of western ringtail possum scats in outlying habitat which was considered to be potentially suitable for ringtails. This conclusion should be seen as speculative only. It may well be the case, but can't be inferred from the information provided. It is possible the Binningup population is genetically discrete. If this is the case, it is likely to be of conservation significance.

It is also possible the Binningup population was sourced originally from unsanctioned translocations (see Section 4, below). Given the genetic analyses confirmed the series of roadkills from the Old Coast Road near the White Hill Road translocation release site (Fig. 2) originated from the translocated population, it is also plausible the Binningup population was sourced from dispersal from sanctioned translocations to Leschenault Peninsula Conservation Park. Genetic analyses is recommended to assess this.

Tissue sampling for genetic analysis is recommended as mandatory in any further western ringtail possum population studies. This is most easily achieved by collection of a small piece of ear tissue (2 to 5mm in diameter) taken from live individual western ringtail possums when the animal is anaesthetised. Storage of tissue in dimethyl sulfoxide (DMSO) in a saturated salt solution (Seutin *et al.*, 1991) is recommended

Techniques described in Section 3, combined with analysis of other population parameters (e.g. breeding condition and status, dispersal patterns, etc) also combined with genetic analysis, will clearly enable identification of western ringtail possum populations of highest conservation significance. Identification of such populations is strongly recommended.

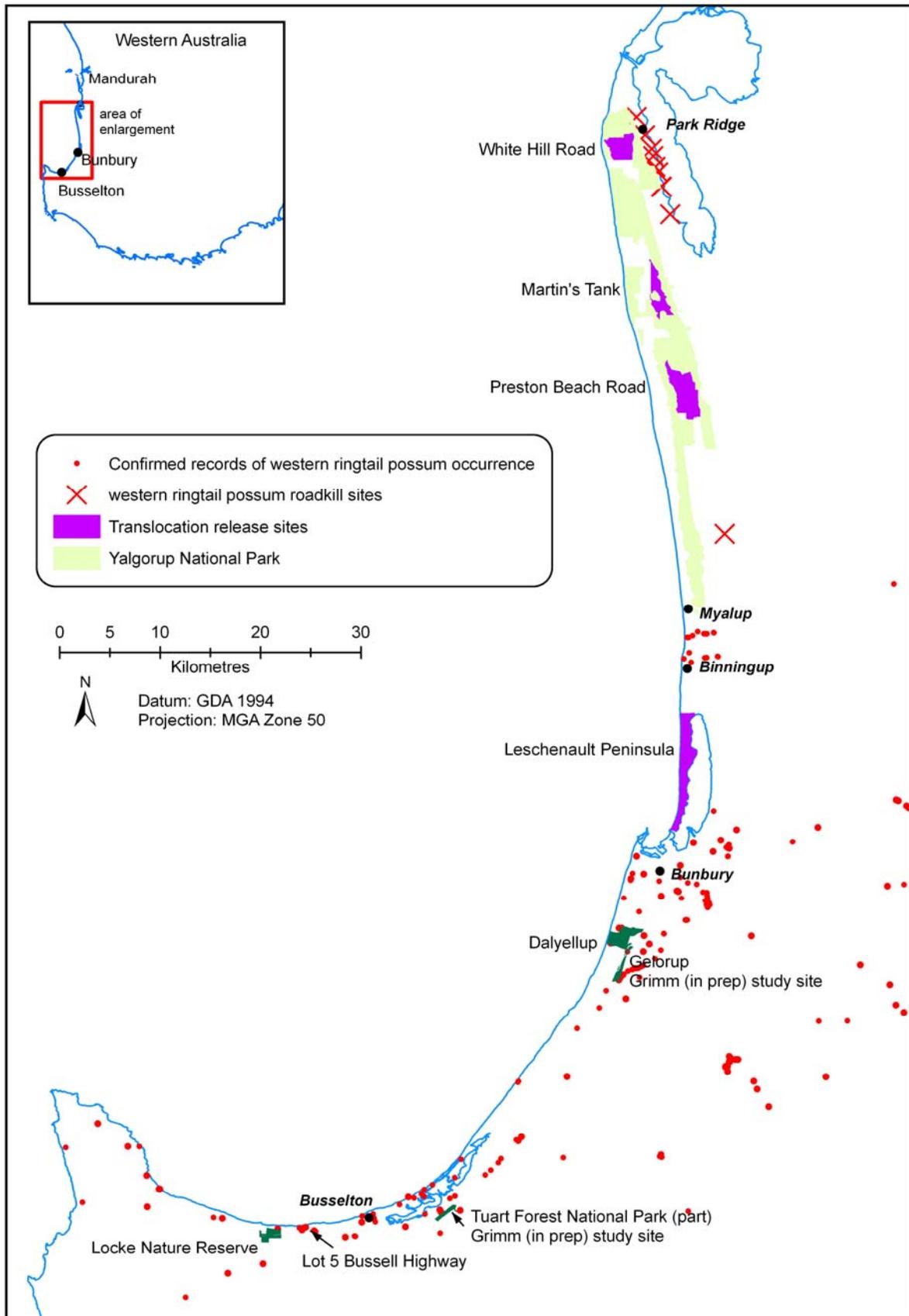


Figure 2: Study sites examining genetic and demographic aspects of the western ringtail possum (*Pseudocheirus occidentalis*).  
 Source: (Clarke, in prep; de Tores, in prep; de Tores, unpublished; de Tores and Elscot, in prep; Grimm, in prep; Grimm and de Tores, 2009; Wilson, 2009)

### 3 Adopting science based survey techniques and inference from the acquired data

Historically western ringtail possum survey has been carried out in an *ad hoc* manner with little justification of the techniques employed. The results from these of surveys are usually reported as the number of sightings per hour, or per linear unit of transect, or per unit area (see for example Jones *et al.*, 2007). Inference from data reported this way has been widely criticised in the scientific literature (see for example Buckland *et al.*, 2005; Buckland *et al.*, 2000; Buckland *et al.*, 2001; Burnham and Anderson, 2002; Burnham *et al.*, 1985; Hedley and Buckland, 2004; Marques and Buckland, 2003; Thomas *et al.*, 2007) and the findings provide no more than a crude estimate of the minimum number of individual animals sighted at any given survey session.

Techniques such as “slow, slightly aimless (or ‘drunken’) walking with a regular scanning strategy” are claimed to detect “more eye-shine than a purposeful linear walkline” (Jones *et al.*, 2007). Such approaches are unrepeatable, make no allowance for detection heterogeneity and provide managers and decision makers with no indication of the level of uncertainty and/or variability associated with the estimates. Unfortunately, once reported (albeit in the grey literature only), these unjustified techniques are then enshrined as reliable and cited as justification for further use of the same techniques in subsequent surveys (see for example appendix 11 of the Southern Seawater Desalination Project terrestrial flora and fauna survey).

Repeatable surveys and analysis of data using more sophisticated analytical techniques can overcome most of the problems associated with western ringtail possum surveys and can result in reliable and repeatable estimates of population size. Distance sampling (Buckland *et al.*, 2005; Buckland *et al.*, 2001), based on the information-theoretic approach, is well described and has become the widely accepted methodology for estimating the population size for survey of species for which population estimates are otherwise difficult to derive.

Where western ringtail possum populations are very small and occur within small patches of remnant vegetation, it would be almost impossible to use Distance in isolation in these cases. When surveys are reported for these areas they should acknowledge they produce a simple count of the number of individuals seen. This does not equate with a population estimate. However, if the data from these small areas are collected in accordance with Distance sampling protocols, it would be possible to pool these data with data from areas where there are larger counts and then derive population estimates for all areas. This would require a reasonable level of understanding of detection functions, how and when to pool data and how to stratify (*i.e.* the stratum could be the different sites, a density estimate derived for each, but using a generic detection function across all areas).

Funding from DEWHA recently enabled field survey (late 2008 and early 2009) at a landmark Busselton site (Locke Nature Reserve) and a remnant patch of peppermint (*Agonis flexuosa*) dominated vegetation within Busselton townsite (Lot 5 Bussell Highway) (Fig. 2) where population estimates (guesstimates) had been previously derived from *ad hoc* techniques (Elscot unpublished, Jones *et al.*, 2007). The 2008 / 2009 survey adopted Distance Sampling methodology – a technique now widely accepted in the scientific literature as providing robust and repeatable estimates of population density from which reliable inference can be made. The methodology enables estimates of population density to be derived from small samples, incorporates detection heterogeneity, allows for habitat stratification pre or post survey (to account for differences associated with different habitat types), enables use of site specific and/or individual covariates, enables pooling of data across sites, allows for observer differences, enables abundance estimates for any subset of a survey region and provides estimates of variance and confidence intervals for the derived estimates of abundance (Buckland *et al.*, 2005; Buckland *et al.*, 2001).

Preliminary analysis of the data from the two Busselton sites, using Distance sampling, indicated the western ringtail possum populations are considerably larger than previously reported for Locke Nature Reserve and Lot 5 Bussell Highway (de Tores and Elscot, in prep).

Deriving estimates of population size based on scat counts is also unreliable. Scat deposition rates will vary and, in the case of the western ringtail possum, detection of scats becomes problematic where understorey vegetation is intact and where there is dense cover of understorey sedges such as *Isolepis nodosa*, *Gahnia trifida*, *Carex inversa* and *Lepidosperma gladiatum*. Such habitat is often present at sites where western ringtail possum density is high (personal observations and unpublished data). Scat decay rates will also vary with season, weather, habitat, diet and many other factors, also making it problematic to derive reliable estimates of the mean time to decay (Laing *et al.*, 2003). In recognition of this, estimates of population size based on indirect measures such as scat counts need to incorporate methods for estimating the probability of detecting scats and measures for estimating scat deposition and decay rates (Buckland *et al.*, 2005; Buckland *et al.*, 2001; Laing *et al.*, 2003).

Estimating western ringtail possum presence and abundance based on drey counts is equally unreliable. Personal observations suggest there is no correlation between the number of dreys and the number of western ringtail possums removed from development sites within the Bunbury / Busselton area. Similarly, despite the presence of potential competition for tree hollows with the common brushtail possum (*Trichosurus vulpecula*) there were very few dreys recorded and very little evidence of drey use by western ringtail possums at Tuart Forest National Park, Busselton (Grimm, in prep; Grimm and de Tores, 2009). Surveying through use of drey counts would most likely have grossly underestimated the western ringtail possum population size within Tuart Forest National Park.

With the exception of DEWHA funded study (de Tores and Elscot, in prep) and the recent PhD programs (Clarke, in prep; Grimm, in prep), reported estimates of western ringtail possum population size and other demographic information have relied on the subjective techniques described above. Development approval decisions are largely based on consultant driven reports on this subjectively collected data. There is now sufficient evidence to justify decision making authorities insisting on more robust techniques for deriving estimates of western ringtail possum population size and other demographic information. Routine use of more rigorous sampling methodology (e.g. Distance) is recommended to ensure agencies responsible for development approvals, and other decision making agencies, are provided with reliable information on which to base approval decisions.

To continue with the surveying approach used to date will, at best, identify additional populations, but will not provide any meaningful information on population size. Opportunity exists to coordinate survey of potential western ringtail possum habitat on the southern Swan Coastal Plain and to value add to existing vegetation survey information from the Swan Coastal Plain (the Swan Bioplan Remnant Mapping Program, covering the Swan Coastal Plain from the Perth metropolitan area to Dunsborough, inclusive of the Wicher and Darling scarps) (Bronwen Keighery, pers. comm.). Coordination and collaboration with the Swan Bioplan Remnant Mapping Program and involvement of post graduate (Honours and PhD) students and academic supervisors is recommended. Such collaboration and coordination would be cost effective for proponents of individual developments, would assist approval and decision making agencies and would provide biodiversity conservation benefits.

#### **4 Translocation**

Western ringtail possum translocation research has met with qualified success (de Tores *et al.*, 2008; de Tores *et al.*, 2005a; de Tores *et al.*, 2005b). The monitored populations at all locations within Yalgorup National Park have persisted and have resulted in dispersal of recruits and what appears to be an expanding population at a minimum of one of these locations. Genetic analysis has confirmed recruitment is from the founding stock at this site. The outcomes at the Leschenault site have been less clear, with a high rate of predation loss to feral cats and pythons (de Tores *et al.*, 2008; de Tores, 2008; de Tores *et al.*, 2005a; de Tores *et al.*, 2005b). Fox and cat monitoring through the use of sandplotting (resulting in derived indices to activity and estimates of density) has inferred reduced fox presence and continued cat presence.

More recent monitoring at Leschenault (through a Murdoch University, DEC and Australian Research Council (ARC) supported PhD program) (Clarke, in prep) has indicated a continued high loss to predation by cats, with no evidence of disease limiting translocation success, although ringtail survivorship appears to be related to pre-translocation white blood cell counts (Clarke, in prep; Clarke *et al.*, 2009). Similarly, although competition with the resident common brushtail possum (*Trichosurus vulpecula*) is likely to occur, there is insufficient evidence to implicate this competition is limiting translocation success. Similar results have been found from a second Murdoch University, DEC and ARC supported PhD program (Grimm, in prep) examining the prevalence of disease in naturally occurring (*i.e.* not translocated) populations of western ringtail possums and common brushtail possums (Grimm, in prep). This PhD program has also identified a seasonally (autumn) high loss of western ringtail possums to fox predation.

The third PhD project (Bryant, in prep) involved in the western ringtail possum translocation research has focused on the role of predation of possums by pythons. Dietary analysis of python scats has confirmed persistence of western ringtail possums at Leschenault Peninsula Conservation Park at levels difficult to detect from standard survey techniques.

Translocation has the potential to provide a valuable role in contributing to the long term conservation of the western ringtail possum. Issues to be resolved hinge primarily on determining the nature of the relationship between cat abundance and predation by cats in the presence of effective fox control – specifically, determining under what conditions cat density increases and whether increased cat predation on western ringtail possums is an example of a trophic cascade resulting from mesopredator release of cats when fox

density is reduced. The evidence to date suggests this is highly likely to be the case, at least at Leschenault. However, it does not (and wouldn't be expected to) occur in every instance where fox density is reduced. Again, this is now well supported by the data from the western ringtail possum translocations to Leschenault Peninsula Conservation Park and Yalgorup National Park. It is recommended the monitoring program at existing translocation release sites is re-instated and the effectiveness of a range of cat control techniques is assessed at the primary translocation release site (Leschenault Peninsula Conservation Park). It is further recommended the biodiversity conservation outcomes of integrated fox and cat control is assessed, and in particular, the conservation outcomes from mesopredator release of cats and subsequent trophic cascades.

Development proponents and decision making authorities have recently advocated and approved an approach whereby western ringtail possums known to occur within a development site are shepherded from areas to be cleared and "encouraged" to move to adjoining retained (sometimes often only temporarily retained) vegetation. Justification of this practice has been based on the inaccurate perception (held and promoted by wildlife carers and others) of a total lack of success from translocation. The shepherding approach is not based on scientific information and, although it may be a viable option and an alternative to translocation, it has not been demonstrated as such. There is now strong evidence to suggest western ringtail possum density in vegetation patches retained within and adjacent to development sites where clearing has occurred has resulted in an overstocking / over-browsing by western ringtail possums in these remnant patches. Shepherding animals into retained vegetation will, at best, exacerbate this problem.

It is recommended the short and long term conservation value of the "*do nothing*" approach and the "*shepherding*" approach is rigorously assessed prior to it being recommended as a strategy for dealing with western ringtail possums within habitat proposed for clearing. This would necessitate capture, radio collaring and monitoring western ringtail possums within and adjacent to areas of habitat proposed for clearing. Intensive radio tracking before, during and after clearing would be required to assess patterns of dispersal, disruption of existing home ranges, habitat use and survivorship of displaced and resident possums. These data would provide information on the short and long term impact of clearing and the potential for this strategy (or strategies) to contribute to conservation of the western ringtail possum.

Unsanctioned translocations of the western ringtail possum have continued and wildlife carers have revealed some, but not all of these translocation release sites. Continued unsanctioned release of western ringtail possums by wildlife carers and others has the potential to confound interpretation of data from sanctioned translocations and confound interpretation of the geographic range of the western ringtail possum. Such translocations contravene the regulations of the Western Australian Wildlife Conservation Act, 1950 and the Western Australian Animal Welfare Act, 2002. There are provisions within the Western Australia Wildlife Conservation Act 1950 and Regulations for the Western Australian Minister for Environment to declare a species as "notifiable". Where "notifiable" fauna is taken into captivity, the Minister must be notified within the period specified by notice in the *Government Gazette*. The western ringtail possum recovery team has endorsed listing the western ringtail possum as a notifiable species. Such measures would ensure DEC is aware of all western ringtail possums held in care and would enable better coordination of translocation releases.

## **5 Habitat use – radio telemetry studies**

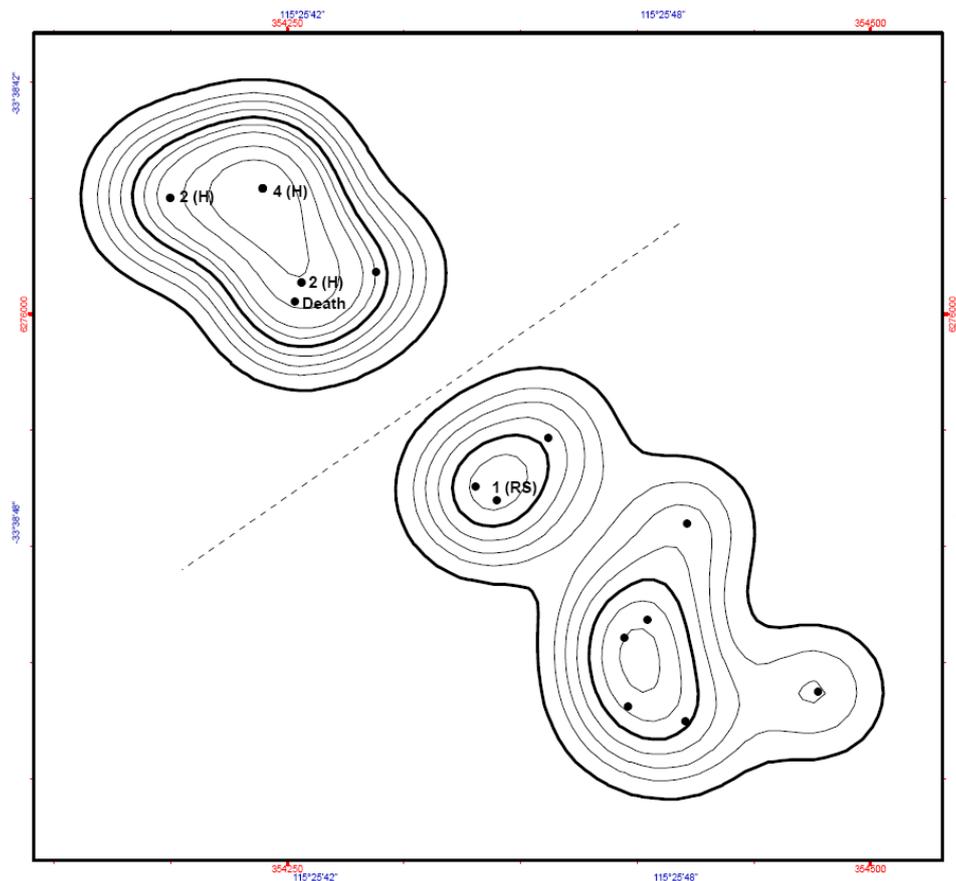
There is a plethora of consultant reports claiming things such as "*the ringtail population ... was small, probably not larger than 50 breeders*" (as reported for the Southern Seawater Desalination Plant (360 Environmental, 2008)). There is insufficient data to justify these claims which, at best, should be seen as speculation only. Unfortunately, these figures become enshrined as fact. Similarly, home range values and habitat use are reported on a similar dearth of data.

Home range analyses have become increasingly more sophisticated over recent years and can now provide more meaningful information for managers and decision makers. The following is from Grimm and de Tores (2009):

"Several modes of analysis now relate the home range to the probability of finding an animal at a particular location on a plane, represented by a density function or "utilisation distribution" (Anderson, 1982; White and Garrott, 1990). The home range is thus defined as "the extent of area with a defined probability of occurrence of an animal during a specified time period" (Kernohan *et al.*, 2001). Given the utilisation distribution is a bivariate probability density function, it can be calculated from the data and isopleths (contour) drawn enclosing a volume under the function (Horne and Garton, 2006; White and Garrott, 1990). The core area within a contour enclosing an arbitrary level of probability, commonly 95%, is considered to be the 'normal' home range. Isopleths can however be drawn at any probability level producing internal contouring which represents differential density of animal activity, and which can be related to habitat features."

The kernel density estimation method was used in the above radio-telemetry study (Grimm, in prep; Grimm and de Tores, 2009) of brushtail possums and western ringtail possums at Tuart Forest National Park and Ludlow State Forest. Home range estimates were derived using the likelihood-cross validation method for choosing the smoothing parameter (Horne and Garton, 2006). The results enabled analysis of the extent of intra-species (ringtail / ringtail and brushtail / brushtail) and inter-species (ringtail / brushtail) home range overlap. Further, it enabled identification of bi-modal and multi-modal home ranges (Fig 3) and in conjunction with GIS techniques, enabled analyses of the relationship between home range and habitat use.

Radio-telemetry studies and longer term studies are recommended to provide reliable information on western ringtail possum population structure, habitat use and home range.



**Figure 3:** An example of the utilisation distribution (home range) for a common brushtail possum from the Tuart Forest National Park and abutting pine plantation, Busselton, south-west, Western Australia, showing a multi-modal pattern – *i.e.* multiple centres of activity, in this case three centres of activity. The diagonal dotted line represents the abrupt division (a track) between a pine plantation (lower right hand side) and open tuart (*Eucalyptus gomphocephala*) woodland with a peppermint (*Agonis flexuosa*) understory (upper left hand side). The outer dark isopleths (contours) bound the area representing a 90% probability of occurrence of this animal within the study period, the inner dark isopleths represent a 50% probability of occurrence.

Datum: GDA 1994. Projection: MGA Zone 50  
 Source: Grimm and de Tores (Grimm and de Tores, 2009)

## 6 Evaporative water loss - western ringtail possum physiology

There are numerous anecdotal accounts of western ringtail possums appearing to be in distress at high ambient temperatures. Wildlife carers have also reported an increase in the number of ringtail possums brought into care during extended periods of high ambient temperatures.

An honours project undertaken at Curtin University (Yin, 2006) examined the metabolic and hygric physiology of the western ringtail possum. The study showed the western ringtail possum to be anomalous in its limited ability to cope with ambient temperatures above 35<sup>0</sup>C. Evaporative water loss increased to what was considered biologically significant at ambient temperatures above 32.5<sup>0</sup>C. There are significant

implications from this aspect of the western ringtail possums physiology in relation to predictions associated with climate change. Climate change modelling is recommended to assess the potential effects to distribution and conservation status of the western ringtail possum.

## 7 Use of nest boxes by western ringtail possums

Nest boxes have been widely advocated for use when translocating arboreal mammal species. However, there are limited studies demonstrating successful conservation outcomes from provision of nest boxes. In an honours study (Moore, 2007) through Murdoch University, nest boxes were found to provide insulative protection for captive western ringtail possums. However, there was no use of nest boxes by translocated ringtail possums and the study concluded, albeit with a small sample size, nest boxes may provide only limited value as a tool to assist recovery of species limited by a lack of den sites. The study further concluded use of nest boxes did not infer any advantage to translocated western ringtail possums (Moore *et al.*, submitted for publication)

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