Submission No 47

INQUIRY INTO KOALA POPULATIONS AND HABITAT IN NEW SOUTH WALES

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The koala is a resilient species that can be easily conserved

Submission to **Inquiry into koala populations and habitat in New South Wales**

by **Vic Jurskis**

Summary

Koalas are naturally rare and have repeatedly irrupted to unsustainable levels in dense forests and declining stands of eucalyptus. Dense populations inevitably crash during droughts. Both conservation and animal welfare can be easily addressed. The priority must be restoration of healthy ecosystems by frequent mild burning.

Koalas are listed as a vulnerable species by IUCN. Koalas in QLD, NSW and ACT are supposedly suffering long-term declines and are listed as vulnerable under Commonwealth and State legislation. World Wildlife Fund (WWF) claims that these koalas are headed for extinction within decades (WWF 2019). NSW has a strategy aiming to increase the koala population. The listings, the NSW Koala Strategy and the various policies and regulations relating to koalas and their habitat are entirely inappropriate. They are based on ignorance of ecological history and of the most fundamental principle of ecology.

Academics, bureaucrats and NGOs such as World Wildlife Fund have quite deliberately misrepresented the ecological history, conflated animal welfare with species conservation issues, and created a 'crisis' to support their fund raising campaigns. They seem to have no idea of what constitutes healthy habitat and sustainable densities of koalas because they dismiss historical observations. Their alternative version of history starts a century after European arrival, when millions of mostly starving and diseased koalas were shot and used for fur. Explorers and pioneers didn't see koalas.

Denial of history condemns us to spend millions upon millions of dollars setting up reserves of dying trees and scrub while animals continue to needlessly suffer. They face prospects of lingering death during future droughts or incineration in megafires.

TOR 1(a) Trends in koala populations and habitats

History of Koalas

At first contact

The first written mention of a koala was a second hand report 10 years after Europeans arrived. Another four years elapsed before Barallier's Aboriginal guide Gory obtained two feet of a koala at the high price of two spears and a tomahawk. After much searching with Aboriginal help, the colonists finally obtained a live koala in 1803, 15 years after they arrived. Award-winning historian and author Bill Gammage (2011) comprehensively researched the Australian landscape under Aboriginal management, and concluded that koala habitats were "*distinct, lightly populated and few*". Oxley, Sturt and Mitchell explored widely within areas now regarded as high quality koala habitats during many expeditions between 1817 and 1846. The explorers and pioneering pastoralists did not see any koalas where they would have been easily visible had they been present in any numbers (e.g. Gammage 2011; Jurskis 2015, 2017). In 1839-40, naturalist John Gould (1863) found very few koalas, and only with Aboriginal help, where they were known to live in The Illawarra and on the escarpments bordering the Liverpool Plains. He was the first to predict their extinction: "*this species is certain to … be ultimately extirpated*".

A notable exception to the scarcity of koalas was observed at the same time in South Gippsland. Strzelecki's party of exploration survived by eating koalas as they struggled for 26 days through dense young eucalypt forest (Strzelecki 1845). This Great Scrub was initiated by a megafire around 1820 in a 'no-man's land' created by the demise of the Yowenjerre people after a smallpox epidemic in 1789 (Wesson 2000). Three-dimensionally continuous fuels developed in the absence of Aboriginal burning. These were apparently ignited by lightning during severe weather, and the resulting conflagration initiated an extremely dense young forest. Another extreme fire affected the area in 1851 creating a second age class of scrub (Howitt 1891, Coverdale 1920, Jurskis 2017). When Europeans started clearing the scrubs in the 1870s, they

reported that there were plagues of dingoes preying on plagues of koalas. The dogs were able to catch koalas on the ground when they moved from one tree to another, or whilst they grazed on rich pastures sown on newly cleared lands fertilized by the ashes of the burnt forest. Koalas were fond of this exotic food as were some insects, especially caterpillars, which plagued the settlers' new pastures (Coverdale 1920).

After pastoral development

The first irruption of koalas was reported in 1836, half a century after the British landing at Warrane (Sydney Cove), by Assistant Surveyor Govett. They were common and numerous in thick stringybark forests on the fringes of the Blue Mountains (Anon. 1836). These forests developed after Aboriginal burning was disrupted by Europeans (Mitchell 1839). Koalas irrupted progressively a few decades behind pastoral development as it extended through the koala's range (e.g. Parris 1948, Lunney and Leary 1988, Gordon and Hrdina 2005, Jurskis 2017). When Europeans disrupted Aboriginal burning and established exotic pastures, thick young forests grew up in the hills and mature trees in the valleys declined, causing irruptions of many folivores including koalas.

There was suddenly an abundance of soft, nutritious and juicy new leaves (Gordon and Hrdina 2005, Jurskis 2017). Lack of frequent mild burning, or pasture improvement, are the major causes of chronic eucalypt decline. Profound changes occur in soil conditions, adversely affecting eucalypt roots and mycorrhizae and altering nutrient cycling processes in stands and within trees. Declining trees continuously turn over new leaves (Turner *et al*. 2008, Jurskis *et al*. 2011, Jurskis 2016, 2017). After government subsidised fertilizer application in New England pastures from the 1960s, koalas irrupted near Walcha, reaching the highest densities recorded anywhere in NSW by CSIRO surveys during the 1980s. Christmas beetles also irrupted and were blamed for 'New England Dieback'.

Grazing or slashing of native pastures can be ecologically analogous to frequent mild burning, and maintain healthy trees with low populations of arbivores including koalas (Jurskis 2017). The least pronounced historical irruption of koalas was in north QLD, where pastoral development was late and not intensive. Koalas were first recorded there in 1919, at the start of a drought, when they were described as uncommon. They declined to scarcity by 1925 (Gordon and Hrdina 2005). Dense populations throughout the extended range of koalas crashed during the Federation Drought around the turn of the19th Century, earlier in the south and later in the far north. Declining trees can no longer sustain constant resprouting of new foliage during severe drought, and dense koala populations expedite their demise.

Eden

Europeans occupied the Bega Valley in 1830 and saw no koalas until they irrupted in the 1860s. Despite heavy hunting for a lucrative skin industry, they increased to plague proportions by 1880. Dingoes increased markedly between 1880 and 1890. Numbers of koalas plummeted during the Federation Drought and they suffered epidemic disease from 1905 until they disappeared in 1909 (Lunney and Leary 1988; FIG. 8, p 80). Dingoes declined again as numbers of koalas crashed. Koalas persisted at very low densities in the surrounding forests (Lunney and Leary 1988; Fig 1(a)). Lunney *et al*. (1997) reported that "*koalas are rare in the Eden region … the number of koalas has been constantly low for the last four decades*" (i.e. 1950-1990, Figs 1(a) + 1(d)). By that time, radio-tracking studies and a regional playback survey had established that there is a healthy breeding population through the region, which is infected by chlamydia without any expression of disease. Predators are common, but only two of 2000 samples of canid faeces collected from the forests in 1987 contained koala hair. The only other record of predation was a juvenile koala taken by a powerful owl – another rare species (Jurskis and Potter 1997, Jurskis *et al.* 2001).

After this NPWS shut down the radio-tracking studies and relied on ineffective mail-out surveys to monitor the regional population. These surveys have repeatedly been used incorrectly to report local extinctions (Jurskis 2017). They employed a South East Forests Conservation Council campaigner to oversee extremely labour-intensive faecal pellet searches around State Forests in the northeast of the region. These searches produce very little ecological information at high cost, compared with radiotracking surveys which produce

a wealth of information, and playback or sound recording surveys which can effectively sample a whole region.

The regional population persisted through the Millennium Drought (Jurskis 2017). A sub-population in dense regrowth from clearfelling and wildfire in the north-east of the region was irrupting by the 1990s. There were only 4 records of koalas in this area between 1920 and 1987 (Reed and Lunney 1990, Reed, Lunney and Walker 1990, DECCW 2010, Lunney *et al*. 2014). No koalas were found during intensive searches of 36 clearfelling coupes totalling 400 hectares in 1980. No koalas were found by NPWS surveys in coastal forests between 1979 and 1984 (Lunney and Barker 1986, 1987). Two koalas were detected from 5 sites during a regional playback survey in spring 1997, 10 times the regional detection rate (Jurskis *et al*. 2001). Faecal pellet surveys between 2007 and 2009 detected koalas at an extraordinary 22% of sites in Mumbulla State Forest (DECCW 2010), equivalent to detection rates by spotlight surveys of relatively high density populations in north coast regrowth forests (Kavanagh *et al*. 1995). By 2012-2014 koalas were detected at 24% of sites (OEH 2016) (Fig. 1(d)).

In 2014, OEH neglected to consider at least 40 post-1996 records of koalas in the south and west of the region (Jurskis *et al.* 2001, Table 1; Lunney *et al*. 2009, Fig 9; DECCW 2010, Fig.1) and erroneously announced that koalas were extinct except in the north-eastern corner, where they had allegedly contracted into a climate refuge. This underpinned their claim that transferring State Forest at Tantawangalo to National Park in 1999 was "*too late for conserving the koala population*" (Lunney *et al.* 2014). In 2010, OEH had reported that they had found koala faecal pellets at Tantawangalo (DECCW 2010, p 9), however they later stated that none had been found (OEH 2016, p9). Whereas Lunney *et al.* (1997) had accurately reported that koalas numbers were stable and low from 1950 to 1990, Lunney *et al.* (2014) made a model supposedly showing "*regional loss of the koala over the past five decades*" (i.e. 1960-2010, Fig. 1(b)). Alternatively they claimed that "*Our data showed shrinkage in the distribution of Eden's koalas… contracting progressively to the north-east of the region since European settlement*" (i.e. 1830-2010, Fig 1(c)). Figs. 1(a) and 1(d) indicate the real history of koalas at Eden.

OEH stated that logging plans in the northeast of the region needed to be "*revisited*" (Lunney *et al.* 2014). As a result, four Flora Reserves were established, supposedly to protect koalas, and timber resource was lost to industry in contravention of the Regional Forest Agreement. A 2.5 million dollar subsidy was announced to obtain timber from further away. The management plan for the Reserve will endanger koalas because it restricts mild burning. This is the same strategy that led that led to the loss of 60 homes at Tathra, and some koalas were probably incinerated in the southernmost Reserve at the same time.

The paper that paved the way for these reserves was: *Extinction in Eden: identifying the role of climate change in the decline of the koala in south-eastern NSW.* After koala sightings at Tantawangalo in 2013 and 2017, OEH stated: "*The argument over purported extinctions is a distraction. A koala sighting does not make a population. The overwhelming reality of koalas in the Eden region is one of disappearance to a level of regional rarity that threatens their viability.*"

Fig. 1 shows the historical trend in the koala population at Eden from European arrival to the present time (1d + 1a + 1d) compared to the misrepresentations published by OEH in 2014. Line 1a was published by NPWS (Lunney and Leary 1988) and shows that population irrupted around 1860 and reached plague proportions around 1880 before crashing after 1900. Koalas then remained rare until the 1980s. Line 1d on the left shows the missing information that koalas were not seen after Europeans arrived until the 1860s. Line 1d on the right shows the missing information: firstly, that koalas were increasing in the northeast and stable through the remainder of the region in 1997 (Jurskis and Potter 1997, Lunney *et al.* 1997, Jurskis *et al.* 2001). (OEH declared they were extinct through most of the region by 1996 and barely hanging on in a climate refuge in the northeast (Lunney *et al.* 2014).); secondly, that koalas continued to increase in the northeast during the Millennium Drought (OEH 2016, Jurskis 2017).

Lines 1b and 1c illustrate two alternative misrepresentations of the history published by OEH (Lunney *et al.* 2014). Koalas were not abundant in 1960 (Line 1b). The large area above Line 1c in the 19th Century and below Line 1c in the 20th Century, compared to Line 1a illustrates the departure from reality of this version of history.

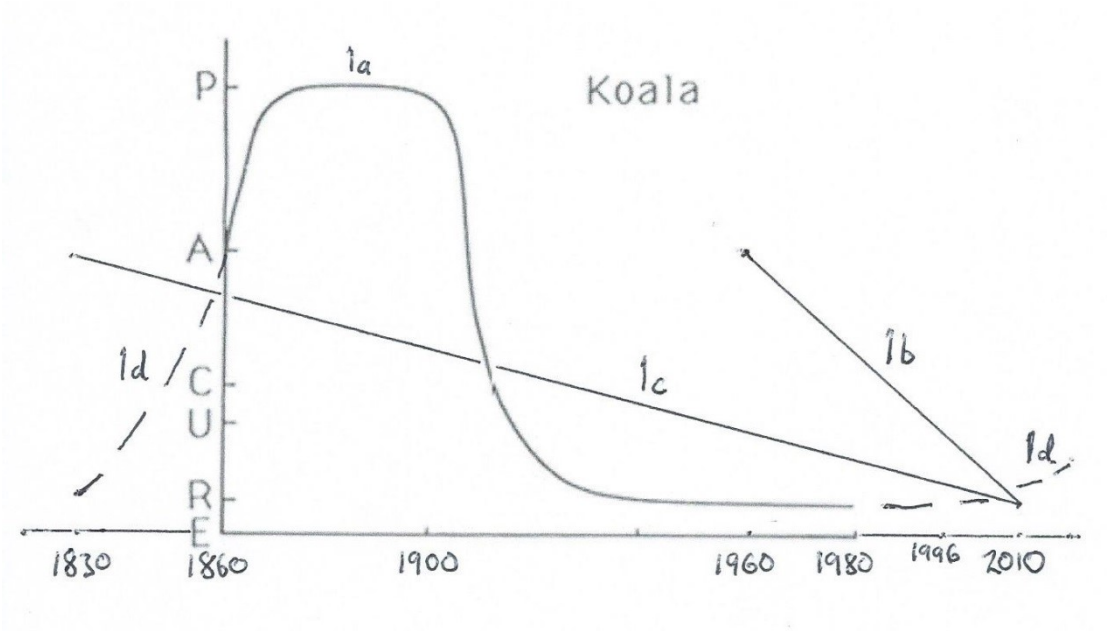

Fig. 1 E extinct R rare U uncommon C common A abundant P plague

Campbelltown

After European settlement extended across the Cumberland Plain, koalas irrupted firstly in the west, and by the late 19th Century in the south. At the turn of the century they were in plague proportions around Campbelltown and there was commercial hunting for skins. Koalas were "*in almost every tree*" (Lunney *et al.* 2010). However, Lunney *et al.* (2010) wrote of an "*apparent population crash from the early part of the century and recovery in the 1980s*", ignoring the original irruption and the inevitability of a crash during the Federation Drought. The second irruption began when suburban development extended into the area ~10 years after a major wildfire devastated the adjoining Sydney Water catchments in 1977 (Tilley and Uebel 1990; Lunney *et al*. 2010; Close *et al*. 2015).

Alienation of formerly grazed and/or burnt bushland for urban development and thick wildfire regrowth in the water catchments produced this second, as yet unrecognised, irruption of koalas that is misrepresented by OEH as recovery. They stated that "*the population is low and always has been*. … *historical clearing of fertile plateau land for agriculture and urban development resulted in an initial decrease in the Campbelltown population*" (Predavec 2016). Close, Ward and Phalen (2015) recognised, on the basis of radiotracking studies, that the current low density population is healthy and increasing, even though it was "*virtually unknown prior to 1986, although numbers had been apparently sufficient for the Koalas to be shot for their skins in the early years of the twentieth century*". They suggested it is a 'dangerous idea' that a low density population of koalas (~0.03 ha^{-1}) might be viable, because the perceived vulnerability of this population has been used to 'protect' habitat for endangered non-iconic fauna, such as the broad-headed snake, *Hoplocephalus bungaroides*, in the same area (Close *et al*. 2015, p. 1).

However, the density of this population is obviously relatively high compared to stable populations, because the koalas are easily visible. The population is clearly irrupting, because young female koalas are establishing new home ranges adjacent to their mothers (Close *et al*. 2015). Carrying capacity of this habitat for koalas is temporarily increasing and decline is inevitable. Meanwhile, carrying capacity for other animals, such as the broad-headed snake, requiring open sunny conditions, is declining because of woody thickening (e.g. Pringle *et al*. 2009).

Barrenjoey

On the Barrenjoey Peninsula, just north of Sydney, koalas declined from an estimated 123 in 1970 to eight in 1989, as the area of bushland was progressively reduced from probably ~382 ha to 125 ha. The bushland was suffering "*extensive eucalypt dieback associated with urban runoff*" and was threatened by invasion of scrub (Smith and Smith 1990, p. 109). Smith and Smith (1990) concluded that the koalas were threatened by further loss of habitat and further mortality from dogs, motor vehicles and chlamydiosis after their density declined from ~0.32 ha^{-1} to 0.06 ha^{-1}. Had loss of habitat been the main problem, there should still have been about 40 koalas. However, it is evident they were living at unsustainably high densities in chronically declining eucalypts.

Coffs Harbour

The koala was "*conspicuously absent from the explorer Clement Hodgkinson's account* [published in 1845] *of the tribes he encountered along the Bellinger River, in which he noted animals they consumed*". There were no records of hunting for skins, or historical photographs, or early oral histories of koalas at Coffs Harbour. A newspaper report from 1950 indicated that a resident in the area from 1896 to 1901 saw koalas, and there was a newspaper report of a koala crossing a road three quarters of a mile from Coffs Harbour in 1939. In an oral history recording from 1987, an 82 year old woman recalled seeing koalas in town around the late 1920s and early 1930s (Lunney, Wells and Miller 2016).

A postal survey in 1990 attracted a respondent who saw a koala in Conglomerate State Forest as a young man in 1937, another who saw koalas at Nana Glen as a child around the 1950s and a third who saw koalas in dense scrub or "*up telegraph poles*" in Coffs Harbour in the 1940s. Apart from the foregoing, Lunney, Wells and Miller (2016) produced no records of koalas in the region prior to the 1960s. Agricultural development around Coffs Harbour was limited by steeply dissected topography and thick forest. It was mostly confined to narrow creek and river flats. Koalas irrupted in the immediate vicinity of Coffs Harbour township around 1960 with the commencement of urban sprawl and consequent reduction of grazing and burning. Koalas disappeared from some suburbs and localities as urban development progressed (Lunney, Wells and Miller 2016).

At the same time, koalas were increasing in dense regrowth forests created by intensive logging using new post-war technology and equipment. By 1991 koalas were strongly associated with these forests, being three times more frequent in heavily logged than unlogged forests (Kavanagh *et al.* 1995). Lunney *et al.* (2009) reported that this was one of only three areas in NSW where mail-out surveys showed that koalas were increasing. Another mail-out survey in 2011 produced another increase in sightings at Coffs Harbour. OEH manipulated the data. They reported that *"While the raw data show an increase in the number of koalas … they do not account for the forgetfulness of people".* So they "*downsampled*" postal survey data and adjusted it for "*forgetfulness*". They turned a sampled increase in koala sightings between 1990 and 2011into "*a small, yet statistically significant, decline in the number of koalas of 4% over 21 years*" (Lunney, Predavec *et al.* 2016). Lunney, Wells and Miller (2016) stated that "*habitat loss has been relentless since European Settlement* and *the Koala population had been reduced from its pre-European size by 2000*".

North Coast

During the late 20th Century, koalas increased in dense young regrowth forests on the north coast. For example, a survey of nearly 300 sites in 1991 found koalas at 22% of intensively logged sites compared to only 4%, on average, of unlogged or selectively logged sites (Kavanagh *et al*. 1995). After prescribed burning was reduced from the 1980s, chronic eucalypt decline extended through the forests and koalas began to irrupt. By the early 1990s, koalas were detected at 46% of survey sites in State Forests' Urbenville Management Area in the Upper Clarence and Richmond Valleys of NSW. They became the most common arboreal mammal, occurring throughout the forests (State Forests 1995) where they had previously been uncommon (Calaby 1966). By the turn of the millennium there were more than 20,000 hectares of severely declining forest around Urbenville (Jurskis 2005).

Koalas and a range of other species including arbivorous insects, fungi and parasitic plants increased as decline extended through forests. 'Bell Miner Associated Dieback' is a facet of this more general problem, which has attracted disproportionate attention. Bellbirds have irrupted in response to irruptions of psyllids which constitute plentiful, nutritious food for the birds in some types of declining forests (Jurskis 2005, 2017). Between 2015 and 2017, Law *et al*. (2018) "*sampled a broad range of timber harvest intensities and times since harvesting, at both site (~300 m radius) and a larger landscape scale (1 km buffer), together with old growth forests for comparison*" across the north coast. They found koalas at 64% of sites irrespective of whether there had been any logging, the intensity of logging or time since logging. It is clear that koalas have increased throughout the declining forests since 1990, because they are no longer associated with dense regrowth (Jurskis 2017).

Pilliga, Liverpool Plains, Gunnedah

Surveyors General Oxley and Mitchell noted, described, collected or illustrated a variety of wildlife in this region, but no koalas. At that time, koalas were known only from the cedar brushes of the Liverpool Range at the southeastern edge of the region where they were scarce (Gould 1863, Gammage 2011). After they irrupted in the Pilliga during the late 19th Century, koalas were harvested commercially, eaten by increasing numbers of foxes, and suffered diseases during the Federation Drought (Rolls 1981, Jurskis 2017). OEH (Reed, Lunney and Walker 1990) reported local extinctions in the region based on mail-out surveys. After widespread treeplantings, koalas irrupted and OEH stated that "*There is no long-term ecological history for the region. However there are perceptions of long term trends and studies that point to a stable or increasing population prior to the recent declines … The 2006 state-wide community survey highlighted the Gunnedah region as the only area of NSW with an increasing koala population*" Predavec (2016).

Lunney, Predavec *et al.* (2017) reported that koalas occurred "*in exceptionally low numbers until the 1980s*" when they irrupted into very high numbers. Then the regional population was considered by "*experts*" to be "*secure and stable*" until it crashed during the Millenium Drought around the first decade of the current century. They discussed possible reasons for the crash, but not for the dramatic irruption in koalas that preceded it. They referred to "*one significant contraction in the past*", which coincided with the Federation Drought, but they did not acknowledge the original irruption. The second major irruption, in the late 20th Century, was misrepresented as a "*recovery*". Lunney, Predavec *et al*. (2017) found that koalas in The Pilliga actually persisted at relatively hot and dry sites during the Millennium Drought and were lost from "*moist riparian habitats*".

The original irruption in the Pilliga coincided with dense new growth of forest in wet seasons after destocking and abandonment of pastoral holdings during drought. The second irruption also coincided with a dramatic increase in young eucalypt foliage. Poisoning of eucalypts to promote cypress growth had been discontinued in 1972 and ringbarking of eucalypts was discontinued early in the 1980s. Also, logging of small or defective ironbark trees commenced when the Insultimber sawmill opened in 1975, and produced relatively dense coppice regeneration (van Kempen 1997).

Lunney, Predavec *et al.* (2017) stated that "*the current findings now place them* [koalas in this region] *squarely within the overall pattern of decline in NSW … and consistent with the listing of the species as threatened at both state … and federal … levels*". OEH have been deliberately obscuring the fact that koalas were naturally rare at the time of European settlement, and that they irrupted and subsequently crashed during the Federation Drought. The recent population crashes during the Millenium Drought were inevitable consequences of secondary irruptions in the late twentieth century, but they are being used to justify expansion of the NPWS estate and ongoing 'research' to perpetuate the misrepresentations.

McAlpine, Lunney *et al.* (2019), who represent themselves as "*Australia's most experienced koala ecologists*" seemingly contradicted their own published data and denied the fact that koalas were naturally rare and have repeatedly irrupted and declined at different times and places since European arrival. They dismissed historical observations by explorers and pioneers, as well as modern survey data, in the following terms: "*This tenet is fundamentally flawed. That koala populations are irruptive is remarkably naïve. It is*

based on anecdotal observations based on the recollections of individual residents, none of which are supported by rigorous data from the modern era".

Population trends and causes

A 2011 Senate Inquiry stated: "*It is estimated that the koala population prior to European settlement was in the order of up to 10 million koalas*" and that koalas "*experienced a 'severe decline'*" soon after European settlement (Commonwealth of Australia 2011). According to "*17 of Australia's most experienced koala ecologists*", hereafter 'the experts', populations crashed by the early 20th century "*due to hunting for fur*". Recent inevitable crashes in unsustainably dense koala populations have been attributed to clearing, climate change, disease, predation and/or road accident trauma (McAlpine *et al.* 2015).

Clearing and climate change

According to the experts, koalas in the Eden Region are at "*critically low levels*" because of clearing and climate change. However koalas first appeared in the Bega Valley after clearing, and they persisted in stable low-density populations in the forests during the Federation and the Millennium Drought. A subpopulation in dense regrowth forest in the northeast continued to increase during the Millennium Drought, as did a sub-population near Campbelltown.

In 2005, Premier Bob Carr announced the permanent reservation of 350,000 hectares of forest around The Pilliga, with a key aim of protecting koalas. This was the largest continuous area of forest with the largest koala population in the Murray-Darling Basin of NSW, comprising a significant proportion of the NSW population. This dense population crashed during the Millennium Drought, falling by 79% (Lunney *et al*. 2017). Habitat loss and fragmentation were not a threat to the population and extensive reservation of land as national park did not protect it. WWF mounted a media campaign linking tree removal in rangelands and in suburban developments to the unrelated crashes in koala populations. At the same time, ecologists uncritically attributed the inevitable crash to climate change (McAlpine *et al*. 2015).

The Koala Coast population was also considered to be "*relatively secure*" but declined by 75% during the Millennium Drought. Population densities in the region varied from < 0.1 to 0.8 koalas per ha, and the steepest declines apparently occurred in the sub-populations having the highest initial densities. The rate of decline flattened after drought-break. Average densities in bushland and urban areas were 0.1 koalas per ha in 2012 (McAlpine *et al.* 2015, Fig. 2). Between 1997 and 2013, more than 20,000 koalas were submitted to veterinary hospitals in the region. Fifty-two percent were diseased, 16% had suffered road accident trauma and 14% were wasting. However, vehicle injuries declined from ~30% to ~10% whilst wasting increased from ~3% of submissions in 1997 to ~20% by 2013 (Gonzalez-Astudillo *et al*. 2017, Table 1, Fig. 1).

Food for koalas dwindled, but starving koalas continued to feed predators and diseases. The results of two radio-tracking studies, before and after the Millennium Drought, suggest that the overall mortality rate nearly doubled during the drought. The experts attributed this crash to so-called extinction debt "*where populations continue to decline long after the main habitat destruction*". They alluded to major destruction of koala habitat before 1996, but presented no evidence of any decline in koalas prior to the onset of drought.

Very sparse populations of koalas, occupying what was formerly considered to be sub-optimal habitat in central QLD, were unaffected by the Millennium Drought, whereas dense populations in supposedly high quality riparian habitats, suffered severe decline (Ellis *et al.* 2010). Koala populations crashed in the region around Minerva Hills National Park QLD, whereas koalas persisted in the park at densities of 0.02 per ha (Australian Government 2018). Defoliation of trees and/or decline of koala populations have occurred wherever reported densities were 0.1 per ha or higher Jurskis (2017).

Predators, disease and motor vehicles

Historically, increases in the prevalence of predators and disease followed irruptions of koalas, for example in the Bega Valley and The Pilliga. High mortality of koalas in QLD during the 1920s was attributed to

overly dense populations, disease, predation by dingoes and foxes, drought and other factors (Gordon and Hrdina 2005; p 78, Table 8). When populations of arbivores increase, so can their predators. Dingoes, wild dogs, foxes, pythons and/or diseases have increased in response to irruptions of koalas. On the Koala Coast, White and Kunst (1990) recorded moderate rates of predation and disease when koalas increased after pastoral lands were initially alienated for future residential development. Later, Beyer *et al*. (2018) found an extraordinarily high density of wild dogs and a high rate of predation by dogs and carpet pythons after koala densities had doubled at some sites before crashing in the Millennium Drought.

Beyer *et al.* (2018) controlled wild dogs and disease in a Koala Coast sub-population, from 2013 to 2017. Their study occurred in conjunction with clearing of 62 ha for a railway. They concluded that loss of habitat was unlikely to limit the population. Five hundred and three koalas were captured and mostly monitored by radio-telemetry. Some were euthanased and a few were translocated. Forty-one wild dogs were destroyed. There were 144 confirmed predations of koalas, 81% by wild dogs, 15% by carpet snakes (a native python) and 4% by domestic dogs. There was 15% annual mortality of adult koalas; 63% by predation, 29% by disease and 3% by road accident trauma. Population growth rates were 0.7, 0.9, 1.1 and 1.2 over four years. The current rate is clearly unsustainable. If it were maintained, the population would double within four years from an already unsustainable level. It is more likely that the rate will increase until the next drought.

Grogan *et al*. (2018) found strong evidence for *Chlamydia pecorum* as a cause of morbidity, sterility and mortality, but not of population declines, because declining fertility allows increasing survival of juveniles. It's all about food and carrying capacity. Grogan *et al*. (2018) stated that Chlamydia are not opportunistic and are never innocuous commensals because they are obligate intracellular pathogens. However, koalas from the very low-density population at Eden are infected without clinical signs of disease, and the low-density Campbelltown population also has no clinical symptoms. Diseases have typically been associated with crashes of dense populations during drought.

It is a fundamental ecological principle, established by Elton almost a century ago, and enshrined in the concept of the trophic pyramid, that predators are limited by their prey. This concept applies in the broadest terms to folivores, carnivores and diseases. When the base of the pyramid (more accurately described as a ziggurat) increases, successive levels increase in turn. When the base contracts, higher levels over-run their food resources and seem to be controlling them from above (e.g. White 2008, 2013; Jurskis 2018). Koalas are naturally limited by the availability of palatable and nutritious young eucalypt foliage. Wild dogs, carpet snakes and diseases are limited by the availability of easily caught or weak, nutritionally stressed prey. When food availability temporarily increases and koalas irrupt, irruptions of predators and diseases usually follow.

Substantial levels of road trauma are also a consequence of unsustainably dense populations. Radio collared koalas at Campbelltown occupying home ranges that included roads and domestic dogs lived long lives and died of natural causes (Close *et al.* 2015). Experience on the Koala Coast indicates that motor vehicle trauma can be substantially reduced by traffic management.

Logging

There is a concerted campaign by many conservation or animal welfare organisations, led by WWF, to create additional national parks to supposedly protect koalas from logging, especially on NSW north coast. Unequivocal evidence that koalas were associated with dense regrowth from intensive logging (e.g. Kavanagh *et al.* (1995) has been represented by Law *et al*. (2018), The Commonwealth Threatened Species Scientific Committee (TSSC) and NSW Natural Resources Commission (NRC) as indicating that koalas tolerate selective logging. More money ($300,000) is being thrown at research into impacts of intensive logging on koalas and their habitat as well as millions on a new forest monitoring scheme (NRC 2019). Koalas now occur at 64% of survey sites throughout north coast forests independently of logging history or intensity (Law *et al*. 2018). The money should go to reinstating mild fire regimes, forest health and sustainable densities of koalas.

Chronic eucalypt decline

TSSC identified "*Bell Miner Associated Dieback (BMAD)*" as a potential threat to koala habitat. After decades of spending many millions of dollars on researching bellbirds and psyllids, NSW recently spent $100,000 on a literature review of BMAD, which incorrectly concluded that bellbirds "*facilitate sustained psyllid infestations that lead to dieback*" (Silver and Carnegie 2017). So-called Grey Box Psyllid Dieback near Sydney is another recognised threat to koala habitat, where psyllids supposedly kill trees without assistance from bellbirds. NSW funded research on this problem to the tune of $415,000 (University of Western Sydney 2013). However, irruptions of psyllids occur widely, together with irruptions of koalas and other arbivores, in declining forests. Rather than funding narrowly focused research, aimed at reducing psyllids and increasing koalas, NSW should support adaptive management by frequent mild burning to restore healthy ecosystems (Jurskis 2005, 2015, 2017).

Habitat and Carrying capacity

Koala densities greater than 0.1 per ha and as high as 3.0 per ha have been regarded as moderate and sustainable (e.g. Close *et al.* 2015, DELWP 2016) or even as low (e.g. White and Kunst 1990, Beyer *et al.* 2018). History shows that these are unnaturally high densities, and that dense populations have repeatedly crashed during droughts. Part of the problem is that ecologists studying dense populations have been unable to recognise early stages of eucalypt decline, as have ecologists studying the parallel problem of psyllid irruptions (Jurskis 2005, 2017).

For example, Close *et al.* (2015) predicted that koalas near Sydney "*will continue to increase in number and distribution until all suitable female home-ranges are occupied*". They didn't recognise that the koalas are increasing in response to temporarily increasing food supplies. Koalas are irrupting in dense regrowth forest arising from wildfires in 1977 near Campbelltown, and clearfelling and wildfires around 1980 near Bega. In both areas, there is also accelerated leaf-turnover in trees that are declining as a result of absence of mild burning and/or grazing.

The great majority of ecological studies have been unknowingly conducted in irrupting or unsustainably dense populations of koalas. Consequences of irruptions, such as high levels of predation, disease and trauma have been misinterpreted as causes of decline, whilst resilient low-density populations have been considered especially vulnerable to extinction. For example, McAlpine *et al*. (2015; p 229, Fig. 1) concluded that numbers of koalas were "*small but relatively stable*" near Sydney, whilst the population extending south to Victoria was at "*critically low levels*". However, when koalas were translocated from Campbelltown 100 km south into supposedly unoccupied habitat, local koalas appeared and one contributed DNA to an offspring of an introduced koala. Although no koalas had been seen in the area for 30 years, there was clearly a very low-density sustainable population.

Close *et al.* (2015) discussed the wider implications in some detail: "*Directly south of Campbelltown, there is continuous bushland through the protected catchments of the Cataract, Cordeaux, Avon and Nepean Dams and then Moreton National Park, Budawang NP, Deua NP, Wadbilliga NP and then the South East Forests NP, as well as several smaller State Forests and National Parks. Although koalas have been sighted in the dam catchments … in the South East Forests … and in all the National Parks listed above … , few reports of Koalas were recorded for those National Parks and forests during state-wide* [mail] *surveys … However, we predict that functional populations of very low densities exist in all these forests*". This population extends south through a continuous belt of forest to Victoria, where irruptions are occurring in long-unburnt chronically declining forests in East Gippsland ((Jurskis and Potter 1997, Jurskis 2017).

With their highly-developed olfaction enabling them to detect food from afar, their strong ability to disperse, and their capabilities for long-distance communication, koalas are well adapted to occupy extensive habitats of low carrying capacity. In the absence of disturbance such as fire suppression and/or high-intensity fire, low-density populations of koalas in forests remain stable. Most young do not survive because they cannot find enough food. However, koalas have a very high reproductive potential. This ensures that portions of

habitat vacated through adult mortality are quickly occupied by dispersing juveniles. It also ensures that irruptions will occur whenever disturbance creates a surplus of food.

Koala surveys and definition of koala habitat

OEH uses ineffective survey methods that cannot identify the presence or distribution of natural habitats containing sustainable low density koala populations. Effective methods such as playback surveys or sniffer dogs have been available for many decades. Recently, sound recordings have been demonstrated to be even more effective for regional surveys. Law *et al.* (2018) claimed that koala detections on the north coast were "*at least five times more than expected based on previous surveys using alternative methods*". This method was recently used at Eden, not as you would expect, in areas where koalas are feared to be extinct, but in the northeast where they are known to be increasing. So OEH continues to focus on 'protecting' unsustainably dense populations of koalas in declining forests and excluding mild fire which will exacerbate forest decline and hasten the inevitable collapse of these populations.

TOR 1(b)

The impact of various rules and regulations and codes of practice on koalas and their habitat.

Restrictions on frequent mild burning are causing unsustainable increases in koala populations which inevitably lead to population crashes during droughts or as a result of megafires.

TOR 1(c)

The effectiveness of NSW Koala Strategy in protecting koala habitat and responding to key threats.

The strategy was misinformed by OEH. The Chief Scientist's report was not independent. It relied heavily on a document by Predavec of OEH. Interestingly, neither The Chief Scientist's Office nor OEH acknowledged ownership of the document. The strategy is based on complete misrepresentation of ecological history and does not correctly define or identify sustainable habitat or key threats. The idea that koala populations should be increased above already unsustainable levels is ridiculous. Animal welfare considerations are conflated with conservation issues. The idea of protecting habitat by locking it up is a recipe for ongoing disaster.

TOR 1(d)

Key habitat, logging, clearing and climate change

See relevant sections under TOR 1(a).

TOR 1(e)

The environmental, social and economic impacts of establishing new protected areas.

These are all negative as illustrated by the example of the new Flora Reserves at Eden.

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