

Review of the Koala Augmentation Proposal for the South East Forests of New South Wales

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Status of the Koala in the South-eastern Forests of New South Wales (SENSW)

The status of the koala in the Southeastern forests of New South Wales is precarious at best. A small but increasing population of koalas is present in and around the Mumbulla State Forest and even smaller "... and disjunct clusters of koala activity occur to the southwest of Bermagui, and again in the Kooraban and Gulaga National Parks to the north." These are referred to as coastal populations of SENSW subsequently. A population that was present as recently as the early 1990s in Tantawangalo -Yurammie area is no longer detectable and is likely to be extinct (C. Allen, 2010).

The loss of koalas in the Southeastern forests that used to support them is the result of many factors. Major declines occurred as the result of hunting for the fur trade 100 years ago. Recovery from the impact of the fur trade has most likely to have been impacted by habitat destruction. Clearing of the the most fertile land for farming has had two impacts, it has resulted in the loss of the most productive koala habitat and has fragmented the remaining koala habitat. Additionally, logging in much of the remaining forests has resulted in the loss of some of the most important koala food trees (Allen and Phillips 2012).

Augmentation as a Tool to Help Recover Koalas in the South-east Forests of NSW

Allen and Phillips (2012) proposed that augmentation of the koala populations of the south east forests could be an important conservation tool to assist in the recovery of koala in this region. This modest proposal envisaged the capture of koalas from the Strzelecki Ranges with a carefully controlled release of animals into the Postman's Crossing area of Tantawangalo Creek. Up to 9 koalas (3 males and 6 females) would be released onto the site initially with additional animals to follow once the initial translocation was shown to be a success. A male and two females would be captive-housed with release of their young as they became independent. Tantawangalo was selected as the release site as historically this habitat had supported koalas and while heavily logged in the past had not been logged for more than 20 years. As a result the primary food species, *E. viminalis*, has recovered and is now the predominate species in this area and there are secondary food species also present. This site was also selected as it was located so that there was sufficient habitat for a new population of koalas to grow and expand. Strzelecki koalas were selected as the source of the animals for translocation as genetic data suggested that they were once continuous with the historical population and would be most closely related to current populations in coastal populations of SENSW (D. Phalen, unpublished data).

Detection of *Chlamydia pecorum* in Strzelecki Koalas

A preliminary study designed to determine the feasibility of capturing koalas in the Strzelecki Ranges and to determine their *Chlamydia* infection status was undertaken earlier this year.

A total of eight animals were captured and tested for *C. pecorum* and *C. pneumoniae* and six were found to be infected with *C. pecorum*. These findings are significant as *C. pecorum* is the known cause of ocular and urogenital tract disease in koalas that impairs fertility and reduces the lifespan of infected animals.

Alternate Proposal

Given the challenges of capturing sufficient number of chlamydia-free koalas of the necessary age from the Strzelecki Ranges, an alternate plan has been proposed where animals would be sourced from the Campbelltown population. This population appears to be chlamydia-free.

Request for a Review of the Augmentation Proposal by the Koala Health Hub

In light of the discovery of a high prevalence of *C. pecorum* in the Strzelecki koalas, the Office of Environment and Heritage has asked the Koala Health Hub at the University of Sydney to review the proposed augmentation plan including a modification of it where animals would be sourced from an apparently *C. pecorum*-free population of koalas found to the east of Campbelltown, NSW.

In making this review, the following were considered.

1. Allen, C., S. Phillips. 2012. Koala Conservation in the South-east Forests: Assessment of the Need for and Feasibility of a Population Augmentation program.
2. Allen, C., R. McKinnon, S. Phillips. 2014. Translocation proposal for the re-introduction of koalas into the Tantawangalo section of the South East Forest National Park, NSW.
3. Recent correspondences with Chris Allen

As the result of our review, we have concluded that three major factors needed to be considered when making a decision as to whether translocation of koalas into the Tantawangalo should occur from either the Strzelecki Ranges or Campbelltown. These factors are:

1. Disease: The introduction of *C. pecorum* or novel genotypes of *C. pecorum* into the existing south-east population of koalas or, in the event that it was already there, infection of augmented animals following their introduction.
2. Genetics: Specifically, the ability to translocate sufficient animals to establish a population of koalas that will maintain the genetic diversity of the original population. Equally important is the possible impact of mixing the genetic pool from the translocated animals with remnant populations of animals in the region.
3. Logistics: Is it possible to obtain sufficient numbers of disease-free animals of the proper age to establish a genetically meaningful population and should captive breeding be considered as part of the plan?

Findings and Recommendations

Risks associated with C. pecorum

The potential impact of *C. pecorum* on augmented koalas or koalas populations already present in the south-east forests would be significant. *Chlamydia pecorum* is able to cause severe ocular infections that can result in blindness. It is also able to cause bladder, prostate and, occasionally, epididymal and testicular infections in male koalas and bladder and uterine infections in female koalas. The ocular and urogenital infections are both debilitating, lead to reduced fertility or infertility and often cause death of the infected animal.

The epizootiology of *C. pecorum* is proving to be complex. Genetically, it is a diverse species and koalas can be infected with a range of genotypes. New work suggests that some genotypes are present in Victoria that are not found in NSW (Alistair Legione pers. comm.). Whether these different genotypes of *C. pecorum* have differing abilities to cause disease is not known, but it is likely, based on the range of virulence among strains of other chlamydial species, and among strains of *C. pecorum* in ruminants. Movement of Victorian genotypes from Victoria to NSW in koalas intended for augmentation would generate a significant risk.

An essential requirement in recovery of small, endangered populations, such as those of the south-east forests, is the preservation of remaining genetic diversity. Genetic diversity is lost in small populations through the failure of some individuals to pass on their genes. Two fundamental rules of population recovery are, therefore, that all individuals breed, and that numbers are increased as rapidly as possible to limit loss of alleles (genetic drift) and to create the necessary population stability to be able to translocate animals for the establishment of insurance populations. Reduced fecundity associated with chlamydial disease would be a severe impediment to both of these aims.

The current disease status of populations in the south-eastern coast region are unknown, as are the scope of movements between the proposed release site and existing remnant koala populations- though a koala was sighted recently within 5 km of the proposed release site (Sarah Ferguson, pers. comm.). This is well within the range of dispersal for a koala, illustrating the scope for transmission of disease between translocated and remnant local koala populations.

The introduction of *Chlamydia*- or, if *Chlamydia* exists in the existing population, novel strains of *Chlamydia* - would have a negative impact on fecundity of this population. Strzelecki animals have high prevalence of known genotypes of *C. pecorum* and are therefore, not suitable for translocation. Testing animals prior to translocation would reduce but not eliminate risks of chlamydial transmission. Chlamydiae (in koalas as well as humans) are notorious for forming latent, non-shedding (and therefore not detectable) infections that re-activate during periods of stress or hormonal changes. Declaring a koala to be free of *Chlamydia* requires repeated testing and then should still be considered at some risk, based on the chlamydial status of its source population.

Conclusion 2.

Based on the high prevalence of chlamydia infection in the Strzelecki Ranges and the less than 100% sensitivity of currently available diagnostic tests, we conclude that this population of animals is not an appropriate source for augmentation efforts into Tantawangalo.

- **Additionally, given that the chlamydia status of the koalas in SENS is not known, it must be considered a possibility that local animals could be a source of *Chlamydia* for introduced animals. Therefore, koala translocation from Campbelltown should not be undertaken until the chlamydial status of the koala population in SENS is determined and found to be negative.**

Genetics

Maintaining genetic diversity. For a translocation program to be a success sufficient animals need to be translocated to maintain the genetic diversity of the animals translocated to the same level as the source population. If this is not done then the translocation will result in a genetic bottleneck. The number of animals that need to be translocated will vary depending

on many factors including reproductive rates, genetic diversity in the original population, and prevalence of different alleles in the source population. Factors such as mating preferences and survival rates at translocation sites will also impact the number of animals that need to be translocated. Taking all these factors into consideration the minimum number of koalas that would need to be translocated is 20. This assumes that these 20 animals represent the genetic diversity of animals in the source population.

Based on microsatellite studies the Strzelecki Ranges koalas appear to have significant genetic diversity (Lee et al., 2012). Studies using the same techniques suggest that the Campbelltown population has considerably less genetic diversity (Lee et al., 2010). A contrasting finding regarding the Campbelltown koala genetic diversity was found when immune genes were studied (Lau et al., 2014). This study found significant diversity in this population that was equivalent to that found in other geographic areas. Either way, some form of genetic testing would need to be done to make sure that if koalas that came from either the Strzelecki Ranges or Campbelltown region to make sure that the translocated koalas are genetically representative of the source population.

The original translocation proposal for animals from the Strzelecki range would have sourced the minimum number of animals. The current proposal to translocate smaller numbers of animals from Campbelltown would result in a genetic bottleneck unless it was consistently done over many years.

Conclusion 3. To maximize the genetic diversity of the translocated koalas, a minimum of 20 koalas will need to be translocated and to capture the genetic diversity present in the Campbelltown population it may be that more than 20 koalas will need to be translocated.

Genetics of the source population. There are many theories regarding the best way to restore a small population by augmentation. These include augmenting them with animals that are genetically the most similar or, alternately, outbreeding a population with the introduction of animals with diversity that is not present in the population to be augmented. Which approach would result in the best outcome for koalas is not known. Based on the situation in koalas in western Victoria that have derived from a small number of koalas translocated to French Island, at least one significant genetic bottleneck has not had a significant impact on their success as a species, though their ability to adapt to future climate change or introduction of novel diseases has not been evaluated..

Originally, koalas from the Strzelecki ranges were going to be the source population for the augmentation program. This was based on work (D. Phalen, unpublished data), which showed that the coastal population of koalas in SENSW had historically been continuous with animals in the Strzelecki ranges. This same work showed that the Campbelltown population, although genetically connected to upland populations of SENSW, did not share the same historical genetic connectivity with the coastal population of SENSW.

An unintended but possible negative consequence of an augmentation process is that the introduced animals may reproduce more successfully than the local animals, resulting in a loss or dilution of the genetic diversity present in the native population before translocation.

Conclusion 4: Augmentation of koalas from Campbelltown into Tantawangalo will likely result in the introduction of a population of koalas that are genetically distinct to the current coastal population of SENSW. The potential impact of this augmentation on the longterm genetic diversity of the coastal population of SENSW is not known and has at least a small chance of being detrimental.

Logistics

Chlamydia. The high prevalence of *Chlamydia* infection in Strzelecki means that capturing the appropriate numbers of chlamydia-free animals of the appropriate age range is not possible. Originally, a possible solution to the *Chlamydia* problem in Strzelecki was the idea that capturing young animals before they had a chance to breed would improve the chance of capturing chlamydia-free animals. Based on current studies in the Southern Highlands, this does not appear to be true. The bulk of the young males that have been tested in the current study of *Chlamydia* prevalence in this area have been positive. Infection of juvenile koalas with *Chlamydia* has also been reported in the literature.

Obtaining adequate numbers of animals. Using Campbelltown koalas as a source population has a number of logistical challenges. The first is the availability of animals. Based on past experiences with this population (R. Close pers. comm.) it is likely that only small numbers of animals, 2-3 per year, would be available for translocation. These would be young dispersing animals that were getting into trouble by moving into urban areas. This means that the augmentation program would have to continue on for a minimum of 7 years to get the necessary genetic diversity to make the augmentation effective, assuming all animals breed.

Changes in diet. The same species of food trees used by koalas are present in both the Strzelecki Ranges and the coastal areas of SENSW. This is not the case for the Campbelltown habitat where the predominate tree used by the Campbelltown animals is the grey gum (*Eucalyptus punctata*) a species that is not present in Tantawangalo. This raises the question as to whether translocated koalas will adapt behaviourally and physiologically to the new tree species they would need to feed on. One way to test the ability Campbelltown animals to adapt to the new habitat in Tantawangalo would be to move a small number of animals to a captive facility and monitor food consumption and body condition scores. This poses a small risk in that if animals do not adapt it is possible that one or more animals could die.

Captive breeding: The use of a captive breeding program as a source of animals for augmentation has been considered. These animals could either be sourced from translocated animals or from the small number of coastal SENSW animals that come into care. Hand-raised joeys have been shown to survive in the wild after release so this may be a viable option. Sourcing animals locally would be the best option, but the number of animals that might be available may be insufficient and may not be of the appropriate age class and sex.

Conclusion 5

- **The logistics of translocating Chlamydia-free koalas from the Strzelecki Ranges make them as a source of augmentation for SENSW impractical.**
- **The logistics of translocating koalas from Campbelltown are challenging with many unknowns. If animals are to be translocated, then their ability to adjust to new feed trees will have to be demonstrated and, because of the limitation in the number of available animals, this would have to be done over many years.**
- **The value of captive animals as a source of augmentation animals is uncertain.**

Summary of Conclusions

It is our conclusion that, because of the high prevalence of *Chlamydia* in the Strzelecki Ranges population, these animals should not be used as a source population for augmentation for the coastal SENSW koalas; the risk of disease transmission is too high. and the logistics for the translocation would be impractical even if the disease issue could be overcome. Our recommendation would be the same, irregardless of whether or not the coastal population of SENSW is found to be infected with *Chlamydia*.

The use of Campbelltown animals as an augmentation population should not be considered until the *Chlamydia* status of the coastal SENSW is established. Given that Faye Wedrowicz has found that the *Chlamydia* status of individual animals can be determined from faecal DNA, and she has samples from the coastal SENSW population, this should be readily accomplished. If *Chlamydia* is present in the coastal SENSW population then augmentation from Campbelltown should not be undertaken. If *Chlamydia* is not present in SENSW animals, then several questions need to be answered before augmentation from Campbelltown can be done. These include: the ability of the animals to adapt to the new environment, the longevity of the current project and its ability to obtain a sufficient number of koalas and, lastly, the issue of augmenting this population with genetically unrelated animals and its implications. Taken together, these issues pose significant impediments to using Campbelltown koalas as a source for augmentation and we conclude that this option is not currently viable.

References

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