NSW SCIENTIFIC COMMITTEE

Preliminary Determination

The Scientific Committee, established by the *Threatened Species Conservation Act* 1995 (the Act), has made a Preliminary Determination to support a proposal to list a population of the Koala *Phascolarctos cinereus* (Goldfuss, 1817) in the Port Stephens area (north of the Hunter River, east of the Pacific Highway and south of Nelson Bay/Karuah River) as an ENDANGERED POPULATION in Part 2 of Schedule 1 of the Act. Listing of Endangered populations is provided for by Part 2 of the Act.

The Scientific Committee has found that:

1. The Koala *Phascolarctos cinereus* (Goldfuss, 1817) (family Phascolarctidae) is not currently listed as an Endangered species in Part 1 of Schedule 1 or a Critically Endangered species in Part 1 of Schedule 1A and, as a consequence, populations of this species are eligible to be listed as Endangered populations. The Koala population which is the subject of this determination is located within the area north of the Hunter River, east of the Pacific Highway and south of Nelson Bay/Karuah River in the Port Stephens area.

2. The Koala is a medium-sized, stocky marsupial: head-body 674–820 mm (males), 648–730 mm (females); weight 4.2–14.9 kg (males), 4.1–11 kg (females). The tail is vestigial, the limbs are well developed and all paws are equipped with long robust claws. The woolly fur ranges from grey to brown dorsally and is paler ventrally, often with irregular pale patches on the rump. The ears are large, oval and well furred; the nose is prominent, unfurred and black (Van Dyck and Strahan 2008; Menkhorst and Knight 2010; OEH 2013).

3. Koalas are arboreal and obligate folivores feeding predominately on leaves from *Eucalyptus* trees (over 70 species) but in any one area have a small range of preferred species (Martin and Handasyde 1999; Van Dyck and Strahan 2008; OEH 2013). In the Port Stephens area, Swamp Mahogany (*Eucalyptus robusta*) and Drooping Red Gum (*E. parramattensis*), are preferred by Koalas for browse (Phillips *et al.* 2000). Koalas inhabit a variety of woodlands and forests that are dominated by *Eucalyptus* tree species. Recent radio-tracking of Koalas at Port Stephens also confirms the importance of high quality swamp sclerophyll forest dominated by Broad-leafed Paperbark (*Melaleuca quinquenervia*) and Swamp Mahogany (*E. robusta*) (McLean *in litt*. May 2017). Forest Red Gum (*E. tereticornis*) growing on soils derived from Quaternary alluvials and volcanics has also been identified as a food source for Koalas in Port Stephens (Port Stephens Council 2002). Some other plants are also occasionally consumed, including species of *Acacia*, *Corymbia*, *Angophora*, *Leptospermum* and *Melaleuca* (Martin and Handasyde 1999; Port Stephens Council 2002; CoA 2011).

4. Koalas are largely sedentary and spend up to 20 hours per day resting or sleeping, often in a fork of a tree. They are most active at night, climbing into the canopy to feed or moving within or between trees. Koalas spend most of their time in trees but will descend and traverse open ground to move between trees (Martin and Handasyde 1999; Van Dyck and Strahan 2008). Koalas are generally solitary and home range size varies from less than 2 ha to over 100 ha depending on habitat quality (Martin and Handasyde 1999; Van Dyck and Strahan 2008). In a post-wildfire environment at Port Stephens Koala home ranges are reported to be between 0.2

Contact Address: C/o PO Box 1967 Hurstville BC NSW 1481 Telephone: (02) 9585 6940 Facsimile: (02) 9585 6606

ha to 171.2 ha (average 39.5 ha) (Matthews *et al.* 2016). Home ranges may overlap among individuals of the same sex in high quality habitat but are usually discrete in drier or less fertile areas. Males have larger home ranges than females and a dominant male's home range overlaps with those of several females and subordinate males (Martin and Handasyde 1999; DECC 2008; Van Dyck and Strahan 2008; OEH 2013; Matthews *et al.* 2016). Adult Koalas show a high level of site fidelity, although at 2–3 years of age, young adult Koalas of both sexes disperse from their natal range, typically moving 0.3–20 km, to establish their own home range (Mitchell 1990; Mitchell and Martin 1990; Dique *et al*. 2003a; Kavanagh *et al*. 2007; DECC 2008; Matthews *et al.* 2016). Sexual maturity in female Koalas is reached from eighteen months and in the wild they produce one offspring every 1-2 years (McLean and Handasyde 2006). Female Koalas live to about 15 years and males to 12 years (CoA 2011). The generation length is estimated to be 6 years (Phillips 2000).

5. Koalas are widespread in eastern Australia, distributed from north-eastern Queensland to south-eastern South Australia (CoA 2011). The Koala was once widely distributed throughout the eastern half of New South Wales (NSW) (DECC 2008). Koalas generally occur at low altitudes (< 800 m) and are most common in the foothills of the ranges and coastal plains (Van Dyck and Strahan 2008). Due to extensive clearing of forest and woodland for agriculture and urban development, the distribution of the Koala is now highly fragmented (Martin and Handasyde 1999; Van Dyck and Strahan 2008). In New South Wales, Koala populations are now concentrated on the central and north coast and west of the Great Dividing Range in the north of the state. Smaller isolated populations also occur on the tablelands and the south coast (DECC 2008; OEH 2013). Studies of factors influencing the distribution of Koalas in south-eastern Queensland indicate that the likelihood of Koala presence declines rapidly as forest cover drops below 60–70% of the landscape (McAlpine *et al*. 2006, 2007). In addition, Koala presence starts to decline when patches of habitat are <150 ha. Koalas are likely to be absent from habitat patches smaller than 50 ha (McAlpine *et al*. 2007). However, in some parts of NSW, Koalas persist in peri-urban areas such as Port Macquarie and Coffs Harbour (Lunney *et al.* 2016) and in highly fragmented rural landscapes such as the Liverpool Plains (Kavanagh and Stanton 2012).

6. On the mid-north coast of New South Wales records of Koalas between the Hunter River and Nelson Bay/ Karuah River are most common on the Tomaree Peninsula, the Medowie-Tilligerry area and Heatherbrae/Raymond Terrace area (Knott *et al.* 1998; OEH *in litt*. 29 June 2016). Prior to European settlement the Port Stephens area contained a substantial amount of contiguous Koala habitat of varying significance, which covered approximately 70% of the Port Stephens Local Government Area (Knott *et al.* 1998). During the last two centuries, this area has been severely modified with habitat highly fragmented as a result of clearing for agriculture, housing, sand mining and roads (Knott *et al.* 1998). Clearing first commenced on fertile and well-watered lands along the banks of the Lower Hunter and Williams Rivers which were rapidly and extensively cleared and then later progressed to the east (Knott *et al.* 1998).

7. The Koala population which is the subject of this determination is located within the area north of the Hunter River, east of the Pacific Highway and south of Nelson Bay/Karuah River in the Port Stephens area. This population consists of three sub-populations – Tomaree, Medowie-Tilligerry and Ferodale-Karuah. The first two of these sub-populations provide most of the

Contact Address: C/o PO Box 1967 Hurstville BC NSW 1481 Telephone: (02) 9585 6940 Facsimile: (02) 9585 6606

records of the species in the region, showing a concentration of Koala records from Heatherbrae/Raymond Terrace in the west to Shoal Bay in the east, and especially in the Tomaree and Medowie-Tilligerry areas (Knott *et al.* 1998; OEH *in litt*. 29 June 2016). Land clearing patterns and topography have rendered the Tomaree Peninsula population relatively isolated, limiting recolonisation both to and from this area from nearby populations (Knott *et al.* 1998). Recent Koala records are extremely sparse in the third sub-population (Feroday-Karuah) which extends north from the other two toward Limeburners Creek (Knott *et al.* 1998; OEH *in litt*. 29 June 2016). Port Stephens Council (2002) defined the following Koala management units (KMU) relevant to this determination: Tilligerry Peninsula KMU; Tomaree Peninsula KMU; Raymond Terrace KMU; Medowie KMU; Tomago Sandbeds KMU; Karuah/Ferodale KMU; and Fullerton Cove/Stockton Bight KMU. Lunney *et al.* (1998) suggested that some habitat in the Port Stephens area no longer supports extant Koala populations, most notably in the western and northern parts of the Port Stephens area. A widely dispersed, low density population, possibly comprising transient individuals, may characterise these areas, although prior to clearing of the fertile riverbanks and flats, this area would have supported higher densities of Koalas than the areas where Koalas remain extant (Knott *et al.* 1998). The Pacific Highway also appears to have restricted movements of Koalas and areas west of it have not been recolonised (Knott *et al.* 1998) or contain predominately non-breeding animals. Declines in Koala distribution and abundance within Port Stephens area have previously been noted and concern for the species' long-term persistence has been expressed for some decades (Lunney and Reed 1990; Phillips *et al.* 1996; Knott *et al.* 1998; Lunney *et al.* 1998).

8. The Koala population in the Port Stephens area (north of the Hunter River, east of the Pacific Highway and south of Nelson Bay/Karuah River) can be considered disjunct due to the interaction between natural and anthropogenic barriers to movement. Both rivers that form the northern and southern boundaries are more than 150 m wide at their narrowest points (and Nelson Bay in the north and the Hunter estuary in the south are much wider), and preferred Koala habitat is generally not found on either side of these rivers due in part to past clearing (Knott *et al.* 1998; OEH *in litt*. 29 June 2016). While Koalas will move through habitat that is unsuitable for occupation (Moon 1990; Ramsay 1999), and there are occasional observations of individuals swimming across rivers >100 m wide, rivers >50 m wide are considered to be a barrier to demographic connectivity (NSW Scientific Committee 2005). The Pacific Highway, a four-lane dual carriageway, represents the western boundary of the population. Major roads are considered a significant barrier to the movement of Koalas, functioning both as a substantial habitat gap that resident Koalas are reluctant to cross and as a significant source of mortality (Dique *et al*. 2003a, 2003b; NSW Scientific Committee 2005; Lassau *et al.* 2008; Rhodes *et al.* 2014). Although there are several fauna underpasses in the region (at the Raymond Terrace and Karuah bypasses) which have been monitored, there is only scant or anecdotal evidence of their use by Koalas (SMH 2004, RTA 2006, RMS 2015). In a similar landscape further north, Phillips *et al.* (2011) found negligible use of under- and over-passes by Koalas, while Taylor and Goldingay (2003) found Koalas only infrequently used culverts beneath the Pacific Highway in northeast NSW. Koalas are also known to avoid using rope bridges across roads (Goldingay and Taylor 2016).

Contact Address: C/o PO Box 1967 Hurstville BC NSW 1481 Telephone: (02) 9585 6940 Facsimile: (02) 9585 6606

9. The geographic distribution of the Koala in the Port Stephens area (north of the Hunter River, east of the Pacific Highway and south of Nelson Bay/Karuah River) is highly restricted. The Extent of Occurrence (EOO) is estimated to be 703–742 km^2. The EOO estimate is based on the method of assessment recommended by IUCN (2016). The area of occupancy (AOO) was estimated to be 488–608 km^2, based on 122–152 2 x 2 km grid cells, the scale recommended for assessing AOO by the IUCN (2016). The EOO and AOO were estimated using Koala records from Bionet (accessed 12 April 2017) of variable spatial accuracy. The lower estimates were obtained when including only recent records (1997–2015) and the higher estimates were obtained when all records were included.

10. The estimated total number of mature individuals of Koalas in the population in the Port Stephens area (north of the Hunter River, east of the Pacific Highway and south of Nelson Bay/Karuah River) is considered to be low. Prior to recent declines, Lunney *et al.* (2007) used a population estimate of 800 animals in a population viability analysis within the Port Stephens area (which includes disjunct areas west of the Pacific Highway). Earlier estimates by Phillips *et al.* (1996) report the population to be in the order of 300–500 animals. Recent surveys have suggested much lower numbers of Koalas, commensurate with recent evidence of decline (see Paragraphs 11 – 16). Recent estimates are based on individual road surveys, hospitalisation rates and from intensive surveys by the Hunter Koala Protection Society (HKPS) and these suggest the population may currently contain 100–200 animals, with a large proportion of the total population (approximately 125–200 animals) occurring within the Tomaree population (McLean *in litt.* 8 May 2016; D Paull *in litt.* 31 July 2016). The HKPS state that in areas such as Raymond Terrace, Medowie and Tomago where they were common 20 years ago, Koalas are now scarce or absent (D Paull *in litt.* 31 July 2016).

11. Koala populations throughout NSW are subject to several ongoing threats including habitat loss and degradation, increased mortality due to high frequency of wildfire, dog attacks and vehicle strike, and disease (DECC 2008; Phillips *et al.* 2011). Human population growth is linked with extinction risk, habitat loss and degradation (Harte 2007) and in NSW the human population is projected to increase by 48% in the period 2007–2056 (ABS 2016). Port Stephens local government area is projected to increase in population by 37.9% between 2011 and 2036 (Planning NSW 2016). Development pressures continue in the Port Stephens area. Several developments are under consideration as of January 2016, including more than 500 ha of preferred Koala habitat and over 700 ha of supplementary habitat (OEH *in litt*. 29 June 2016). Habitat loss and fragmentation also have the potential to further impede dispersal and recruitment between sub-populations and are associated with increased risks of vehicle strike and domestic dog attack (McAlpine *et al.* 2006; Phillips *et al*. 2011). 'Clearing of native vegetation' is listed as a Key threatening process under the Act.

12. Inappropriate fire regimes, particularly high intensity or high frequency wildfires, also represent a significant threat to Koala populations east of the Pacific Highway (Phillips *et al*. 2011; Hopkins and Phillips 2012). A population viability analysis of the Tomaree Koalas suggested that with the current rate of detected mortality the population would be extinct within a decade and highlighted the threat of future large wildfires (McLean *in litt.* 8 May 2016). Fires impact Koalas directly through mortality of animals and habitat fragmentation reduces the ability of animals to subsequently recolonise burnt areas. An extensive wildfire in the Medowie

Contact Address: C/o PO Box 1967 Hurstville BC NSW 1481 Telephone: (02) 9585 6940 Facsimile: (02) 9585 6606

area in 2016/17 burnt a large area of Koala habitat. In the Medowie-Tilligerry sub-population high frequency of wildfire appears to have led to periodic reductions in the size of the sub-population and it is likely to have drastically declined (OEH *in litt*. 29 June 2016). Habitat loss from wildfire can be short term for Koalas because their mobility allows rapid recolonisation of the burnt forest, and they can maintain home ranges within sites regenerating from fire (Matthews *et al*. 2016). This may no longer be the case at Port Stephens due to the reduced size and restricted nature of this population, making it vulnerable to a single fire event affecting a large proportion of the population. The fragmented nature of the landscape acts as a barrier for fires, potentially also limiting fire extent although in certain climatic conditions severe fires can still burn fragmented patches due to spotting. Increased wildfire frequency may reduce quality of Koala habitat and has the potential to exacerbate population decline, especially where Koala habitat is fragmented (Starr 1990; Melzer *et al*. 2000; Lunney *et al*. 2007). Frequent wildfires are also thought to have led to the near complete loss of the once abundant Billinudgel Nature Reserve Koala population in the Byron LGA (Hopkins and Phillips 2012; NSW Scientific Committee 2016). This reserve was almost completely burnt in 2004 following two other fires with inter-fire intervals of only three and nine years (Hopkins and Phillips 2012). 'High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition' is listed as a Key Threatening Process under the Act.

13. Natural mortality is also exacerbated by vehicle strikes. The total number of Koala deaths from vehicle strike is likely to be larger than that reported and the risk of vehicle strike can be expected to rise with increased urbanisation and human population growth. The long-term viability of Koala populations can be particularly sensitive to slight changes in mortality rates. For example, Phillips *et al*. (2007) concluded, based on a population viability analysis, that a small increase in the mortality rate of 2—3 % (as a function of total population size) from road mortality would lead to population decline in an otherwise demographically stable Koala population in south-eastern Queensland.

14. Chlamydial disease and the Koala Retrovirus (KoRV) are common in Koala populations in eastern Australia (CoA 2011) and are present in the Koala population east of the Pacific Highway, north of the Hunter River and south of Nelson Bay/Karuah River (D. Paull *in litt.* 15 March 2015). Chlamydia can cause blindness, infertility and pneumonia (Polkinghorne *et al*. 2013) while KoRV has been linked to some cancers and suppression of the immune system (Denner and Young 2013). Both diseases impact the general health of populations and can exacerbate the effect of other environmental stressors.

15. The Koala population in the Port Stephens area (north of the Hunter River, east of the Pacific Highway and south of Nelson Bay/Karuah River) is threatened by mortality due to dog attack (Lunney *et al.* 2007; DECC 2008). In the period 1988–1998, 125 Koalas were admitted to Koala hospitals as a result of dog attack and the mortality rate was 62% (Port Stephen Council 2002). More recently in 2014, 7% (of 29) of mortalities detected by the Hunter Koala Protection Society resulted from dog attacks. On the mid-north coast of NSW, attacks by dogs are the cause of *c.*15% of admissions to the Port Macquarie Koala Hospital (Phillips *et al*. 2011).

Contact Address: C/o PO Box 1967 Hurstville BC NSW 1481 Telephone: (02) 9585 6940 Facsimile: (02) 9585 6606

16. Survey data are not consistently collected for Koalas in this region. Records from the New South Wales Wildlife Atlas show marked reduction in the distribution of the population over the last two generations. Area of occupancy maps were gridded for 2003–2009 and for 2009–2015 and comparison of the two time periods shows a reduction in grid squares occupied from 61 to 34 – a 43% reduction in two generations (D. Paull *in litt.* 15 March 2015). Survey effort was not uniform between 2003-2009 and 2009-2015 although the number of records in each period is similar (1,118 vs 1,037). The differing survey effort due to methodological difference between community wildlife surveys and other factors in each period is a potential limitation of this approach. Recent spot-lighting surveys at 70 sites on the Tomaree Peninsula revealed an occupancy rate of 31%, though faecal pellets, which can persist for some time, were recorded on 68% of sites (McLean *in litt*. 8 May 2017). Most Port Stephens residents who responded to community surveys reported that Koala populations were either declining or static in 1992 and again in 2006 (Predavec *et al.* 2016). Continuing decline is anticipated as only 36% of preferred Koala habitat in the area is found within reserved lands and there is increasing pressure for suburban development which is likely to cause habitat loss and increased mortality from vehicle collision and dog attack. Population viability analysis by Lunney *et al.* (2007) in the Port Stephens area suggested a population of 800 Koalas would decline to 20 by 2050 and more recent population viability analysis for the Tomaree sub-population suggested that 200 individuals would decline to zero in 20 years (McLean *in litt*. May 2017). Elsewhere, an isolated population of Koalas on the Iluka peninsula declined to extinction due to the effects of fire on its adjacent source population (Lunney *et al.* 2002; DoE 2017). The estimated rate of decline for Koalas in NSW was 33% between 1990 and 2010 (DoE 2017).

17. The population of the Koala *Phascolarctos cinereus* (Goldfuss, 1817) in the Port Stephens area (north of the Hunter River, east of the Pacific Highway and south of Nelson Bay/Karuah River) is eligible to be listed as an Endangered population as, in the opinion of the Scientific Committee, it is facing a very high risk of extinction in New South Wales in the near future as determined in accordance with the following criteria as prescribed by the *Threatened Species Conservation Regulation 2010:*

Clause 11

The population is facing a very high risk of extinction in New South Wales in the near future as, in the opinion of the Scientific Committee, it satisfies any one or more of the following paragraphs and also meets the criteria specified in one or more of the following clauses:

(a) it is disjunct or near the limit of its geographic range.

Contact Address: C/o PO Box 1967 Hurstville BC NSW 1481 Telephone: (02) 9585 6940 Facsimile: (02) 9585 6606

Clause 13
The geographic distribution of the population is estimated or inferred to be highly restricted and either:

(a) a projected or continuing decline is observed, estimated or inferred in either of the key indicators:
  (a) an index of abundance appropriate to the taxon, or
  (b) the geographic distribution, habitat quality or diversity, or genetic diversity of the population, or

(b) at least two of the following three conditions apply:
  (i) the population or habitat is observed or inferred to be severely fragmented;
  (ii) all or nearly all mature individuals are observed or inferred to occur within a small number of locations.

Clause 14
The estimated total number of mature individuals in the population is low and either:

(a) a projected or continuing decline is observed, estimated or inferred in either of the key indicators:
  (i) an index of abundance appropriate to the taxon, or
  (ii) the geographic distribution, habitat quality or diversity, or genetic diversity of the population, or

(b) at least two of the following three conditions apply:
  (i) the population or habitat is observed or inferred to be severely fragmented,
  (ii) all or nearly all mature individuals are observed or inferred to occur within a small number of locations.

Dr Marco Duretto
Chairperson
Scientific Committee

Exhibition period: 18/08/17 – 13/10/17 Proposed Gazettal date: 18/08/17

References:

Australian Bureau of Statistics (2016) Population Projections, Australia, 2006 to 2101 http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/3222.0Main+Features12006%20to%202101?OpenDocument (accessed 21 November 2016).

CoA (Commonwealth of Australia) (2011) The Senate: Environment and Communications References Committee. The koala—saving our national icon. Commonwealth of Australia, Canberra.

Contact Address: C/o PO Box 1967 Hurstville BC NSW 1481 Telephone: (02) 9585 6940 Facsimile: (02) 9585 6606

DECC (Department of Environment and Climate Change) (2008) Approved Recovery Plan for the Koala (*Phascolarctos cinereus*). Department of Environment and Climate Change, Hurstville.

Denner J, Young PR (2013) Koala retroviruses: characterization and impact on the life of koalas. *Retrovirology* **10,** 108.

Dique DS, Thompson J, Preece HJ, de Villers DL, Carrick FN (2003a) Dispersal patterns in a regional koala population in south-east Queensland. *Wildlife Research* **30**, 281–290.

Dique DS, Thompson J, Preece HJ, Penfold GC, de Villers DL, Leslie RS (2003b) Koala mortality on roads in south-east Queensland: the koala speed-zone trial. *Wildlife Research* **30**, 419–426.

DoE (Department of the Environment) (2017). *Phascolarctos cinereus* (combined populations of Qld, NSW and the ACT) in Species Profile and Threats Database, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/sprat. (Accessed 4 May 2017).

Goldingay RL, Taylor BD (2016) Targeted field testing of wildlife road-crossing structures: koalas and canopy rope-bridges. *Australian Mammalogy* **39**, 100–104.

Harte J (2007) Human population as a dynamic factor in environmental degradation. *Population and Environment* **28**, 223–236.

Hopkins M, Phillips S (2012) Byron Coast Koala Habitat Study. Report to Byron Shire Council. Biolink Ecological Consultants, Uki.

IUCN Standards and Petitions Subcommittee (2016) Guidelines for Using the IUCN Red List Categories and Criteria. Version 12. Prepared by the Standards and Petitions Subcommittee. http://www.iucnredlist.org/documents/RedListGuidelines.pdf.

Kavanagh RP, Stanton MA (2012) Koalas use young Eucalyptus plantations in an agricultural landscape on the Liverpool Plains, New South Wales. Ecological Management & Restoration, **13**, 297–305.

Kavanagh RP, Stanton MA, Brassil TE (2007) Koalas continue to occupy their previous home-ranges after selective logging in *Callitris-Eucalyptus* forest. *Wildlife Research* **34**, 94–107.

Knott T, Lunney D, Coburn D, Callaghan J (1998) An ecological history of Koala habitat in Port Stephens Shire and the Lower Hunter on the Central Coast of New South Wales, 1801—1998. *Pacific Conservation Biology* **4**, 354–368.

Lassau SA, Ryan B, Close R, Moon C, Geraghty P, Coyle A, Pile J (2008) Home ranges and mortality of a roadside koala *Phascolarctos cinereus* population at Bonville, New South Wales. In 'Too close for comfort: contentious issues in human-wildlife encounters.' (Eds D Lunney, A Munn, W Meikle) pp. 127–136. (Royal Zoological Society of NSW: Mosman)

Lunney D, Crowther MS, Shannon I, Bryant JV (2009) Combining a map-based public survey with an estimation of site occupancy to determine the recent and changing distribution of the koala in New South Wales. *Wildlife Research* **36**, 262–273.

Lunney D, Gresser S, O'Neill LE, Matthews A, Rhodes J (2007) The impact of fire and dogs on koalas at Port Stephens, New South Wales, using population viability analysis. *Pacific Conservation Biology* **13**, 189—201.

Lunney D, Phillips S, Callaghan J, Coburn D (1998). Determining the distribution of koala habitat across a Shire as a basis for conservation: a case study from Port Stephens, New South Wales. *Pacific Conservation Biology* **4**, 186–196.

Lunney D, Reed P, (1990) Epilogue: Reflections on the Summit. Pp. 243—46 in Koala Summit. Managing Koalas in New South Wales ed by D. Lunney, C. A. Urquhart and P. Reed. New South Wales National Parks and Wildlife Service, Hurstville.

Martin RW, Handasyde KA (1999) 'The koala. Natural history, conservation and management.' (UNSW Press: Sydney)

Matthews A, Lunney D, Gresser S, Maitz W (2016) Movement patterns of koalas in remnant forest after fire. *Australian Mammalogy* **38**, 91–104.

McAlpine CA, Rhodes JR, Callaghan JG, Bowen ME, Lunney D, Mitchell DL, Pullar DV, Possingham HP (2006) The importance of forest area and configuration relative to local habitat factors for conserving forest mammals: A case study of koalas in Queensland, Australia**.** *Biological Conservation* **132**, 153–165.

McAlpine CA, Rhodes JR, Peterson A, Possingham HP, Callaghan JG, Curran T, Mitchell D, Lunney D (2007) Planning guidelines for koala conservation and recovery – a guide to best planning practice. (Australian Koala Foundation and University of Queensland: Brisbane)

McLean N, Handasyde KA (2006) Sexual maturity, factors affecting the breeding season and breeding in consecutive seasons in populations of over abundant Victorian koalas (*Phascolarctos cinereus*). *Australian Journal of Zoology* **56**, 385–392.

Melzer A, Carrick F, Menkhorst P, Lunney D, St. John B (2000) Overview, critical assessment, and conservation implications of koala distribution and abundance. *Conservation Biology* **14**, 619–628.

Menkhorst PW, Knight F (2010) 'A field guide to the mammals of Australia.' (Oxford University Press: Melbourne)

Mitchell P (1990) The home ranges and social activity of koalas - a quantitative analysis. In 'Biology of the koala.' (Eds AK Lee, KA Handasyde, GD Sanson) pp. 177–187 (Surrey Beatty and Sons: Sydney)

Contact Address: C/o PO Box 1967 Hurstville BC NSW 1481 Telephone: (02) 9585 6940 Facsimile: (02) 9585 6606

Mitchell P, Martin R (1990) The structure and dynamics of koala populations – French Island in perspective. In 'Biology of the koala.' (Eds AK Lee, KA Handasyde, GD Sanson) pp. 97–108 (Surrey Beatty and Sons: Sydney)

Moon C (1990) Koala corridors: a case study from Lismore. In 'The Proceedings of the Koala Summit: Managing Koalas in New South Wales.' (Eds D Lunney, CA Urquhart, P Reed) pp. 87–92 (NSW NPWS: Hurstville)

NSW Scientific Committee (New South Wales Scientific Committee) (2005) 'Defining koala 'populations' within the context of the Scientific Committee determinations.' NSW Scientific Committee, Hurstville.

NSW Scientific Committee (New South Wales Scientific Committee) (2016) 'Final Determination to list a population of the Koala *Phascolarctos cinereus* (Goldfuss, 1817) between the Tweed and Brunswick Rivers east of the Pacific Highway as an Endangered Population'. NSW Scientific Committee, Hurstville.

OEH (Office of Environment and Heritage) (2013) Koala Threatened Species profile http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10616

Phillips S (2000) Population trends and the koala conservation debate. *Conservation Biology* **14**, 650–659.

Phillips S, Callaghan J, Thompson V (2000) The tree species preferences of koalas (*Phascolarctos cinereus*) inhabiting forest and woodland communities on Quaternary deposits in the Port Stephens area, New South Wales. *Wildlife Research* **27**, 1–10.

Phillips S, Hopkins M, Callaghan J (2007) Conserving koalas in the Coomera-Pimpama Koala Habitat Area – a view to the future. Report to Gold Coast City Council. Biolink Ecological Consultants, Uki.

Phillips S, Hopkins M, Shelton M (2011) Tweed Coast Koala Habitat Study. Report to Tweed Shire Council. Biolink Ecological Consultants, Uki.

Phillips S, Callaghan J, Thompson V (1996). The Koala Habitat Atlas Project No 6: Draft report to Port Stephens Council.

Planning NSW (2016) 2016 NSW population and household projections http://www.planning.nsw.gov.au/projections (accessed 21 November 2016)

Polkinghorne A, Hanger J, Timms P (2013) Recent advances in understanding the biology, epidemiology and control of chlamydial infections in koalas. *Veterinary microbiology* **165**, 214–223.

Contact Address: C/o PO Box 1967 Hurstville BC NSW 1481 Telephone: (02) 9585 6940 Facsimile: (02) 9585 6606

Port Stephens Council (2002). Port Stephens Council Comprehensive Koala Plan of Management (CKPoM) – June 2002. Prepared by Port Stephens Council with the Australian Koala Foundation.

Predavec M, Lunney D, Hope B, Stalenberg E, Shannon I, Crowther MS, Miller I (2016) The contribution of community wisdom to conservation ecology. *Conservation Biology* **30**, 496–505.

Ramsay S (1999) 'The ecology and dispersal patterns of juvenile koalas, *Phascolarctos cinereus*, in fragmented habitat.' PhD thesis, University of Sydney, NSW.

Rhodes JR, Lunney D, Callagan J, McAlpine CA (2014) A few large roads or many small ones? How to accommodate growth in vehicle numbers to minimise impacts on wildlife. *PLoS ONE* **9**, e91093.

RMS (Roads and Maritime Services) (2015) Years of research shows fauna crossings on Pacific Highway are a success. http://www.rms.nsw.gov.au/about/news-events/news/roads-and-maritime/2015/151023-fauna-crossings-on-pacific-highway-a-success.html (verified 17 July 2017)

RTA (Roads and Traffic Authority) (2006) Bonville factsheet - meeting environmental needs - Upgrading the Pacific Highway. http://www.rms.nsw.gov.au/documents/projects/key-build-programs/pacifichighway/bonville-factsheet-environmental-needs.pdf (cited in OEH *in litt*. June 2016, no longer available)

SMH (Sydney Morning Herald) (2004) The arbour tunnel. Article in the Sydney Morning Herald June 27 2004 by Jim O'Rourke. http://www.smh.com.au/articles/2004/06/26/1088145022503.html (cited in OEH *in litt*. June 2016, verified 9 May 2017)

Starr J (1990) Management of koalas in an urban environment. In 'Biology of the koala.' (Eds AK Lee, KA Handasyde, GD Sanson) pp. 319–321 (Surrey Beatty and Sons: Sydney)

Taylor BD, Goldingay RL (2003) Cutting the carnage: wildlife usage of road culverts in north-eastern New South Wales. *Wildlife Research*, **30** 529–537.

Van Dyck S, Strahan R (2008) 'The Mammals of Australia.' (New Holland Publishers: Sydney)

Contact Address: C/o PO Box 1967 Hurstville BC NSW 1481 Telephone: (02) 9585 6940 Facsimile: (02) 9585 6606