Landscape, koalas and people: A historical account of koala populations and their environment in South Gippsland

Faye Wedrowicz [A B E], Wendy Wright [B], Rolf Schlagloth [C D], Flavia Santamaria [C], Fred Cahir [D]

[A] Faculty of Science, Monash University, Australia

[B] School of Applied and Biomedical Sciences, Federation University Australia, Churchill, Victoria, Australia

[C] School of Health, Medical and Applied Sciences, CQIRP, Central Queensland University, Rockhampton, Queensland, Australia

[D] Faculty of Education and Arts, Federation University Australia, Mt Helen, Victoria, Australia

[E] Corresponding author: faye.wedrowicz@gmail.com

ABSTRACT

We present an ecological history of the koala (*Phascolarctos cinereus*) population and its environment in South Gippsland, Victoria, both pre- and post- European settlement. We consider the role that the region's history may have had on the genetic structure of the current koala population in South Gippsland, which is the only known koala population in Victoria that does not originate from animals re-introduced as part of the Victorian translocation program.

Following European colonisation of Australia, a range of anthropogenic factors, including hunting for the fur trade, resulted in widespread population declines for the koala. In Victoria, the situation was extreme. Currently, many koala populations in Victoria are derived from only a few individuals which existed less than 120 years ago. These populations therefore have comparatively low genetic diversity, a factor that plays a key role in long term population viability.

In Victoria, the koala is not listed as a threatened species. Despite the low genetic diversity of most populations, the species is widely distributed across the state, and relatively common. Indeed, some populations are considered overabundant. However, many koala populations are not abundant, and population data are lacking for most. The South Gippsland koala population is of high conservation significance as it has greater genetic diversity compared to other Victorian populations, though there is little additional data to inform its conservation.

An improved understanding of genetic diversity and gene flow between populations across the koala's range is required to guide the conservation of genetic diversity in this species. Monitoring population size, health and genetic relationships both within and between koala populations will enable better conservation outcomes.

Key words: *Phascolarctos cinereus*, Aboriginal history, translocation, *Chlamydia*, genetic diversity, Strzelecki Ranges, landscape change and management.

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Introduction

The present distribution and structure of Australian wildlife populations are the result of the events and environmental conditions of the recent and distant past. While environmental changes in the distant past occurred relatively slowly, a multitude of changes impacting Australian flora and fauna have been occurring rapidly since European colonisation (1788–present), resulting in the extinction of many species (Woinarski *et al.* 2015) and changes in the genetic structure of populations of surviving species (Tracy and Jamieson 2011; Frankham *et al.* 2012). Deforestation or 'land clearing' has been a major factor affecting Australian wildlife populations since European settlement. Clearing of forests and woodlands occurred in order to allow the rapid development of agriculture from the mid-1800s up until to the mid-1900s (Bradshaw 2012). Extinctions and biodiversity losses may take a considerable length of time to occur following habitat disturbances such as land clearing (MacHunter *et al*. 2006; Vellend *et al*. 2006); species may therefore falsely appear to be unperturbed by landscape changes for a long time after degrading processes appear to have ended (Szabo *et al*. 2011). Even for species which remain relatively abundant, environmental changes can alter population structure and reduce the level of genetic diversity within populations, so that apparently robust populations carry with them the legacy of past environmental pressures (Bijlsma *et al*. 2000). Genetic diversity is important for populations as it allows them to adapt to further changes and challenges which may emerge within their environment (Frankham *et al*. 2012), and therefore to persist, rather than becoming another entry on the list of extinct native Australian wildlife species.

Species that are habitat specialists are considered more prone to the negative impacts of environmental change than habitat generalists (Travis 2003). One habitat specialist, the koala (*Phascolarctos cinereus*) is an iconic Australian marsupial which exists on a near exclusive diet of eucalypt leaves. The distribution and genetic structure of koala populations is likely to have changed substantially since European settlement. In addition to the widespread clearing of habitat for agriculture, hunting in order to harvest pelts for the fur trade had a major impact on koala populations (Lewis 1934). In the future, rapid changes in climate are anticipated to result in contractions and spatial shifts in the distribution of most eucalypt species, which is of significant conservation concern for koalas (Adams-Hosking *et al.* 2011; McAlpine *et al.* 2015; González-Orozco *et al.* 2016). Continued habitat loss and forest fragmentation, due to urbanisation, industrial developments, forestry and fires have ongoing effects on contemporary koala populations, while the frequency and severity of droughts and fires, predicted to increase in Australia due to climate change (Hennessy *et al.* 2005; Bradstock 2010), will also continue to put pressure on this species. Climate change and increased atmospheric carbon dioxide may also alter the nutritional composition of eucalypt leaves, potentially reducing the suitability of some eucalypts as browse for koalas (Moore *et al.* 2004).

The movement of individual koalas from one region to another, particularly in south eastern Australia, has also affected the health (Santamaria and Schlagloth 2016) and genetic structure (Houlden *et al.* 1999; Lee *et al.* 2011) of koala populations. Early translocations of koalas (1860s–early 1900s), by individuals and acclimatisation societies (ASV 1872) were followed by more recent (1923—present) interventions by government agencies charged with population management objectives (Menkhorst 2004; Menkhorst 2008; DELWP 2015b). Thus, both environmental changes and translocations are likely to have impacted the present distribution and genetic structure of koala populations. The situation for the koala is now likely to be vastly different in terms of where, and how many, individuals can be found; and in the genetic composition of individuals and populations, compared to at the time of European settlement (McAlpine *et al.* 2015).

Koalas were once more broadly distributed across Australia. Fossils have been found on the Nullarbor Plain and on the southern coast of Western Australia (Black *et al.* 2014). The disappearance of the koala from these former parts of its range (sometime after 43,000 years ago) is thought to have occurred due to expansion of shrub and grass land and contraction of forest and woodlands during the last glacial period, where rainfall decreased and seasonality and droughts increased (Price 2012; Black *et al.* 2014).

There is no fossil evidence that koalas ever occupied Tasmania (Price 2012; Black *et al.* 2014). This fact suggests that the southerly expansion of koalas into Victoria occurred relatively recently (Sherwin *et al.* 2000), after the inundation (around 10,000 years ago) of the Bassian Plain, which formed the land bridge between present day Victoria and Tasmania. It is also possible that more southerly cooler climates at the time rendered Tasmania unsuitable for koalas, though currently, parts of Tasmania are modelled as climatically suitable for koalas (Adams-Hosking *et al.* 2011).

South Gippsland

South Gippsland is a Victorian region located to the east of Melbourne (Figure 1). It includes the Bass Coast, South Gippsland, Latrobe City and Wellington shires and consists of three bioregions: the Strzelecki Ranges, the Gippsland Plain and the Wilsons Promontory bioregions (Figure 1B)[1].

Agriculture and forestry are the major land uses in the South Gippsland area and koalas use trees within both environments. The South Gippsland koala population is believed to be a remnant population; not derived from animals relocated as part of the Victorian koala translocation program (Menkhorst 2004; Lee *et al.* 2011).

The Strzelecki Ranges

One of the three bioregions in South Gippsland, the Strzelecki Ranges encompasses 3,500 square kilometres of land (Figure 1). Extant natural forest in the Strzelecki Ranges bioregion is of several major forest types: wet and damp forest at higher elevations, and lowland and shrubby foothill forest in the lower areas (DELWP 2015c). The western Strzelecki Ranges (from Western Port Bay in the west to approximately Mirboo in the east) is dominated by agricultural land, which was taken up and cleared by selectors during the second half of the 19th century.

The eastern end of the Strzelecki Ranges, extending from near Mirboo in the west through to the Carrajung area in the east covers an area of around 2,000 square kilometres (DELWP 2016). Ongoing land cover changes resulting from agriculture, forestry and wildfires in the eastern Strzelecki Ranges (Zhang *et al.* 2008) are likely to have had a substantial impact on koala populations

1 In Australia, bioregions are both defined and used by state government agencies, and others, for biodiversity planning and land management purposes (DELWP 2015b). Bioregions are areas of land defined by similarities in geological and ecological characteristics.

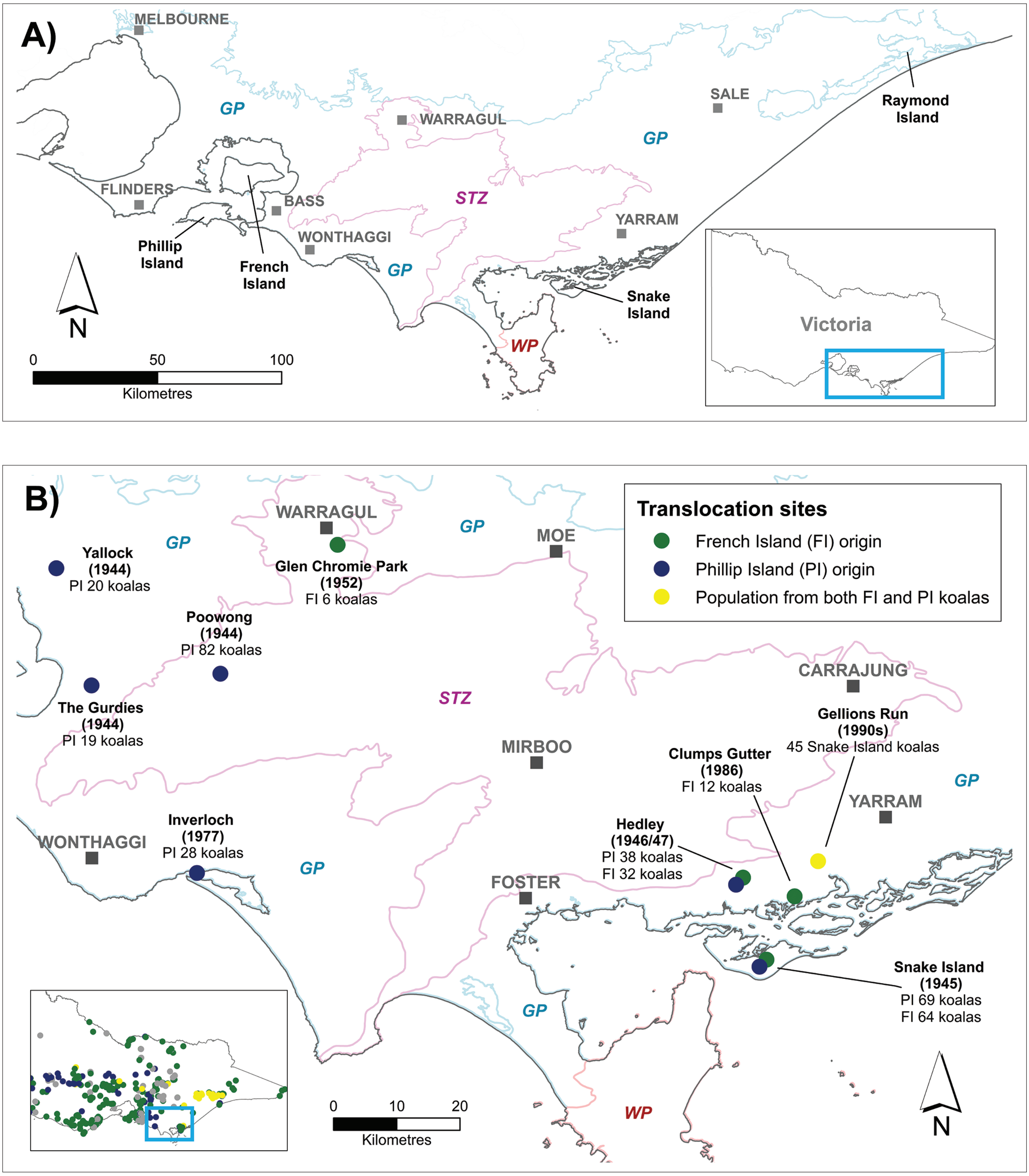

Figure 1. A) Map of southern Victoria showing the regions and islands discussed in the text. Bioregions are outlined in purple (STZ: Strzelecki Ranges bioregion), blue (GP: Gippsland Plain bioregion) and red (WP: Wilsons Promontory bioregion). B) Map of South Gippsland indicating sites and years that island koalas were translocated to the region. Grey points on the inset map of Victoria indicate translocations of koalas of unknown origin. The Victorian Bioregions dataset (DELWP, 2017) was obtained from www.data.vic.gov.au. Translocation data were obtained from Martin (1989) and Emmins (1996). Most individuals released from Snake Island onto the mainland were sterilised.

in this region. Land was first released in the Strzelecki Ranges by the government during the period from 1869 to 1874 (Legg 1986). At the time of settlement, koalas were reported to be "fairly numerous" and "plentiful" in the region (Elms 1920; Murray 1920; Williams 1920). As the land was settled, the forests of the eastern Strzelecki Ranges were cleared for agriculture[2] and by 1910 almost all of the land available for agricultural development in the ranges (approximately 1,800 square kilometres) was taken up (Legg 1986; Nelson *et al.* 2009).

Due to difficult terrain, erosion, the wet climate and infestations by weeds and introduced animals, many farms in the eastern Strzelecki Ranges failed and were ultimately abandoned (Legg 1986; Noble 1986). Farms were abandoned as early as 1882 but it wasn't until the late 1920s that farms began to be deserted on a large scale (Legg 1986). By 1930 there were more than 600 square kilometres of abandoned farmland and about 650 square kilometres of additional farmland in a serious state of neglect, representing close to 70% of the farms in the area (Legg 1986).

Following the mass abandonment of farms in the 1920s, further agricultural development in the ranges was not promoted by the government (Legg 1986) and the emphasis for the area became reafforestation; the development of a timber resource (Noble 1986). The Forests Commission (a Victorian state government agency) began buying run down land in the early 1930s while APM Forests Pty Ltd (the forestry division of Australian Paper Mills, with a major milling operation in the nearby Latrobe Valley) began purchasing land in the 1950s. These land acquisitions were followed by the establishment of plantations across the region (Noble 1986).

Currently, around 650 square kilometres of forested land in the eastern Strzelecki Ranges is managed by HVP Plantations (HVP). The remaining area is mostly utilised for agriculture, but also contains numerous parks and reserves (EaCRC 2011b; DELWP 2016). HVP's estate consists of a matrix of plantations and native forest. The predominant species in the plantations are pine (*Pinus radiata*) and eucalypt species (*Eucalyptus regnans, E. nitens and E. globulus*); these are interspersed with around 250 square kilometres of native forest (EaCRC 2011b) managed for conservation purposes (HVP plantations 2015). Eucalypt species that dominate in native forest on the north of the range include Mountain Ash (*E. regnans*), Messmate (*E. obliqua*), Southern Blue Gum (*E. globulus*) and Mountain Grey Gum (*E. cypellocarpa*). On the south of the range Yellow Stringybark (*E. muelleriana*), Mountain Ash, Messmate and Mountain Grey Gum dominate in native forests. Koalas inhabit the forests and plantations of the eastern Strzelecki Ranges. Past research on this population has been scant (EaCRC 2011a); so population structure, fragmentation and the rates of population growth or decline are not known. Preferred food species for koalas in the area are Mountain Grey Gum, Southern Blue Gum and Yellow Stringybark (Allen 2015). In areas containing these tree species, work carried out by HVP (R. Appleton, pers. comm. 2015, HVP) and Allen (2015) independently determined koala density estimates of 0.29 koalas per hectare and 0.25 koalas per hectare, respectively. Koala densities are much lower outside of these areas of good quality habitat (R. Appleton, pers. comm. 2015, HVP). The size of koala habitat trees is important to koala tree use; Allen (2015) demonstrated a preference for large mature trees of three highly favoured species (Mountain Grey Gum, Southern Blue Gum and Yellow Stringybark) in the Strzelecki Ranges, illustrating the importance of mature native forest to koala populations. A preference for larger trees has also been found for Manna Gum (*E. viminalis*) and Blackbutt (*E. pilularis*) in other areas (Santamaria *et al.* 2005; Matthews *et al.* 2007).

Fire has also played a role in environmental change in the eastern Strzelecki Ranges. Several major wildfires have affected the region since the mid-1800s. The first large bushfire documented to have impacted Victoria occurred in 1851, prior to the period in which the ranges were opened up for selection. A quarter of the state is believed to have burned at this time (Pyne 1991; DELWP 2015a). Anecdotal reports, from early settlers of the nearby Gippsland Plain indicate that the Strzelecki Ranges were widely burned by the 'Black Thursday' fires of 1851 and that the dense undergrowth, later encountered in the area, was a result of regrowth following these fires (Murray 1920). Subsequent major fires affecting the region included the Red Tuesday fires of 1898, which burned about 2,600 square kilometres throughout South Gippsland and the Black Friday fires of 1939, which affected an extensive area of the eastern Strzelecki Ranges (Pyne 1991; DELWP 2015a). Part of the eastern Strzelecki Ranges were also burned in the Black Saturday fires of 2009 which affected approximately 200 square kilometres of forest in the area surrounding Traralgon South, Koornalla and Callignee (DELWP 2015a).

In the 1920s and 1930s, koalas had become scarce in the Strzelecki Ranges and were believed to be very near to extinction (Williams 1920; Lewis 1954). However, during this time, surviving koala populations were reported at Wilsons Promontory (Kershaw 1928), Yarram (Lewis 1954) and around Carrajung and the foothills of the Strzelecki Ranges south of Morwell (Martin 1989). Ongoing changes in forest type and density in the Strzelecki Ranges since European settlement are likely to have had a continual impact on koala populations, resulting in a long history

2 One driving force of rapid land clearing in Australia were the Land Selection Acts of the 1800s which required that landholders made certain 'improvements' within their first two years of tenure (Nelson ***et al.*** 2009).

of population disruption and fragmentation. Since land clearing, forest regeneration and plantation establishment has occurred in various areas at different times for almost 150 years (1869–present); koala habitat in the Strzelecki Ranges is therefore likely to have locally shifted, appeared and disappeared since being opened up for selection.

In the mid to late 1800s, hunting of koalas by European settlers for the fur trade was widespread (Lewis 1934). In 1889 throughout Australia, 300,000 koala skins were reported to be exported for the year (Lydekker 1894) while in 1902 more than 600,000 koala skins were exported (*The Advertiser* 1902). Hunting for the commercial fur trade also occurred in the South Gippsland area with one Melbourne tannery reporting that their koala skins were mostly obtained from the South Gippsland region (*Weekly Times* 1896). In December 1898, koalas were provided protection in Victoria under the *Game Act 1890* (Victorian Government 1898). Purportedly however, hunting of koalas continued to some extent by exporting (both interstate and overseas), koala skins falsely labelled as 'wombat' in order to circumvent these protections (*The Argus* 1928; Jackson 2007).

The Gippsland Plain

The Gippsland Plain bioregion surrounds the Strzelecki Ranges bioregion (Figure 1A) and extends from the Mornington Peninsula in the west to Bairnsdale and Lakes Entrance in the east. It includes Phillip and French Islands in Western Port Bay. Altogether, the Gippsland Plain bioregion encompasses an area of about 12,000 square kilometres. On arrival to South Gippsland the first settlers are said to have seen a koala in almost every tree (Lewis 1952). After European settlement, deforestation initially occurred mainly in the fertile coastal areas (Bradshaw 2012) where pastoral runs were taken up from the 1840s; large scale conversion of forest to agricultural land is likely to have begun around 30 years earlier on the Gippsland Plain than in the Strzelecki Ranges. Early after settlement, Howitt (1890) described the Yellow Stringybark forest in the region as consisting of trees ranging from 30 to 60 metres in height and covering an area of around 800 square kilometres, extending from the foothills of the Strzelecki Ranges towards the coast[3]. Within the Strzelecki Ranges, koalas are currently found at relatively high densities in remnant vegetation dominated by Yellow Stringybark (R. Appleton, pers. comm. 2015, HVP; Allen 2015). Due to conversion to farmland, the majority of the Yellow Stringybark forest on the Gippsland Plain no longer exists. Substantial impacts on koala populations would have resulted from the widespread loss of this important food tree in the region. Settlers on the Gippsland Plain did not face the same difficulties as those in the eastern Strzelecki Ranges; agriculture has been successful there and the area is a major dairy centre in Victoria (Agriculture Victoria 2014).

Wilsons Promontory

The third of the South Gippsland Bioregions is Wilsons Promontory, a headland, connected to the Victorian mainland by a low narrow isthmus (~ 8 kilometres wide; Yanakie Isthmus). It extends into Bass Strait forming the southernmost part of the Australian mainland. Wilsons Promontory covers an area of over 400 square kilometres and is located south of the Strzelecki Ranges and Gippsland Plain bioregions (Figure 1). Koalas were once very abundant on Wilsons Promontory and were reportedly common around Oberon Bay, Sealers Cove, Five Mile Beach, Barry Creek, the Darby River area and on the Yanakie Isthmus (Meagher and Kohout 2001; Garnet 2009). Koalas were apparently so common on the promontory that they could be seen "in nearly every manna gum" with "several" often being seen in a single tree (Barrett 1939). Currently, the density of the Wilsons Promontory koala population appears extremely low, and koala sightings are rare (J. Whelan, pers. comm. 2013, Parks Victoria). Reasons for recent decline of the Wilsons Promontory koala population are not clear though the area has undergone a variety of land use and land cover changes since European settlement.

Cattle and sheep were once grazed on the promontory, with pastoral leases encompassing most of Wilsons Promontory from the 1850s (Garnet 2009). During the 1800s, whaling settlements were built at Sealers and Refuge Coves, and Tin Mine Cove was settled by workers mining tin at Mount Hunter (Meagher and Kohout 2001). The forests around Sealers Cove were heavily logged in the 1840s and 1850s as well as in the early 1900s (Garnet 2009). During World War II, a military camp was established at Tidal River with training exercises frequently occurring throughout the park (Meagher and Kohout 2001). Wilsons Promontory was declared a National Park in 1908, though grazing licences were still granted through to the 1970s (Meagher and Kohout 2001). Many plant and animal species were introduced to Wilsons Promontory in the late 1800s and early 1900s (Garnet 2009), including hog deer, emus and kangaroos, which continue to thrive there (Meagher and Kohout 2001; Whelan 2008). Numerous fires have affected the promontory since European settlement, with major wildfires occurring in 1863, 1907/08, 1921, 1939, 1943 and 1951 (Meagher and Kohout 2001; Garnet 2009). Due to its isolation, being largely bounded by sea, fires on Wilsons Promontory are likely to have had a severe impact on wild animal populations, since post-fire recolonization opportunities are limited.

3 In the foothills of the Strzelecki Ranges (on HVP estate), the area currently covered by forest dominated with Yellow Stringybark is around 13 square kilometres. The Won Wron and Mullungdung State Forests to the east of the Strzelecki Ranges (on the Gippsland Plain) encompass about 175 square kilometres of Plains Grassy Woodland (EVC 151) that is often dominated by Yellow Stringybark and/or Messmate and may also be important koala habitat.

In the late 1800s and early 1900s, the koala population on Wilsons Promontory was at a high density (Barrett 1939); hunters were purportedly able to obtain 2000 koala pelts from the promontory in a single year (Hardy 1906). A "diminishing quantity" of koalas was noted by Hardy (1906) and attributed to predation by dingoes and wild dogs for which over 100 strychnine baits were laid by the Field Naturalists Club of Victoria. During 1915–1918 it was reported that koalas were overpopulating Frasers Creek, near Oberon Bay (Kershaw 1915; Hardy 1918) and the flats north of Darby River (Barrett 1939). The flats near Darby were, however, previously forested with "fair sized eucalypts" in which koalas were common, but by 1913, the trees were reported to have been killed by ringbarking[4] (Kershaw 1913). Localised overpopulation of koalas at Wilsons Promontory resulted in the defoliation and death of many of their remaining food trees (Barrett 1939; Menkhorst 2008). In order to prevent the starvation of many animals, koalas were captured and moved to other regions of the promontory, given to wildlife societies across the country and culled (Hardy 1918; *The Argus* 1939). Koalas have persisted on Wilsons Promontory but have not increased to the high levels observed in the early 1900s. The population is currently at very low density illustrating that overpopulation does not necessarily guarantee long term population security.

Pre-European South Gippsland

Humans have inhabited the Australian continent since the arrival of Aboriginal Australians at least 60,000 years ago (Roberts *et al.* 1994; Malaspinas *et al.* 2016). At the time of European settlement, South Gippsland was home to the Brataualung clan of the Gunaikurnai people (Figure 2) (Fison and Howitt 1880; Gunaikurnai Traditional Owner Land Management Board 2016). In the east of the South Gippsland region, the Brataualung people are believed to have lived mainly on the plains near the coast where food was plentiful; the forests of the Strzelecki Ranges were less commonly used as they were too wet, and supported less abundant food resources (Morgan 1997; Gott 2005). Neighbours to west of the Brataualung, were the Bunurong people who lived around Western Port Bay and eastwards into South Gippsland (Wesson 2000; Ellender 2002).

Koalas in South Gippsland were hunted on occasion by Aboriginal people, though to what extent is not well documented (Fison and Howitt 1880; Howitt 1904). Aboriginal people are known to have used fire to promote the availability of food resources, both plant and animal, although there is little information on fire use and regimes locally (Gott 2005; Gott *et al.* 2015). Cahir *et al.* (2016) noted that most historical accounts of Aboriginal burning practices in south-east Australia (including Gippsland) indicate that the application of fire, "was managed, was frequent and was generally over small areas of grassland plains". Conversely, burning of wet sclerophyll forest (such as parts of the Strzelecki Ranges) is not considered likely, especially given the scarcity of food plants in such forests (Gott 2005).

By 1860, the Aboriginal population had decreased dramatically (Gardner 1993). Historic evidence indicates a major cause of decline to be the widespread murder of Aboriginals by the settlers and numerous massacres organised and led by early settler and explorer, Angus McMillan (Gardner 1993). A widespread lack of burning by Aboriginal people in the post-colonial period (Gardner 1993) is likely to have resulted in changes to habitats and their ecosystems that may subsequently have had an impact on resident wildlife populations. For example, in 1840, explorers noted the presence of thick scrub on the Gippsland Plain (Horton and Morris 1983; Morgan 1997) which has been suggested to be growing vigorously on lands previously burned by Aboriginal people, but left unmanaged after their displacement some years before (Ellender 2002). Additionally, localised tree dieback was attributed, by Howitt (1890), to the cessation of firing by Aboriginal people resulting in an increase in insect populations and insect attack.

Early translocations

The Acclimatisation Society of Victoria (ASV) was formed in 1861 with the major aim of introducing foreign "innoxious" plant and animal life to Victoria (ASV 1861). Additional aims included exchanges of live animal specimens with other countries and "the spread of indigenous animals from parts of the colonies where they are already known, to other localities where they are not known" (ASV 1861). The ASV advertised requests for donations of native animals (*The Argus* 1861), including "native bears" (koalas), which were caught and "donated" to the ASV. Little was known about koala husbandry and koalas were difficult to keep in captivity (Le Souef 1878); numerous early attempts to send live koalas to societies overseas failed, resulting in the deaths of these animals (Jackson 2007) and by the 1870s requests for donations of native animals specifically excluded koalas (ASV 1871). A search of Victorian newspapers between 1861 and 1894 found reports of 134 koalas donated to the ASV, with many occurring after the 1870s (Appendix, Table A1); it is therefore clear that receipt of these animals continued despite their exclusion from advertisements. Ferdinand von Mueller, government botanist and member of the ASV reported that koalas were sent to Hobart Town, Tasmania in 1862 (three koalas; *The Leader* 1862), 1864 (eight koalas; *The Argus* 1864) and 1872 (nine koalas; ASV 1872) and to South Australia in 1864 (five koalas; *The Leader* 1864). Apart from the few releases listed above, evidence indicating the fate of the many koalas donated to the ASV were not located. Though undocumented,

4 Ringbarking describes the cutting away of bark around a tree trunk in order to kill the tree. Ringbarking was an often-employed method for clearing trees for agricultural purposes.

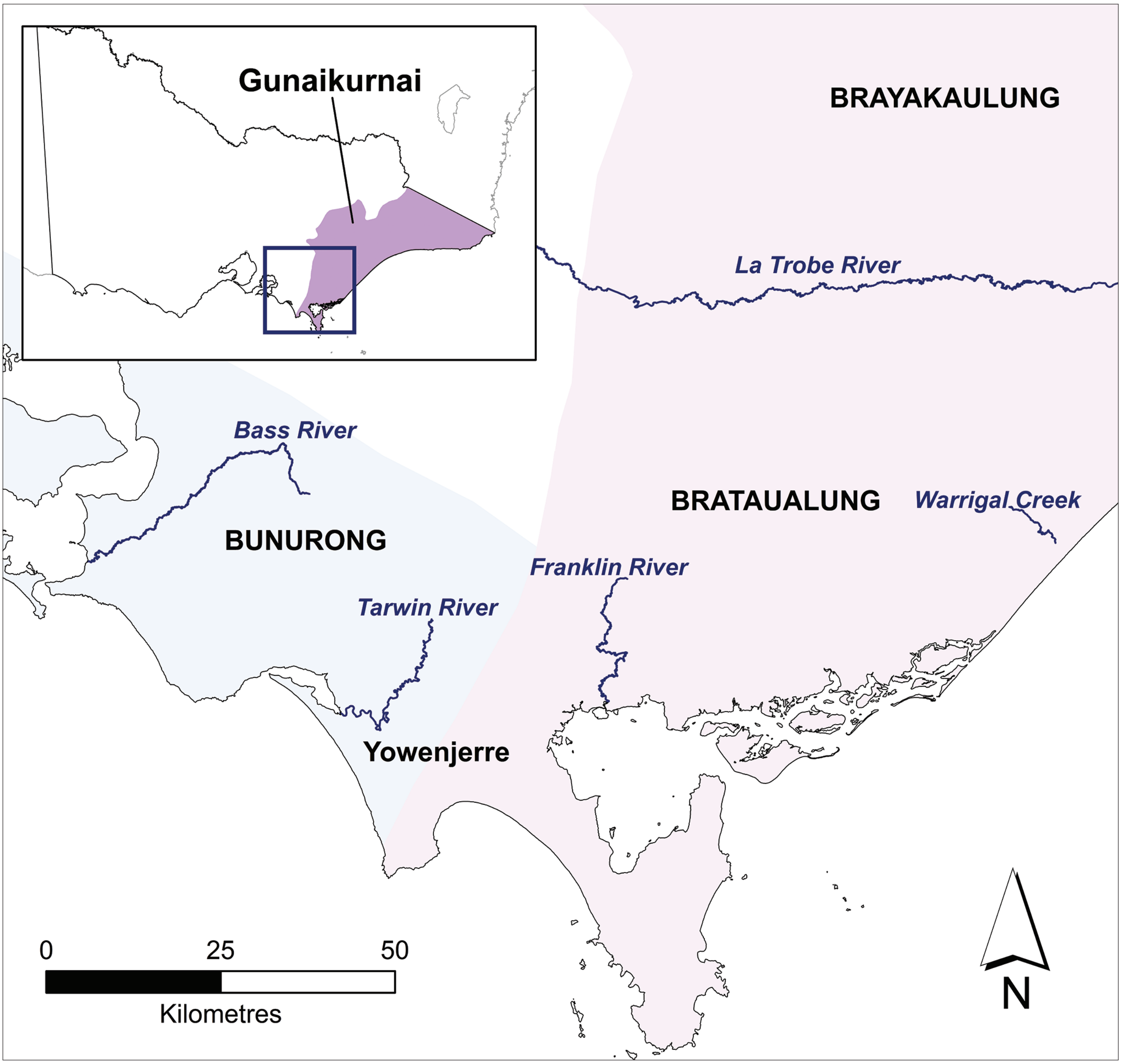

Figure 2. Aboriginal clans in the South Gippsland region. Adapted from Fison and Howitt (1880), Ellender (2002) and Gaughwin and Sullivan (1984).

numerous koalas are likely to have been transferred from one area to another via the ASV and their donors, as well as by other individuals or groups. In 1911, for example, while in the Wonthaggi district (on the Gippsland Plain), Nicholls (1911) reported having heard that thirty koalas had been sold to travellers from a nearby train station platform at Christmastime for half a crown each.

French and Phillip Islands

Phillip and French Islands in Western Port Bay were not inhabited by koalas at the time of settlement. The current French Island koala population is believed to have been founded by a single release of a small number of koalas taken to the island by fishermen from Corinella in the late 1800s (Figure 3; Lewis 1954). In *The Argus* (1924), J. G. Palmer from Corinella stated that in around 1898–1900 his brother, F. Palmer took two "old" koalas and one "young" koala from the mainland and released them on French Island. Genetic evidence suggests that a minimum of three individuals (Houlden *et al.* 1996) founded the French Island population: two females and one male (Taylor *et al.* 1997).

The Phillip Island koala population was established by a larger number of individuals than the three released on French Island with introductions occurring on more than one occasion (Figure 3; Lewis 1954). John McHaffie

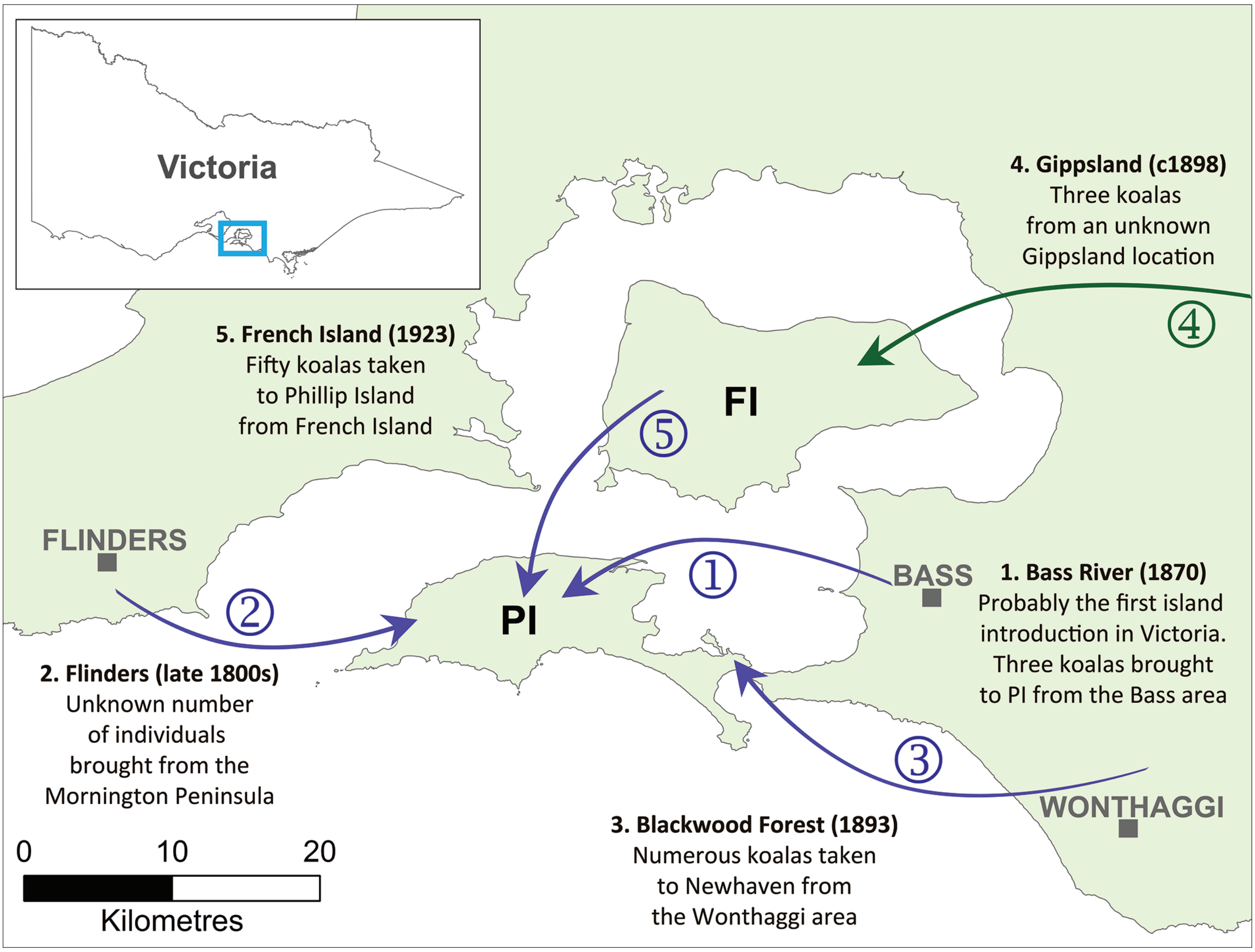

Figure 3. Map illustrating the 1800s history of koalas moved to French Island (FI) and Phillip Island (PI) in Western Port Bay, as described in the text, whose descendants were to become the source of most contemporary Victorian koala populations.

was the sole occupant of Phillip Island from 1848–1868 a dedicated member of the ASV, breeding and releasing many animals on Phillip Island for the society (Wright 1980), though no evidence was located to suggest that koalas were ever released on Phillip Island by the ASV. Koalas were reportedly taken to Phillip Island by early pioneers (Gliddon 1958; Edgecombe 1989) and were brought from Bass River, by J. F. Smith, in 1870 (Lewis 1954; Gliddon 1958); from Flinders (on the Mornington Peninsula), by W. Kennon (Lewis 1954); from Blackwood Forest (near Wonthaggi), by C. and R. Grayden in 1893 (*The Age* 1938; Lewis 1954); and from French Island, by W. E. Thompson in 1923 (Lewis 1954).

Gliddon (1958) describes Mr John F. Smith's recollection of hunting for wallabies at Bass River in 1880 with his brother, George, and Bill and Jack Walton. During this hunting trip, three koala joeys were captured and brought back to Phillip Island. Richard Grayden reported, in a letter to the editor in *The Age* (1938), that as a teenager, he had captured dozens of koala joeys from Blackwood Forest (near Wonthaggi). These, he took home to Newhaven, Phillip Island, where "every child living there had one for a pet" and "after a few days they were allowed to climb a tree, and soon gained their freedom". Richard Grayden stated that it was after this time that the koala population increased and spread across the entire island and also mentions that the introduction of 50 French Island koalas to Phillip Island by Mr. Thompson in 1923 was prompted by a particularly wet winter which resulted in the death of many koalas on Phillip Island (*The Age* 1938).

Unsustainable koala densities can occur where habitat is isolated and/or animals are unable or unwilling to disperse (Whisson *et al.* 2016), often resulting in over browsing and death of food trees, which may subsequently lead to the starvation of individual animals. Increased population densities therefore often necessitate the relocation of animals to other regions to prevent the death of both trees and koalas (Menkhorst 2004; DELWP 2015b). By the 1920s and 1940s, the koalas released on French and Phillip Islands, became established to the point of unsustainability; the population density having increased above the carrying capacity of the islands.

Re-establishing koala populations across Victoria

In 1924, 25 years after the initial release of as few as three koalas on French Island, it was reported that around 20 koalas could be counted along a 400 metre stretch of forested road (*The Argus* 1924). At roughly the same time, the first documented translocation, as mentioned in the preceding section, was undertaken (by W. E. Thompson), where, assisted by schoolchildren, 50 French Island koalas were captured and released on Phillip Island (*Frankston and Somerville Standard* 1924; Martin 1989). The first translocations from Phillip Island were carried out in 1941 (Martin 1989). Such translocations were intended to solve the growing problem of koala overpopulation on the islands as well as to assist koala conservation by re-establishing mainland koala populations (Menkhorst 2008).

Since the state government translocation program began in the 1920s, koalas have been released at hundreds of different sites across Victoria[5] (Menkhorst 2008). Over 8,500 koalas were translocated from French Island between 1923 and 2006 (Menkhorst 2008), while approximately 3,500 Phillip Island koalas were translocated to various sites across Victoria between 1941 and 19786 (Martin 1989). Since 1978, however, the Phillip Island koala population has declined considerably to an estimated 13 individuals in 2006 (EaCRC 2011a), again illustrating how population size can change dramatically over a relatively short time span. The re-establishment of koala populations across Victoria, through the translocation program, has been claimed to have been so successful that koalas are currently occupying almost all suitable habitat in the state (Menkhorst 2008). A history of koala management and the translocation program in Victoria has been thoroughly reviewed by Menkhorst (2008) and reveals that most koala populations in Victoria are descended from the small numbers of founding individuals initially introduced to French and Phillip Islands.

It is unlikely that the full breadth of koala translocations is known, given undocumented translocations by the ASV in the late 1800s, and since then by the government, wildlife carers (Guy and Banks 2012) and other individuals. Documented translocation data may also be incomplete or have inaccuracies (e.g. Hogan *et al.* 2013). For example, official translocation records indicate that six and twelve French Island koalas were translocated to Kangaroo Island, South Australia in 1923 and 1925, respectively (Martin 1989). A report in *The Argus* (1923), however, reports that the first six koalas translocated to Flinders Chase, Kangaroo Island in 1923 were from Wilsons Promontory National Park (rather than French Island) which was at the time highly overpopulated (Kershaw 1915; Hardy 1918; Barrett 1939). Genetic data also provides evidence that the documented source population for the first Kangaroo Island translocation may be inaccurate; alleles and haplotypes not present in the French Island population have been detected in the Kangaroo Island population (Houlden *et al.* 1996; Cristescu *et al.* 2009; Cristescu *et al.* 2010; Neaves *et al.* 2016). The Kangaroo Island koala population may, therefore, have been established by a broader subset of koalas than from French Island alone. Findings such as these reinforce the need to confirm historic records using molecular methods, where required, in order to ensure that management decisions are based on the most accurate information possible.

Genetic diversity in Victorian koala populations

Although government translocations (1923–present) of koalas within Victoria have been successful in terms of re-establishing koala populations across the state, the translocations that followed the decimation of Victorian mainland koala populations are likely to have had an overall negative impact on the genetic diversity of Victorian koalas. By the 1920s the koala was nearing extinction (Lewis 1954) and the gene pool already narrowed. A state government investigation at the time estimated that the koala population on the Victorian mainland had been reduced to around 500 to 1000 individuals, predominantly located in and near to the Strzelecki Ranges (Lewis 1934; Lewis 1954; Martin 1989; Menkhorst 2008). The Victorian situation was mirrored in other states at this time. In the 1920s there were an estimated 10,000 koalas remaining in Queensland, 200 in New South Wales and none in South Australia[7], though whether koalas were widely distributed in South Australia at the time of European settlement is not clear[8] (Phillips 1990). This represented a considerable reduction in population size and hence a loss of genetic diversity (known as a genetic bottleneck) for koala populations at a national scale.

When populations decrease in size, there is an initial loss of genetic diversity and a possibility of continued loss across future generations due to chance, in a process called genetic drift (Frankham *et al.* 2012). Small population sizes also increase the chance of inbreeding which can further exacerbate losses of genetic diversity (Frankham *et*

5 Koala translocations continue to present day (2017) in order to manage the size of some Victorian koala populations

6 These figures represent official documented translocations and therefore the minimum number of individuals translocated. It is possible that further official translocations occurred for which documents were not kept or have been lost. More than 12,000 additional individuals have also been translocated from other populations established by the translocation program (Menkhorst 2008).

7 Although the koala is considered a single species (Houlden ***et al.*** 1999), documented translocations across state borders have not been common and may have been bureaucratically difficult.

8 It is stated in Lewis (1952) that "when white people first came to Australia the koala was exceedingly abundant in the three eastern mainland States, even extending into South Australia at the south-east corner, along the Glenelg Valley".

al. 2012). In addition, when a small subset of individuals separate and establish a new population (either naturally or via translocation), genetic structure can be altered further. These changes are termed 'founder effects' by population geneticists (Frankham *et al.* 2012).

The founder effect is relevant to many modern Victorian koala populations. The translocation of small numbers of Gippsland koalas to French and Phillip Islands is an example. Since the numbers of founding individuals for both island populations were small, further losses of genetic diversity due to inbreeding and chance (genetic drift) may have occurred within the island populations. Because these island populations were subsequently used as source populations for additional translocations, to re-establish koala populations in other areas of Victoria, the situation has been exacerbated. Mainland koala populations founded by island individuals have undergone at least two genetic bottlenecks within 100 years, with some populations having undergone multiple founder events, potentially resulting in even greater losses of genetic diversity.

The importance of genetic diversity

Genetic variation is important as it provides populations with the capacity to adapt and survive environmental changes, while decreased variation negatively affects survival, growth and reproduction rates (Sherwin *et al.* 2000; Frankham *et al.* 2012). Species that have been subjected to bottlenecks in the past are at a greater risk of extinction, even when numbers of individuals within populations recover (Bijlsma *et al.* 2000). Levels of genetic variability can therefore be more important than abundance for a population's future viability. For example, the Tasmanian devil (*Sarcophilus harrisii*) was abundant in Tasmania prior to 1996, despite its history of bottlenecks and low levels of genetic diversity (Siddle *et al.* 2007). Since that time, Tasmanian devil populations have decreased by between 50% and 90% due to the emergence of the highly contagious, devil facial tumour disease (Siddle *et al.* 2007). Low genetic diversity is thought to have resulted in a reduced ability of the Tasmanian devils' immune systems to recognise and destroy tumour cells (Siddle *et al.* 2007; Woods *et al.* 2007). This is not to say, however, that species with low genetic diversity do not have a future in the long term, as there are examples of species surviving for relatively long periods despite low genetic diversity (Reed 2010). The risk of extinction due to low diversity also depends on life history, stochastic factors and the interplay between them (Reed 2010). Certain Victorian koala populations with low levels of diversity are currently thriving, however, there is a chance that these populations are yet to be subjected to pressures to which they may not be able to cope with because of their limited gene pool. Such a situation is likely to result in population declines. There is therefore potential for low diversity koala populations to undergo rapid decline due to future pressures such as epidemics, changes in climate and/or further loss or fragmentation of suitable habitat.

Chlamydia associated risks

A disease which afflicts some koala populations is chlamydiosis. It results from a bacterial infection with *Chlamydia* and can affect the urinary and reproductive tracts, sometimes rendering female koalas sterile. *Chlamydia* can spread quickly through populations. Translocation of *Chlamydia* free animals to habitat containing resident *Chlamydia* positive individuals was found to result in the infection of 13/14 animals tested after 19 months (Santamaria and Schlagloth 2016). This study did not observe any overt signs of infection, however, breeding success went from 6/16 in the first breeding season to 1/16 in the second breeding season. *Chlamydia* is not currently widespread in koala populations derived solely from French Island (Emmins 1996; Legione *et al.* 2016a; Legione *et al.* 2016b) and, on exposure, these koalas are sometimes found to be more susceptible to severe infections (Martin and Handasyde 1990). Therefore, koala populations derived from the historical French Island population could be at greater risk of future declines and extinction if urogenital infections with *Chlamydia* were to become prevalent in these populations. This situation is suggested to have occurred for the koala population in the Grampians National Park, established by the translocation of 611 French Island (*Chlamydia* negative) individuals in 1957 (Martin 1989; Martin and Handasyde 1999). The Grampians population quickly increased, but crashed in the 1970s (Menkhorst 2008) and afterwards remained at much lower densities (Martin and Handasyde 1999). A survey of the Grampians population in 1986/7 identified high levels of infection and a fertility rate of zero (Martin and Handasyde 1990). The decline in the Grampians koala population has been suggested to be due to the release of 60 *Chlamydia* positive koalas[9] translocated to the Grampians National Park in 1963 and the subsequent spread of *Chlamydia* throughout the naïve population (Martin and Handasyde 1999).

Population genetic studies in the South Gippsland region

The history and geography of landscapes in South Gippsland landscape are thought to have permitted the survival of a relatively substantial koala population at the time when most other Victorian koala populations had severely declined or were extirpated (Lewis 1954; Houlden *et al.* 1999; Menkhorst 2008; Lee *et al.* 2011). The South

9 The 60 koalas were from Wartook Island in the Grampians. This population had been founded by stock from Phillip Island and the Creswick koala reserve (the latter originally established using Phillip Island koalas; Martin 1989).

Gippsland koala population has also remained somewhat separated from other Victorian koala populations. Current government policy prohibits the release of island-derived animals in South Gippsland (Menkhorst 2004), though several early translocations from island populations to South Gippsland have occurred (Figure 1B). The extent to which island individuals may have integrated with local populations is unknown, though genetic studies show that remnant diversity exists in South Gippsland indicating that complete genetic swamping of local diversity by translocated island animals did not occur (Lee *et al.* 2011; F. Wedrowicz, unpublished).

Genetic studies have shown that the South Gippsland koala population, which includes koalas in both the Strzelecki Ranges and Gippsland Plain bioregions, is genetically different from, and more diverse than, island populations and their descendants (Emmins 1996; Houlden *et al.* 1999; Lee *et al.* 2011; F. Wedrowicz, unpublished). The greater genetic diversity of the South Gippsland koala population could provide it with a greater chance of survival, compared to island derived populations, when challenged with future environmental changes. The potential importance of the South Gippsland koala population is recognised within Victoria (Martin 1989; Menkhorst 2004), though comprehensive surveys of genetic diversity in South Gippsland and throughout Victoria, to identify other potential remnant populations, are lacking. Koala population trends in South Gippsland are also unknown and there is a need for such data to inform appropriate conservation strategies.

Conclusions

After European settlement, widespread landscape modification occurred rapidly, resulting in irreversible changes to landscapes and their flora and fauna. Species extinctions, and, in surviving species, the loss of biodiversity at genetic levels, are effects that cannot be undone. This article has discussed a range of past anthropogenic and environmental impacts, which have occurred over the last two centuries and which have affected the South Gippsland koala population. Further genetic studies in the region can provide us with key understandings that will help us to gain a more thorough appreciation of past events and their effects. The management of overabundant koala populations, in order to protect habitat and prevent widespread starvation of individual koalas, has been a key focus for the Victoria government. Of some concern for these populations, is that large population sizes may not be sufficient to evade the problems associated with low genetic diversity in the future. Conservation of the South Gippsland koala population and its genetic diversity is important because its higher genetic diversity may increase this population's future viability relative to other Victorian populations (Menkhorst 2004). The morphological (e.g. Briscoe *et al.* 2015) and genetic diversity (F. Wedrowicz, unpublished) present in South Gippsland koalas' represents a unique subset of the total diversity present across the species' range. The success of any one population in the face of future environmental changes is not known; some populations may persist while others may become extirpated. Conserving populations and their genetic diversity across the entire range of a species is important to minimise the risk of extinction. To date, research and data collection for Victorian koala populations has focussed on the few translocated populations that have become overabundant and require management. Information for a larger number of populations, particularly those with high levels of remnant genetic diversity, is needed for a successful approach to koala management and conservation. Studies to identify additional populations with high genetic diversity, to understand genetic relationships within and between populations and to monitor population size and impacts of disease are key actions required for future koala conservation.

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APPENDIX I

List of koalas reported to have been donated to the Acclimatisation Society of Victoria between 1861 and 1894. This summary is likely to be far from complete but gives an indication of the number of koalas that were purportedly removed from the wild and donated to the Acclimatisation Society in the late 1800s.

Date	Paper	Page	No. koalas	Donated by	Of
16/11/1861	*The Argus*	4	1	Mr. Trenchard	St Kilda
28/3/1862	*The Age*	5	1	Mr. Saint	Russell St
19/6/1862	*The Argus*	5	1	Mr. Richard Vinicombe Dennis	Birregurru
25/9/1862	*The Age*	4	1	Mr. W. Watson	Wooling, near Gisborne
30/10/1862	*The Argus*	5	1	Mr. Fleming	Plenty
30/10/1862	*The Argus*	5	2	Mr. John Mason	Belfast
20/11/1862	*The Age*	5	2	Mr. Feehan	City Arms Hotel
18/12/1862	*The Age*	4	1	Mr. Durrell	Gisborne
18/12/1862	*The Geelong Advertiser*	5	1	Mr. Landells	
8/1/1863	*The Argus*	4	1	Messrs J & R Waugh	Queensberry St
8/1/1863	*The Argus*	4	1	Mr. Hutton	North Melbourne
15/1/1863	*The Bendigo Advertiser*	2	1	Mr. Collie	Carlton
16/4/1863	*The Argus*	5	1	Mr. Mulcahey	
26/11/1863	*The Age*	5	1	Mr. R. T. Firebrace	Heyfield, Gippsland
31/12/1863	*The Age*	5	1	Mr. Bagshawe	Eltham
31/12/1863	*The Argus*	6	1	Mr. P. C. Borkey	Richmond
21/1/1864	*The Age*	5	1	Mr. J. Harvey	Woodend
18/2/1864	*The Argus*	2	1	Mr. Henry Howard	Schnapper Point
4/3/1864	*The Farmer's Journal and Gardener's Chronicle*	12	1	Mr. Tom Chew	Princess St, Fitzroy
10/3/1864	*The Argus*	5	1	Mr. Purvis	Richmond
14/4/1864	*The Age*	4	2	Miss Ellis Ryan	Brighton
12/11/1866	*The Geelong Advertiser*	2	1 white	Mr. J. Connor	M.L.A Colac
9/1/1867	*The Age*	5	1	Mr. D. C. Macarthur	Heidelberg
23/3/1867	*The Australasian*	3	1	Mrs. Hubbard	via Geelong branch
23/3/1867	*The Australasian*	3	1	Mr. Bedgegood	via Geelong branch
31/5/1869	*The Geelong Advertiser*	2	1	Mrs. Blackwood	
16/1/1871	*The Geelong Advertiser*	2	1	Mr. W. Higgins	
20/11/1872	*The Argus*	5	1	Mr. Baxter jun.	Frankston
4/12/1872	*The Age*	2	1	Mr. Robertson	Hotham
18/12/1872	*The Argus*	15	1	Mr. Edgar Slade	Alberton
1/2/1873	*The Australasian*	21	1	Mr. Harding	Maldon
24/9/1873	*The Age*	2	1	Mr. W. Robertson	Wooling

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Date	Paper	Page	No. koalas	Donated by	Of
10/3/1873	*The Ballarat Star*	2	1	Mr. Pickering	Smeaton
8/7/1874	*The Age*	2	1	Mr. Lewellyn	Prahran
25/11/1874	*The Argus*	6	1	Mr. William Lyall	Hazelwood
1/9/1875	*The Argus*	5	2 young	Mr. Ledger	Longwood
29/9/1875	*The Argus*	5	1		Chitern & Murray Acclimatisation Society
27/10/1875	*The Argus*	5	1	Mr. George Black	Norfolk Hotel, Collingwood
8/12/1875	*The Argus*	5	1	Mr. Batts	Yarra Flats
8/12/1875	*The Argus*	5	2	Mr. Oliver	Coliban Park
16/2/1876	*The Argus*	5	1	Mr. Godfrey	Mt Ridley
25/4/1877	*The Argus*	5	1	Mr. Murdoch	Wangaratta
13/4/1878	*The Australasian*	19	1	Mr. C. Tuck	Brighton
25/10/1878	*The Age*	3	1 white	Messrs. Griffiths and Gaunt	Bourke St
25/10/1878	*The Age*	3	1	Mrs. E. M. James	Collins St East
17/1/1879	*The Argus*	5	1	Mr. J. Sweetman	Carlton
26/3/1879	*The Argus*	5	1	Mr. Ballanger	Carlton Brewery
19/12/1879	*The Age*	3	1	Mr. E. C. Clark	Penal Dept., Melbourne
28/1/1880	*The Age*	3	1	Mr. Mindah	Hotham
28/1/1880	*The Age*	3	1	Mr. Simpson	Carlton
21/8/1880	*The Australasian*	19	1	Mr. H. O. Rosson	Bunyip
8/9/1880	*The Argus*	5	2	Mr. French	
8/9/1880	*The Argus*	5	1	Miss Annie Stewart	Western Port
8/9/1880	*The Argus*	5	2	Mr. Saunders	Mickleham
8/10/1880	*The Argus*	5	2	Mr. French	Christmas Hills
22/10/1880	*The Argus*	5	1	Mr. A. Miller	Carlton
20/11/1880	*The Australasian*	19	1	Mr. Coulthard	Carlton
20/11/1880	*The Australasian*	19	1	Mr. R. W. Blythman	Benalla
20/11/1880	*The Australasian*	19	1	Mr. R. Ralston	Wandong
29/1/1881	*The Australasian*	21	1	Mr. Max Straubel	Richmond
26/3/1881	*The Age*	5	1	Mr. Greenwood	
6/5/1881	*The Argus*	5	1	Mr. John Howlett	Hotham
6/5/1881	*The Argus*	5	1	Mr. C. E. May	Melbourne
20/5/1881	*The Age*	2	1	Mrs. Evans	Hotham
1/6/1881	*The Age*	3	1	Mr. Turner	Melbourne
30/6/1881	*The Argus*	5	1	Mr. McKellar	Strathkellar
26/1/1882	*The Argus*	7	1	Mr. Mowling	Windsor

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Date	Paper	Page	No. koalas	Donated by	Of
9/3/1882	*The Age*	3	1	Mr. G. A. Tyler	South Yarra
19/4/1882	*The Argus*	9	1	Mr. W. F. McFee	Hawthorn
4/10/1882	*The Argus*	5	1	Mr. John Johnson	Ascotvale, Flemington
18/10/1882	*The Argus*	5	1	Mr. A. Browning	Batman's Hill
11/1/1883	*The Age*	3	1	Mr. Thompson	Dandenong
11/1/1883	*The Age*	3	1	Mr. Bondle	Royal Park
22/8/1883	*The Argus*	11	2	Mr. John McMahon	Fitzroy
12/12/1883	*The Argus*	11	1	Mr. E. Baldwin	Kyneton
12/12/1883	*The Argus*	11	1 white	Mr. A. Kemp	Kew
10/1/1884	*The Argus*	9	1	Mr. Wm. Hurst	South Melbourne
10/1/1884	*The Argus*	9	1	Mr. Wm. Foster	Brunswick
10/1/1884	*The Argus*	9	1	Mr. D. Gotard	
4/11/1884	*The Argus*	9	1	Mr. F. T. Conway	Yea
2/12/1884	*The Age*	5	1	Mr. S. Merriman	South Melbourne
8/1/1885	*The Argus*	5	1	Mr. Charles Coles	St Kilda
8/1/1885	*The Argus*	5	1	Mr. Malpas	Mount Ridley, Craigieburn
8/1/1885	*The Argus*	5	1	Mr. A. H. S. Lucas	
20/5/1885	*The Age*	6	1	Mr. Spurr	Fitzroy
21/8/1885	*The Age*	7	1	Mr. John McMahon	Trafalgar, Gippsland
8/10/1885	*The Argus*	7	1	Mr. Wm. Bott	William St, Melbourne
8/10/1885	*The Argus*	7	1	Mr. Hugh Gilmour	Broadmeadows
3/12/1885	*The Argus*	10	1	Mr. A. H. Olsson	Macedon
3/12/1885	*The Argus*	10	1	President of the Shire of Echuca, Rochester	
22/12/1885	*The Argus*	5	1	Mr. William Davies jun.	Coburg
22/12/1885	*The Argus*	5	1	Dr. H. R. Bell	
4/3/1886	*The Argus*	11	1	Mr. J. Fleming	Park St, Brunswick
21/4/1886	*The Age*	6	1	Mr. A Howre	Hotham
24/6/1886	*The Argus*	9	1	Mr. Shaw	Coranderrk Aboriginal Station
8/7/1886	*The Argus*	9	1	Miss C Steward	Church St, North Fitzroy
19/10/1886	*The Argus*	10	1	Master Joseph Barrett	South Melbourne
19/10/1886	*The Argus*	10	1	Mr. James Webb	Gippsland
3/11/1886	*The Argus*	10	1	Mr. R. Sparks	
9/3/1887	*The Argus*	7	1	Mr. W. H. Pangbourne	Carlton

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Date	Paper	Page	No. koalas	Donated by	Of
7/9/1887	*The Argus*	6	1	Mr. F. W. Burne	William St, Collingwood
21/12/1887	*The Argus*	5	1	Mr. Henry Harris	Fitzroy
20/1/1888	*The Age*	6	1	Mr. Alfred Weaver	116 Queens Parade
20/1/1888	*The Age*	6	1	Mr. Harry Cox	Trafalgar
7/3/1888	*The Argus*	4	1	Mr. Skinner	Bank St, South Melbourne
7/3/1888	*The Argus*	4	1	Mr. H. Cox	Trafalgar
21/3/1888	*The Argus*	5	1	Freestone Brick Company	Brunswick
19/6/1888	*The Argus*	5	1	Mr. Marstin	Hotham
1/8/1888	*The Argus*	8	1	Mr. Hertie Kohry	Ellacombe, Newport
6/10/1888	*The Argus*	11	1	Messrs. A. Campbell & N. Morrison	Hamilton
6/10/1888	*The Argus*	11	1	Mr. J. H. Elliot	North Fitzroy
17/10/1888	*The Argus*	16	1	Mr. Lowe	Clifton Hill
31/10/1888	*The Age*	13	1	Master Thomas D. Parry	Drouin
20/2/1889	*The Argus*	11	1	Mr. W. J. Cruddas	Glenferrie Rd, Malvern
4/9/1889	*The Argus*	11	1 white	Mr. F. Laner	Drouin, South Gippsland
22/11/1889	*The Argus*	11	1	Mr. J. Burston	Carlton
22/11/1889	*The Argus*	11	1	Mr. Magreath	Fitzroy
9/7/1890	*The Argus*	5	1	Mr. M. J. Brennan	Melbourne
9/7/1890	*The Argus*	5	1	Mr. F. H. McCarthy	Charleville
3/9/1891	*The Argus*	11	1	Mr. Stuart	Windsor
17/8/1892	*The Age*	7	1	Mr. T. Brown	Keilor
6/12/1893	*The Age*	7	1	Mr. F. Marshall	Carlton
8/2/1894	*The Age*	3	2	Mr. W. Irvine	Burwood