AUSTRALIANS FOR ANIMALS NSW INC.

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SUBMISSION TO INDEPENDENT PLANNING COMMISSION, NORTH BYRON PARKLANDS CULTURAL EVENTS SITE SSD 8169 and MP 09 0028 MOD3

TO whom it may concern.

In the past several years, it is abundantly clear that well researched submissions providing comprehensive evidence in relation to NBP sent to both the DOP and the PAC have been completely ignored.

This refusal to take on board, investigate, substantiate or respond to major issues leaves the public with an irrefutable assumption. That submissions to DOP, PAC and IPC are merely smoke and mirror exercises to satisfy legal obligations with no response or proper analysis required.

CARBON EMISSIONS

NSW government has proclaimed a zero carbon target by 2050.
https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Climate-change/achieving-net-zero-emissions-by-2050-fact-sheet-160604.pdf

Byron Shire Council target zero carbon emissions by 2025.
https://www.byron.nsw.gov.au/Services/Environment/Emissions-Reduction-Strategy.

This target estimate completely ignores the impact of tourism estimated at over 2 million annually (https://www.abc.net.au/news/2017-08-18/byron-wants-brakes-on-tourism/8820984) , the Blues Fest, the Falls and Splendour festivals plus the increase in festivals if approved by the IPC.

A bare bones extremely conservative analysis of patron and staff numbers at a Splendour festival estimated at 36,000, all coming from Sydney demonstrates 23,000 tonnes of carbon emissions . that is one festival emits a quarter of Byron's estimated annual emissions.   Burning Man festival with 70.000 patrons in the USA emits 27,000 tonnes by way of an example.

A massive increase in festival patron numbers, together with the number of events demonstrates a very significant, unacceptable increase in carbon emissions, an issue which has been completely

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ignored by the DOP and the IPC. Scientific evidence indicates major climate change impacts in Australia which are already manifesting.
To give approval in perpetuity to an organisation which has completely failed to complete a successful trial; has violated provisions of consent constantly; has exceeded patron numbers; has advertised an increased number of festival days over and above the number allowed, are grounds to ensure that any increase in festivals and patron numbers is denied.

The failure of DOP to take into account carbon emissions including buses, trucks, rubbish removal, overseas flights, fuel, power usage, is a significant concern and demonstrates a complete reversal of the current NSW government policy on carbon emissions.

There's little doubt that the increase in festivals, patrons, will result in Byron Shire having the highest carbon emissions in the state. Any offset provided by NBP in ticket sales is nothing more than lip service.

NOISE IMPACTS ON WILDLIFE.

Australians for Animals Inc. has consistently raised the issue of impacts of festival noise on wildlife with the DOP and at PAC hearings. Every shred of evidence we have presented has been ignored.

KOALAS AND NOISE IMPACTS

* April , 2016 - NSW Scientific Committee designated koalas from Tweed River to Brunswick as endangered. there are approximately 100 koalas left in the area..

* NSW Scientific Committee report concluded the koala population between the Tweed and Brunswick rivers east of the Pacific highway is facing a very high risk of extinction in the near future.

* an updated search of the Bio net atlas NSW Wildlife data base September 2016 produced a total of 22 koala records for the 10 km x l0 km search area focused on the parklands site. (Biolink koala monitoring report North Byron Parklands September 2016)

* the 2016 koala monitoring surveys recorded a significant level of use in the northwestern corner of the North Byron Parklands site. . (Biolink koala monitoring report North Byron Parklands September 2016)

* NSW government introduced a koala strategy recommended by the NSW chief scientist which

underlines the urgent necessity to protect koalas.

The indications of 22 koala records at the NBP site and moderate activity within Billinudgel Nature Reserve at a time when koalas in the state are facing extinction must be an injunction against more festivals, more patrons, more noise, more threats to an endangered population of koalas.

Koalas are particularly susceptible to noise in breeding season. noise can disrupt reproduction, create stress.   Many koalas have died on the Bluesfest site.

The far north coast has been identified by the NSW Chief Scientist and OEH as the remaining stronghold of the species in NSW .

Pasted below is the email correspondence between Dr. Benjamin Charlton, an Irish expert on koalas and noise impacts with details of noise measurements by Acoustic Works. A link to the paper cited by Dr Charlton is included.

From: [redacted]
Date: 12 July 2016 at 11:45:32 AM AEST
To: [redacted]
Subject: RE: Extra logger for SiTG

Hi Paul,

1. The 63Hz octave band is the range of frequencies between 44Hz and 88Hz. Therefore assessment of the 63Hz frequency band will virtually not capture the 10-45Hz range mentioned by Sue.
2. Range 10Hz to 45Hz is captured by 16Hz octave band (11 to 22Hz) and 31.5Hz octave band (22 to 44Hz).
3. For previous SITG events the low frequency noise emissions were generally measured in the 31.5Hz and 63Hz octave bands (with predominant low frequency output in the 30Hz to 80Hz range)
4. So the range of low frequency noise emissions from SITG (and Falls) are partly within the 10-45Hz range.
5. In general noise impacts are expected to be greater this year. Previous years were proven to be above the original noise limit and the new noise limits have been changed to accommodate the previous noise emissions. So the short term maximum noise levels may be similar (or slightly more than) previous years. But with higher limits there is potential for higher noise levels to continue for longer periods of time because they are allowed, rather than 'accidental' breaches of a lower limit. Of course these estimations assume similar weather conditions to the previous years.

Regards,

Mark Enersen

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Director

From Dr Charlton.

What they are basically saying is that there is some noise within the 10-45Hz range, when looking at octave bands (set frequency ranges) to assess noise pollution. I would look at frequencies from 20Hz up to 3000Hz though because formants in koala bellows carry important information about the caller's body size and identity, and these frequency components extend up at least as far as 3000Hz. The koala's fundamental frequency (pitch) is very low at 27.5 Hz, but does not appear to encode important information about the caller.

I have attached a relevant paper of mine. If you look at the SNR plots in Figure 2 you can see the relative amplitudes of formants (F1-F6) across the frequency range 0-3000Hz. Formants are very important for information transfer between koalas during the breeding season. If you use the SNR values in Fig 2 as a guide you can see, for example, that any noise exceeding 40dB will completely wipe out the "information content" of a koala bellow over a distance of 1 metre. That means that koalas would not be able to vocally communicate using bellows unless they were <1 metre from each other. Noise levels of ~30dB would prevent any information travelling further than 25 meters (the re-recording distances are colour coded in the key). Feel free to forward this email and/or the paper to anyone you need to.

Cheers,

Ben "

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His paper: file:///Users/suzannearnold/Downloads/PLoS%20ONE%202012%20Charlton%20(2).pdf is attached.

Australians for Animals Inc. notes there has been no indication that breeding season festivals would be avoided.

Australians for Animals Inc. also attaches the following paper: Narayan and Williams BMC Zoology (2016) 1:2 DOI 10.1186/s40850-016-0004-8 Understanding the dynamics of physiological impacts of environmental stressors on australian marsupials, focus on the koala (phascolarctos cinereus)￼.

Also referenced: https://www.ncbi.nlm.nih.gov/pubmed/26118691 A synthesis of two decades of research documenting the effects of noise on wildlife. Shannon G et al Pub Med.

FALSE ADVERTISING AND VIOLATION OF CONSENT CONDITIONS

At the recent Falls Festival over 2018/l9, the consent provided for THREE DAYS of Festival. One of the attached flyer demonstrates the festival was held over four days. No doubt there will be no response by DOP who have consistently failed to act in terms of breaches of consent conditions. A second flyer advertises FIVE days.

No doubt there will be no response by DOP who have consistently failed to act in terms of breaches of consent conditions.

Noting that the fines levied on NBP for excessive numbers of patrons was only as a result of Australians for Animals Inc. providing evidence of the exceedances.

LEGAL ISSUES

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No information is ever provided on the amount of public insurance which has been obtained by NBP or what any insurance will cover. Given the increased likelihood of bushfire and floods on site, it is critical information.

Further, no desktop study can possibly provide a real time scenario of evacuating a flooded or bushfire site with 50,000 plus patrons and staff. It is therefore imperative to know what insurance coverage has been provided as well as detailed information on how patrons, staff, security, police would be protected in the event of injury or death.

It is also a major concern that the DOP recommends NBP " self monitor". Given the number of drug deaths at festivals over recent months, the massive numbers of police engaged in attempting to stop drugs coming into festivals, it's beyond comprehension why any responsible government would allow a massive increase in NBP festivals.

The NBP has sold 51% of its commercial interests to Live Nation, a US based corporation already under investigation in the US.

The suffering public has been told lie after lie and it's very clear, given the record of NBP that any limit of 50,000 and the numbers of festivals is nothing more than hot air.

Byron Shire is being destroyed by tourism and massive festivals. With a ratepayer base of 15,000 obliged to pay for infrastructure damage, any approval of NBP makes for a strong class action matter. There is also the possibility of civil action.

The denial of public interest by the NSW government through its instrumentalities is shocking. To contemplate increasing carbon emissions created by these festivals in perpetuity at a time when climate impacts are so obvious in Australia is beyond comprehension.

Yours sincerely,

Sue Arnold
Co ordinator
Australians for Animals Inc.
Ph: [redacted]
Mobile: [redacted]

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7 January, 2019

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Registered Charity No: 12644

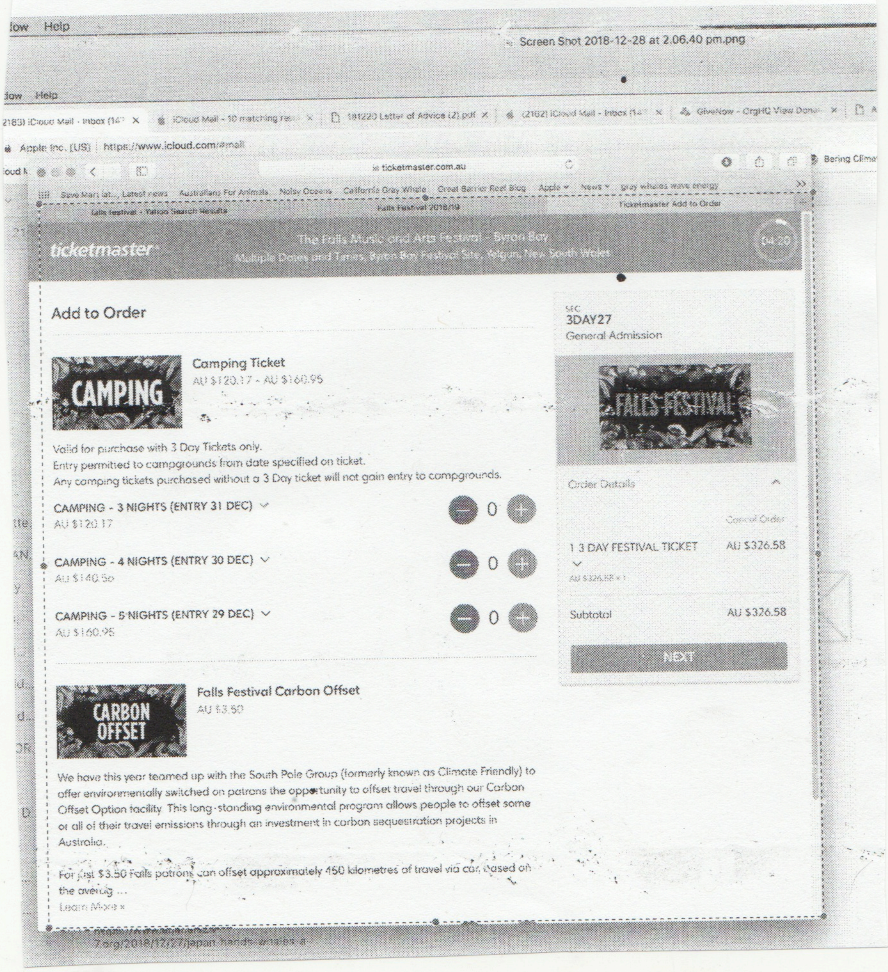
4.4 Baseline emissions

The total GHG emissions from the transport sector in Byron Shire is 93,609 tonnes CO_2e.

Emissions per capita: 3.33 tonnes CO_2e.

Table 1. Emissions by vehicle category for the Byron Shire region.

Vehicle category	Fuel type	No of vehicles	Fuel consumption (litres)	Emissions (tonnes CO_2e)
Passenger vehicles (incl. off-road)	Petrol	16,970	23,826,442	54,800.82
	Diesel	1,886	2,571,016	6,941.74
Motorcycles	Petrol	1,316	195,294	449.18
Buses	Petrol	140	460,502	1,059.15
	Diesel	35	296,426	800.35
Light commercial	Petrol	1,895	4,366,766	10,043.56
	Diesel	2,411	4,645,244	12,542.16
Rigid Trucks	Diesel	459	2,609,323	7,045.17
Non-freight	Diesel	30	99,198	267.83
Articulated trucks	Diesel	10	390,500	1,054.35
TOTAL				**95,004.32**



Screen Shot 2018-12-28 at 2.06.40 pm.png
ticketmaster.com.au
The Falls Music and Arts Festival - Byron Bay
Multiple Dates and Times, Byron Bay Festival Site, Yelgun, New South Wales
ticketmaster
Add to Order
Camping Ticket
AU $120.17 - AU $160.95
CAMPING
Valid for purchase with 3 Day Tickets only.
Entry permitted to campgrounds from date specified on ticket.
Any camping tickets purchased without a 3 Day ticket will not gain entry to campgrounds.
CAMPING - 3 NIGHTS (ENTRY 31 DEC)
AU $120.17
CAMPING - 4 NIGHTS (ENTRY 30 DEC)
CAMPING - 5 NIGHTS (ENTRY 29 DEC)
AU $160.95
Falls Festival Carbon Offset
AU $3.50
CARBON OFFSET
We have this year teamed up with the South Pole Group (formerly known as Climate Friendly) to offer environmentally switched on patrons the opportunity to offset travel through our Carbon Offset Option facility. This long-standing environmental program allows people to offset some or all of their travel emissions through an investment in carbon sequestration projects in Australia.
For just $3.50 Falls patrons can offset approximately 450 kilometres of travel via car, based on the averag ...
SEC
3DAY27
General Admission
FALLS FESTIVAL
Order Details
1 3 DAY FESTIVAL TICKET
AU $326.58
Subtotal
AU $326.58
NEXT

Narayan and Williams *BMC Zoology* (2016) 1:2
DOI 10.1186/s40850 016 0004 8

BMC Zoology

REVIEW Open Access

Understanding the dynamics of physiological impacts of environmental stressors on Australian marsupials, focus on the koala (*Phascolarctos cinereus*)

Edward J. Narayan* and Michelle Williams

Abstract

Since European settlement more than 10 % of Australia's native fauna have become extinct and the current picture reflects 46 % are at various vulnerability stages. Australia's iconic marsupial species, koala (*Phascolarctos cinereus*) is listed as vulnerable under national environmental law. Human population growth, road expansion and extensive land clearance have fragmented their eucalyptus habitat and reduced the ability of koalas to move across the tree canopy; making the species most vulnerable on the ground. Disease principally chlamydia, road death, dog attack and loss of habitat are key environmental pressures and the reasons why koalas are admitted for veterinary care. It is important to understand the dynamics of the physiological impacts that the koala faces from anthropogenic induced environmental challenges, especially on its essential biological functions (e.g. reproduction and immune system function). This review explores published literature and clinical data to identify key environmental stressors that are operating in mainland koala habitats, and while the focus is mostly on the koala, much of the information is analogous to other wildlife; the review may provide the impetus for future investigations involving other vulnerable native wildlife species (e.g. frogs). Oxalate nephrosis associated renal failure appears to be the most prevalent disease in koala populations from South Australia. Other key environmental stressors included heat stress, car impacts and dog attacks. It is possible that maternal stress, nutritional deprivation, dehydration and possible accumulation of oxalate in eucalyptus leaf increase mostly during drought periods impacting on fetal development. We hypothesize that chronic stress, particularly in urban and fringe zones, is creating very large barriers for conservation and recovery programs. Chronic stress in koalas is a result of the synergistic interplay between proximate environmental stressor/s (e.g. heat stress and fringe effects) acting on the already compromised kidney function, immune and reproductive suppression. Furthermore, the effects of environmental pollutants in the aggravation of diseases such as kidney failure, reproductive suppression and suppression of the unique marsupial immune system should be researched. Environmental policies should be strengthened to increase human awareness of the threats facing the koala, increased funding support towards scientific research and the protection and creation of reserve habitats in urban areas and fringe zones. Global climate change, nutritional deprivation (loss of food sources), inappropriate fire management, invasive species and the loss of genetic diversity represent the complexities of environmental challenges impacting the koala biology.

Keywords: Climate change, Australia, Wildlife, Koala, Conservation, Diseases, Extinction, Stress physiology, Reproduction, Immune function, Survival

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Background

Human population growth and global climate change are severely impacting on Australia's environment [1–4]. The negative effects of climate change are clearly demonstrated in the steady decline of native Australian wildlife [5, 6]. Australia is home to a distinctive and robust range of many endemic fauna [4], including the koala (*Phascolarctos cinereus*). To safeguard the future of native wildlife species, it is crucial for researchers to identify the biological impacts that environmental stressors have on animals, hindering their ability to reproduce and survive. In this review, we will use the example of the koala to provide a detailed discussion on the biological impacts of key environmental stressors on wildlife in Australia.

Stress or any disturbance in an animal's natural surrounding activates a 'flight or fight' response; a complex cascade of neurohormonal events [7, 8], including an acute stress response (releasing glucocorticoids-a group of corticosteroids with metabolic actions). Glucocorticoids direct energy towards a physical effort [8, 9] and it is an adaptive survival response [9, 10]. On the contrary, chronic stress (prolonged exposure to any noxious stimulus; predation for example) leads to sensitized glucocorticoid reactivity to stressors (See excellent review by [11]), which could have an inhibitory effect on reproductive hormone secretion ([8, 12]) affecting reproductive organ functionality [7], testicular histology [12, 13] and reproductive success [14]. Furthermore, a compromised immune system [7, 15] concomitantly may expose the animal to increased risk of autoimmune diseases, viral infections/resurgence [16], endotoxic shock [17] and susceptibility to parasitism/wound infections [18].

Mortality events in the koala are reflected similarly in other Australian wildlife [19–22] and include predation by feral/introduced species [4, 23], loss of habitat/fragmentation/suitable trees [24–30], climate change [4], car impacts [31], inappropriate fire management [20], drought/extreme temperature events [4, 32], pollutants [33, 34] and disease [30, 35–39]. Chlamydia is a major contributor within the decline of the koala [38, 40] and together with the Koala retrovirus (KoRV) these are the two major endemic disease manifestations in wild and captive koalas [39, 41]. As in other species, manifestations of disease incidence are strongly associated with unpredictable environmental change [27, 28, 36, 41, 42] reflecting a common environmental stress related impact.

The primary objective of this review paper is to scrutinize both clinical data and published literature to identify key environmental stressors and their biological impacts on koala populations.

Environmental stressors

The negative effects of anthropomorphic driven environmental change (e.g. extreme heat wave events) on wildlife species are increasing [5]. There are consequences of these changes to the physical and biological systems due to environmental stressors, such as wildlife road deaths [2] or pathogen spill over [43–45]. The complexity of the environmental interactions leading to these occurrences can be synergistic and multi-directional. Urbanisation and increasing population spread often have abrupt and tangible effects on the environment; divergence of water sources [46], clearance of habitats for agriculture [47] and logging of forests [35, 48]. Less tangible are the malignant effects of climate change [49–51] and environmental contamination from pollution [33, 52, 53]. Greater aridity, erosion and extreme weather events driven by anthropogenic climate change [54–57] decrease environmental productivity [47] and increase competition between native and exotic herbivores [6, 58]. Competition between introduced and native carnivores [59] significantly alter the predator–prey dyad [60] allowing exotic carnivorous species to gain preeminence and prey on native species with increased rapacity [60–63]. Food availability decreases not only for native herbivores but also for any species that relies on a degraded biome [64]. Interspecies competition for nutrition [59, 64, 65] and suitable breeding niches [64] often preface failure of immune functions [15, 48] and reproductive hormone suppression [66] limiting, at every level, species' ability to fulfil their biological imperative. Fungicides, pesticides [52], perfluorinated compounds and radionuclides [33, 53] persist in the environment [52] and bioaccumulate in the food chain [33, 53, 67]. Reprotoxic pollutants have a multi-faceted interaction with habitat degradation [52] and as a limiting factor within species' reproductive success [68–73]. Wildlife road death appears to be a simple case of cause and effect, but in reality may be the ultimate representation of multiple, synergistic, complex dynamic environmental processes. Hypothetically, the death of a koala may represent a search for food [65], or it could be related to cognitive or psychological malfunction from disease [74] or parasitism ([75–77], [76, 78–83]), be searching for a mate or suitable breeding opportunity [64] or simply trying to escape from an introduced predator species [84–86] or controlled burn off [87]. The selection pressures affecting Australian wildlife are unprecedented [3]. When faced with these challenges species may respond by relocating to a suitable biome. This is clearly demonstrated in the pattern of movement of many native passerines tracking a suitable climatic niche, before major habitat destruction, across arid areas of Australia [88–91]. A species may alternatively show phenotypic plasticity [3] in response to environmental changes and remain within their traditional biome [92] or undergo genetic change in evolutionary time-scale. Evidence of adaptive genetic change is few although Gardner et al. [93] presented strong evidence for genetically driven morphological changes. Environmental degradation and fragmentation within a rapid spatial and temporal pattern limits the species' adaptive ability [48] at the velocity required for species longevity [3]. Isolation of populations as a result of habitat degradation, predation [94] or populations devastated during extreme weather events [95] can impact on species genetic diversity limiting their potential for evolution [94] or recovery when a stressor has subsided.

Evidence suggests that the velocity of climate change within this century is expected to be rapid [96] with a collateral need of species to adapt and redistribute at a pace commensurate with the movement of suitable climates. To calculate the velocity of climate change, global temperature has been used [96] with evidence that a wide species range will/have shift/ed poleward or uphill in response to increased global temperatures [1, 49, 97, 98]. From the late 19th century global temperatures have risen by 0.6 °C with an acceleration of increase recorded in the last 40 years [93] however, these studies have focused on temperate geographical climates [49, 98]. Walther et al. [51] commented that biotic and abiotic ecosystems are not governed by world-wide temperature averages and sub-regional variation is of greater relevance in assessment of the ecological impacts of climate change. Van Der Wal et al. [91]) analysed 60 years of climatic data showing that the dispersal of Australian wildlife often orientated towards increased temperature in response to precipitation events. The findings of Van Der Wal et al. [91] when viewed in the context of the unique Australian weather patterns seem hardly surprising. Australia historically has experienced periods of drought and high rainfall. In the years 1788–1860 south-eastern Australia experienced 27 years of drought and New South Wales, 14 years of heavy rain [99]. The variability of rainfall in Australia, among the world's highest, demonstrates in wet and dry periods often with extreme transition periods between the two [55]. The "Big Dry" from 1997–2009 was extreme and record breaking in its length [100]. The resultant research highlighted this weather event as a combination of traditional solar variability amplified by anthropogenic global warming from increased atmospheric greenhouse gases [54, 56]. Extremes in weather, including decreased rainfall, increased maximum temperatures, flash and basin flooding will impact on wildlife with greater risk of fires, decreased ground cover and possible increased erosion and sediment loading within catchments, rivers and lakes [55].

Chronic stress: impacts on reproduction and immune system

Disruptions to the environment and activation of the hypothalamic-pituitary-adrenal (HPA) axis (Fig. 1) generally prepares the body for some form of exertion ([9], [8, 101]).

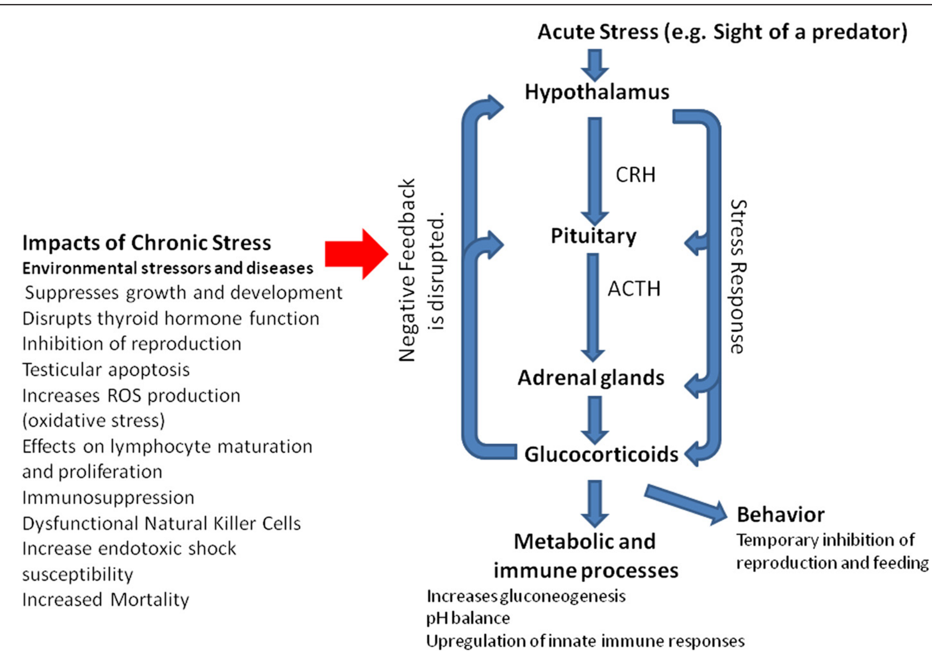

Fig. 1 Activation of the koala hypothalamus pituitary adrenal (HPA) axis and the consequences on biological functions in the presence of acute and chronic stressors

The hypothalamus releases corticotrophin-releasing hormone (CRH) [7], signalling the anterior pituitary to release adrenocorticotrophic hormone (ACTH) [8], which circulates in the blood and results in an increased output of glucocorticoids from the adrenal cortices [101]. Glucocorticoids act to divert storage of glucose, as glycogen or fat, and to mobilise glucose from stored glycogen. Cortisol is the pivotal glucocorticoid within HPA-axis stimulation and then restoration of homeostasis following the physiological stress response [101, 102]. Cortisol stimulates gluconeogenesis, preparing the animal for physical challenge, by partitioning energy, it also assists in balancing pH after the challenge, and finally acts as a chemical blocker, within a negative feedback process [102], to CRH secretion and HPA axis synergy. This interplay between hormonal and metabolic responses are similar across multiple vertebrate taxa and crucial for the maintenance of homeostasis [9, 10]. The HPA axis function comes at a cost of diverting energy away from other corporal functions [3, 7, 8]. Many authors reference concomitant reduction in growth, reproduction [48] and immune function [9, 66, 102] associated with chronic stress.

Chronic stress negatively impacts reproduction. At the levels of the neuroendocrine systems, each component of the HPA axis acts as an inhibitor to the hypothalamic-pituitary-gonadal (HPG) axis and once the HPA axis is activated, secretion of gonadotropin-hormone releasing hormone (GnRH) [8] and pituitary gonadotrophin responsiveness is lowered; testis and ovarian sensitivity to gonadal hormones become reduced [7]. Suppression of the reproductive function during an acute stress episode should be ephemeral whilst priorities of energy expenditure are shifted towards survival rather than reproduction [8] however, chronic stress and continued high levels of glucocorticoids prolong the inhibitory effect on reproduction and may also increase testicular apoptosis [12, 13] contributing to decreased circulating testosterone levels [12]. Aerobic mitochondrial metabolism as a consequence generates reactive oxygen species (ROS) [8, 48] and in the absence of pro-oxidant-antioxidant balance oxidative stress ensues [103]. Leydig cell apoptosis as a result of increased glucocorticoid release generates ROS, which may compromise sperm integrity and fetal development [104, 105].

We hypothesise that wild koala populations are most likely impacted by chronic stressors (diseases and anthropogenic induced environmental change) and they could also be undergoing sub-clinical changes to their reproductive system, such as suppression of gonadal functions, irregular reproductive hormone cycles and infertility in both males and females. These postulations require urgent investigation and it is recommended that general health checks of wild rescued koalas should also include physiological stress evaluation and reproductive health assessment [106, 107].

The stress endocrine response, despite many negative connotations, is a physiological function integral to survival [3, 108] and evidence suggest that vertebrates are designed to display plasticity in response to environmental challenges and evolutionary pressures to maintain allostasis ([3, 9, 15, 18]). Dhabar et al. [109] in studies using rats demonstrated that the immune system response to acute stress is adaptive. The acute stress response resulted in redistribution of immune cells; norepinephrine (NE)/epinephrine (EPI) facilitated an increase in immune cells within the blood stream and EPI/corticosterone (CORT) caused procession of immune cells from the blood stream to the skin [18], lymphoid tissue and to other sites involved in 'de novo immune activation' [109]. In acute stress, fleeing from a predator, interspecies aggression or the hunt for food there is a presumption that the immune response would have adapted to a biological system which is energy efficient, expediently activated and which would protect the animal from skin trauma, bites or non-specific infection, natural corollaries of an exertive effort. This system would also allow for energy to be redistributed to systems engaged in the physical effort. Moller and Saino [82] demonstrated a significant correlation between survival and strong innate immune responses in birds conferring an obvious fitness advantage over those with compromised immune system. Conversely, in the Dhabhar & McEwen [18] study delayed type hypersensitivity (DTH) was lessened and skin leukocytes were attenuated under chronic stress, which correlated with decreased response to glucocorticoids. The implications of a suppressed DTH in combination with attenuated skin lymphocytes may decrease resistance to opportunistic or harmful pathogens [18]. A temporary increase in Natural Killer cells (NKC) followed by suppression in response to peripheral β-adrenergic activation has been demonstrated in rats [110–113] and is part of the innate immune system, however Shakhar & Ben-Eliyahu [114] demonstrated that continuous acute levels of catecholamine were retrograde to NKC sensitive tumour line. The authors comment that a differentiation should be drawn between stress events and major sympathetic activation in which a dysfunction of NKC activity may allow metastasis to establish. Forced swimming [110] and attacked/submissive intruders [112] increased lung tumour metastasis retention/colonisation in rats whilst Vegas et al. [113] did not investigate NKC but found mice with poor social coping strategies, including low social exploration, defensiveness, low social position or avoidance developed more pulmonary metastasis. NKC are considered part of the innate immune system [115] and following challenge with tumour cell inoculation, retention and development of metastasis, are rigidly controlled for 24 h by NKC [112]. The discovery, in mice, of NK cells showing an adaptive immune response, antigen memory and specificity, in the absence of T & B cells [116] to a 'hapten based contact sensitiser' [115] is interesting within the chronic stress-immune system dyad. Social isolation stress, in mice challenged with bacterial endotoxin, has been shown to increase arginine vasopressin (AVP), decrease CRH mRNA (glucocorticoid receptor) and increases endotoxic shock susceptibility [17]. The biological impacts of environmental pollutants on koala populations have not been studied in great detail. Thus, it will be important to investigate the potential impacts of chemical pollutants such as atrazine and other agricultural chemicals as it has been shown that environmental pollutants have the capacity to increase infectious disease susceptibility through chronic stress and of the immune and reproductive system dysfunction (see [15]).

Diseases

Whilst loss of habitat, predation, climate change and fire have been widely studied as important environmental stressors there has been very little research into the decline of marsupial species resultant of toxic chemical exposure [117, 118]. Cluster disease events such as birth defects/thalidomide [119], employees occupationally exposed to polyvinyl chloride/liver angiosarcoma [120], typhoid outbreaks/water quality [121], childhood leukaemia associated/polluted well water [122], fluorosis in kangaroos/aluminium smelter [123, 124] and environmental/animal/human contamination due to polybrominated biphenyls in Michigan [125] indicate that some disease clusters are signals of environmental exposure [126], the consequence of which may have been preventable [127]. Bridging the gap between epidemiological studies, which identify environmental contamination as the probable cause of a disease manifestation and providing regulators with scientific certainties to enact policy often appears at juxtaposition with mitigation of the disease cluster; obvious xenobiotic exposure dismissed as insignificant [125, 127].

Several clusters of disease affect Australian wildlife; oxalate nephrosis in the South Australia koala [128, 129], chlamydia in Queensland koala [39, 130], Tasmanian devil facial tumor [131, 132], mycotic diseases in amphibians [133], mucormycosis in the Tasmanian platypus [134], two of these within a small biome, and increasing amounts of retrovirus, causing leukaemia and lymphoma [135] many not seen before 1950 indicating a commonality of environmental stressor. Rhodes et al. [136] considers that mortality from diseases must be reduced by 59 % to prevent further koala declines. Therefore, identification of environmental stressors that can lead to a decrease in the immune system function is critical to koala conservation and recovery programs.

Oxalate nephrosis

Data from 225 koalas from South Australia represented in Fig. 2 clearly demonstrates oxalate nephrosis (ON) as the predominant disease condition affecting koalas; 26.2 % of the koalas admitted to the hospital diagnosed (November 2013-December 2014) and is considered the leading disease within the Mt Lofty ranges, east of Adelaide in South Australia [128, 129]. This condition, although also present in the Queensland and New South Wales koala is considered of limited incidence and impact in those states [128]. Estimates of 11 % renal dysfunction Mt Lofty Ranges populations in 2000 [128] and 55 % in 2014 demonstrating gross or histopathological changes with oxalate crystal deposition [129] consistent with ON shows a rapid temporal progression [129, 137]. Azotaemia (higher than normal blood urea-BUN) in combination with poorly concentrated urine and low specific gravity was associated with increased severity of histopathological changes [128, 129], which may point to renal disease as the ultimate cause within a complex patho-physiological dynamics.

It is worthwhile to note that metatherian embryos (e.g. koalas) compared to eutherian embryos (e.g. chicken) require significant development dependent upon maternal milk during pouch development. Notably, marsupial mothers dedicate greater investment in lactation than in gestation [138]. Therefore, the effect of nutritional restriction [139–141] and increased maternal circulating glucocorticoids [139, 142–144] on the fetus during critical windows of development can result in decreased nephron numbers [139–141, 143, 144] predisposing offspring to continued nephron loss, progressive renal dysfunction/injury [139], glomerulosclerosis [145] and enhance sensitivity to secondary postnatal environmental insult [139]. Low glomerular number is an important determinant of renal function [146]. Speight et al. [128] found glomerular atrophy in all koala patients with ON accompanied by fibrosis associated with crystal obstruction of the tubules. This may point to a duality of causal factors; maternal stress and nutritional deprivation impacting foetal development in combination with and proximate environmental stressor/s acting on already compromised kidney function. Calcium phosphate, generally associated with calcium oxalate crystals, was found in both healthy and ON koalas [128] and may be only functionally important when renal function is already compromised. The prevalence of ON in young koalas [137] may preclude over consumption of oxalate as a cause implicating a pre-existing renal developmental disorder. The similar incidence of ON in captive koala populations [128] is suggestive of reasons other than a

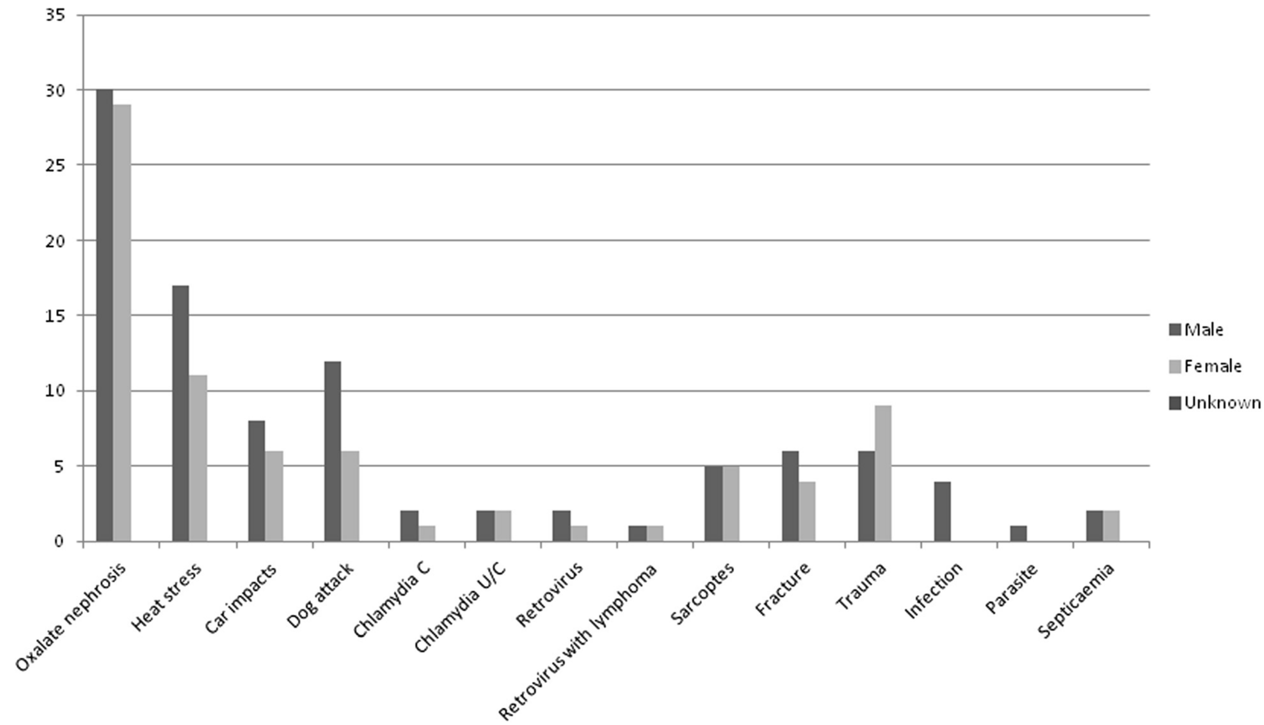

Fig. 2 Clinical cases of koalas ($N = 225$) presented for treatment at a wildlife rescue facility in South Australia from November 2013 December 2014. Many patients presented with multiple conditions reflected in the tabled number of diagnosed condition versus patient numbers. Clearly in SA the major challenge for koalas is oxalate nephrosis, heat stress, car impacts and particularly for males dog attack. Unknown and trauma cases are well represented, many indicative of injuries sustained during dog attack or car collision and had these been included a more profound effect would have been shown. C = confirmed; U = unconfirmed

maternal gestational nutritional restriction impacting fetal kidney development pointing to stress and increased maternal glucocorticoids as the primary cause in both captive & wild populations. Alanine-glyoxylate aminotransferase (AGT) is an enzyme expressed in the hepatocytes and it is crucial for the metabolism of glyoxylate, the end product oxalate, excreted in urine [147]. Isolated populations of decreased genetic diversity show an autosomal disorder demonstrated by AGT deficiency [128, 137, 147, 148] however a decrease in AGT activity was not shown in SA koalas affected by ON [137]. Mt Lofty eucalypts showed higher levels of oxalates than Queensland species but despite this dietary oxalic acid ingestion was not considered as the cause of ON [128] however the results were pooled which may not allow for koala feeding exclusivity on eucalypts with the high oxalic acid content of some eucalypt species.

Koalas show a region/species preference [24, 149] with SA koalas displaying a marked preference for *E. viminalis* (manna gum) [150] and although koalas prefer to browse on young leaves in the wild, they are more likely to consume mature leaves due to availability. Manna gum and messmate leaf samples in the Mt Lofty ranges showed high oxalic acid concentration (4.68, 5.22 and 7.51 % DW respectively) with mature leaves overall showing higher oxalic acid content [128] during Spring sampling. Eucalypt species during times of low rainfall make osmoric adjustments, which reduces leaf water content [151]. Drought stress has been described in the Eucalypt with messmate stringy bark most affected [152]; peach trees demonstrate decreased leaf water content and increased oxalic acid levels [153]. Sampling of the same trees during summer or on the fringe may have had demonstrated different oxalic acid levels and the suggestion would be that eucalyptus seasonal, area specific oxalic acid levels be investigated with koala preferences adjusted for.

Other causal factors for ON are ingestion of ethylene gycol [129], which appears unlikely, however the extensive use of ethylene glycol in airplane deicers, automotive industry and solvents (ethylene glycol, http://www.npi.gov.au/resource/ethylene-glycol-12-ethanediol) and the proximity of ON cases to the Adelaide airport (Fig. 3) requires further investigation. Statistics Australia wide show alimentary tract and intestinal disease represented in 40 and 35 % of the koalas respectively. The possibility exists that over absorption of oxalic acid due to intestinal disease [154], decreased oxalic acid specific anaerobic bacteria [129, 154, 155] or slow microbial adaptation [156] is a factor in the

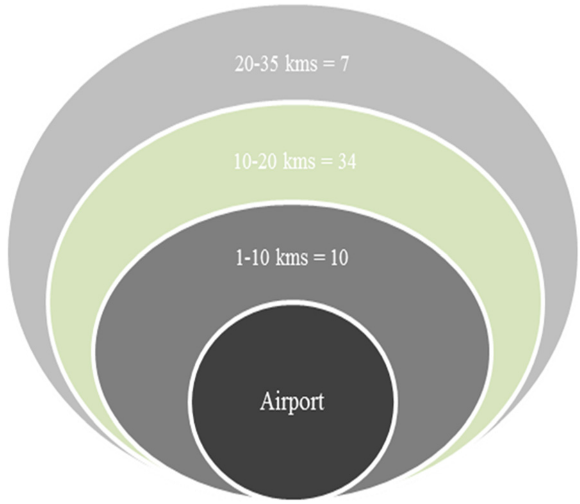

Fig. 3 Oxalate Nephrosis (ON) cases by Adelaide Airport proximity. There is clear evidence of increased ON cases in the area falling within the 10 20kms of the airport. This should be investigated for a commonality of environmental stressor

development of ON disease and also requires further investigation.

Habitual factors mediate the composition of intestinal microbiota however the absence of bacteria with anti-inflammatory action during disease may implicate the essential nature of a functional intestinal bacterial flora for health [157, 158] and further investigation on the effects of elevated glucocorticoids on koala intestinal bacteria is required. Treatment indicated for ON is increased hydration [148], considered quite problematic with low leaf moisture content for the koala. Vickneswaran et al. [144] found male rat nephron numbers were most affected during gestation by maternal stress however Speight et al. [128] found no evidence of koala gender involvement in ON. The identification that prenatal nephron deficiency can be corrected with a single dose of retinoic acid [159] during gestation, even with nutritional deprivation, and during lactation [141] shows system plasticity, which can be exploited, particularly if environmental stressors can be identified and mitigated.

Chlamydiosis

Koalas suffer from two types of chlamydiosis, *Chlamydia pneumoniae* [39, 130], which may be endemic within koalas and *C. pecorum,* responsible for substantial reproductive consequences for the species [38, 39, 160] and possibly result of cross-species transmission [28]. Evidence suggests the chlamydia is associated with nutritional/environmental stressors [27] and symptoms vary from conjunctivitis, which may lead to blindness, respiratory tract infections [130], reproductive discharge and possible infertility [38].

The identification of genes from the natural killer complex (NKC) and leukocyte receptor complex (LRC) in koalas with chlamydia is suggestive of a role in the immune system [38] and may implicate the down-regulation of NKC activity during periods of chronic stress within individual manifestations and severity of chlamydial disease [40]. Rhodes et al. [136], Melzer et al. [27], and Phillips [28] question the impact chlamydiosis has on reproductive rates or survival of the koala with the possibility that 'stable coexistence' [27, 28] between disease and the koala has been demonstrated in population modelling [28]. Rhodes et al. [136] cites high rate of mortality rather than reproductive suppression in coastal koala populations as the stressor limiting the growth rate of the population. Chlamydia diagnosis, in the presence of an inflamed cloaca, without diagnostic confirmation or despite negative results (Narayan unpublished data) may have over emphasised the incidence of the disease within koala populations.

Fringe effects

High cortisol levels in koalas are associated with range edge, lower rainfall and leaf moisture [161] with continuously high cortisol levels, indicating chronic stress, for example, in a fragmented spider monkey colony [162]. Within dry or high temperature environments, leaf moisture dictates eucalyptus choice [27, 163] and combined with fur insulation, low basal metabolism, decreased body temperature [164], evaporative loss from the respiratory tract [165] and the ability to utilise non-fodder trees where the daytime temperature is lower [27, 166] allow thermoregulation and arboreal existence. Ellis et al. [165] found non-fodder daytime trees favoured by koalas were 2 °C cooler than the ambient temperature and are a critical feature of the koala microclimate. During drought and heatwaves koala survival depends upon relocation to a riparian habitat [24, 161, 165, 167, 168] and the availability of free standing water [161] without which dehydration follows. Contraction of riparian habitat is associated with mass mortality events in young koalas pushed from moist sites to the fringe [167] and expectation for fragmented or fringe populations in extreme temperature events increases extinction risk [161, 168]. Heat stress cases, reflected in Fig. 4, clearly show an association between koala heat stress, suburban fringe and temperatures exceeding 40 °C, the exception being 4 heat stress cases at 28.3 °C, however the preceding day was 44.7 °C and demonstrates the potential for heat stress, possibly resultant of dehydration, despite cooler temperatures [169].

Higher leaf moisture is associated with soil water holding capacity [161]; the assumption being that soil would

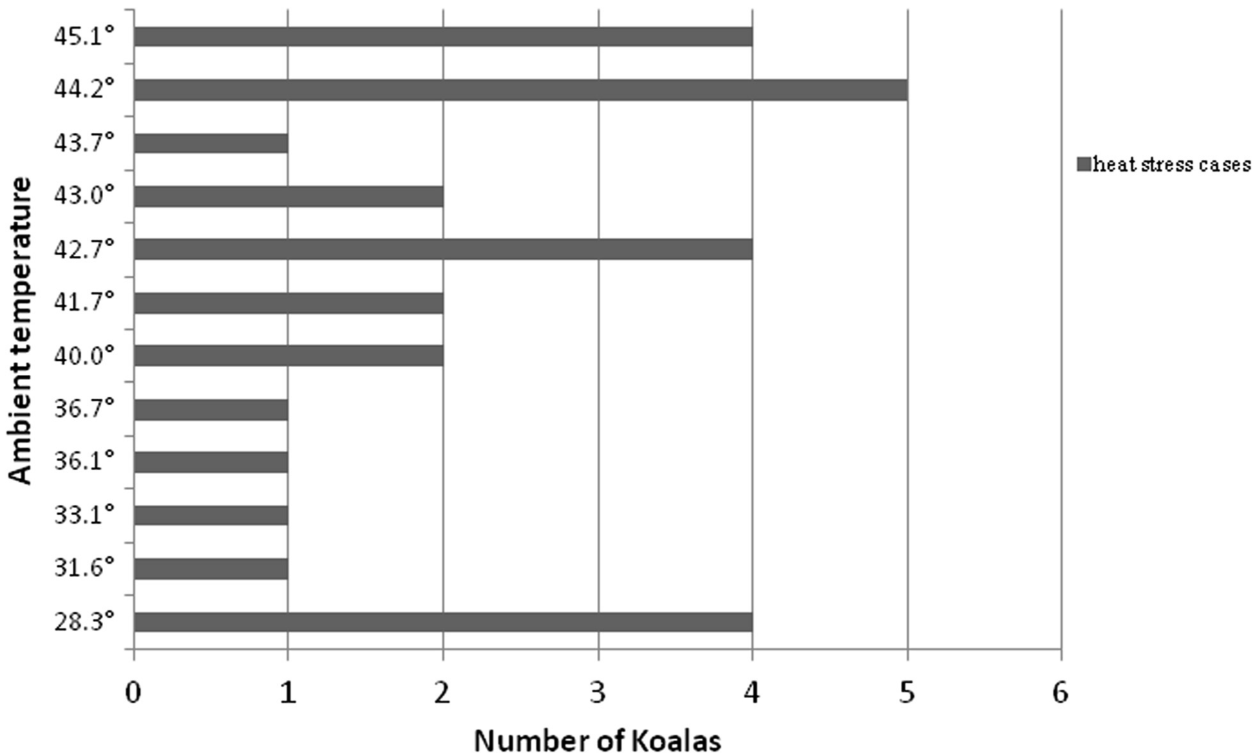

Fig. 4 Heat stress is a major environmental stressor in the koala. Anthropogenic driven global warming with an increase in extreme temperature events pose a substantial risk of mortality when koala colonies have limited access to riparian habitats. It shows the number of heat stress cases against environmental temperature; cases are strongly associated with days of high temperature. Four cases were recorded for a moderate temperature of 28.3 °C however the preceding day was 44.7 °C and illustrates the limited ability of the koala to recover from extreme temperatures despite moderation of conditions. Temperature data was obtained from the Bureau of Meteorology (http://www.bom.gov.au/)

be moisture deprived at the fringe of a habitat. The koala, a caecum-colon fermener [170] maintains a precarious energy balance [171, 172], utilising poor quality diets containing essential oils and tannins within an extensive, prolonged, microbial digestive process [173]. The basal metabolism of the koala is 74 % of the mean of other marsupials [173] with maintenance energy requirements similarly reflected [164, 173]. Koalas spend around 19.3 – 20 h a day resting or sleeping [172, 174] however hypervigilance has been demonstrated in response to human presence/noise [171]. The energetic cost of chronic stress impacts reproduction [12, 13], growth [7], and the immune system [7, 15] whilst hypervigilance, the relationship with proximity to suburbia (Fig. 3) creates an energy/water/thermoregulation deficit [171, 172] when unable to engage in physiological and behavioural adaptations [174]. Large/small body size, within a Bergman's rule (smaller body size as environmental heat increases) creates a paradox for the koala within degraded, fragmented/fringe habitats with water deprived environments experiencing extreme temperature events resultant of anthropogenic climate warming [5, 24, 54, 56, 57, 175]. Small body size in Queensland koalas allows for effective heat dissipation [176] but in the absence of water may encourage dehydration [5]. Koalas are larger in temperate areas as males size under sexual selection [176, 177] and as a result need more water [172] but would consequently have an inability to dissipate heat. This is clearly reflected in heat stress cases (Figs. 3 and 4) in which males ($N = 17$) and females ($N = 11$) showed marked difference in SA koalas.

Predation and road trauma

Rhodes et al. [136] and McAlpine et al. [31] commented that as forest cover is reduced mortality events increase; koala population decline considered to be driven by increased mortality events [31]. Species within a fragmented or isolated habitat have a low probability of survival [178–180]. According to Davies et al. [25, 26], koalas living in the edge of its range often increase their movement in search of food sources and increase their vulnerability to predation in doing so. Both rural and suburban fragmentation/fringe effects are high risk for dog attack/vehicle trauma [28, 31, 35] with natal dispersal of 2–3 year old males clearly represented within

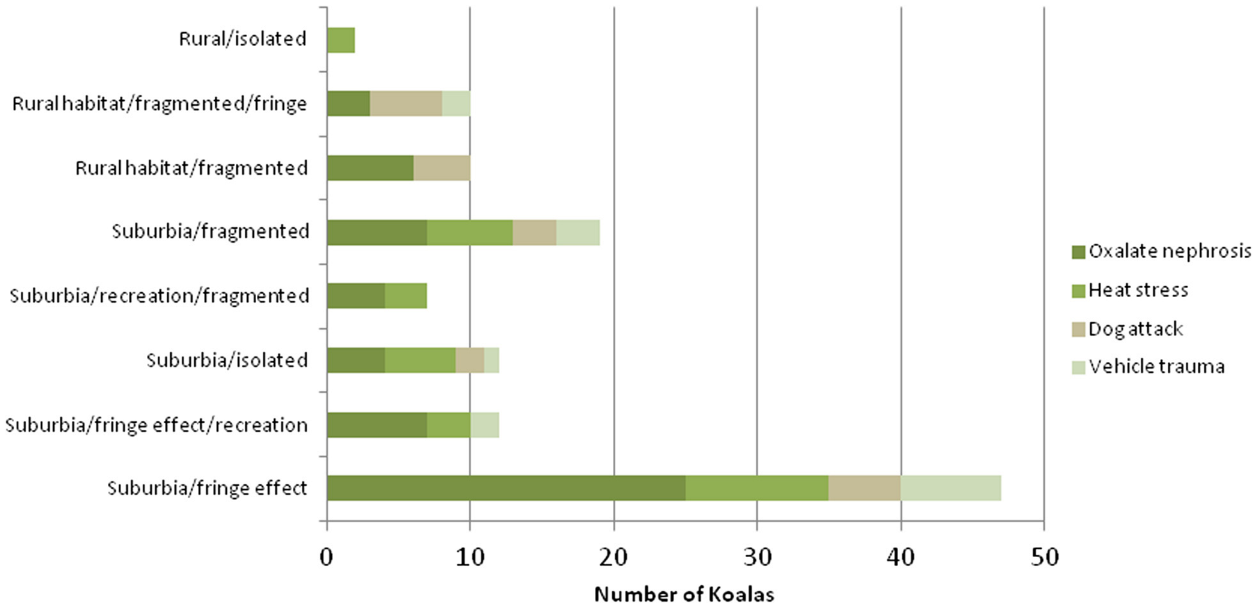

Fig. 5 Relative risk for koalas based upon specific environment. The four main environmental stressors and the occurrence in specific biomes. The suburban fringe appears to be highest risk for three of the four stressors affecting South Australia koalas

deaths (Fig. 5). Absence of overlapping canopy encourages koalas to cross gaps between trees on the ground increasing vulnerability to dog-attack and vehicle trauma [31]. Reduced abundance of vertebrates worldwide is associated with proximity to roads [181]; road trauma, noise [181] and pollution must be also considered within koala chronic stress dynamics.

Conclusions

Our literature review provides fresh evidence that koala populations in urban and fringe areas are being severely impacted by environmental stressors. It is the synergistic nature of environmental stressors that makes the impact much more severe and the prolonged nature of stressors, arrival of new stressors (such as new urban development projects) are causing increasingly more stress to koala populations. We have identified key areas of investigation for future research, including a stronger focus on diseases (e.g. maternal transfer of immune genes to developing embryos), impacts on reproductive fitness traits (e.g. sperm integrity and mortality) and stronger research focus under the thematic area of chronic stress. Clearly, the field of conservation physiology, through non-invasive reproductive and stress hormone monitoring technologies have an important position in koala conservation and management research programs [107, 182]. Koala recovery programs should also focus on the potential impacts of environmental pollutants on the populations, especially those living in close proximity to urban zones. Native wildlife species can provide real-life examples of how anthropogenic induced environmental changes are impacting on Australia's once pristine terrestrial environments. Hence, we should start thinking more seriously about our actions and how we are impacting nature. Stronger support is needed for research and conservation management programs to save our native fauna from the threat of extinction.

Abbreviations

ACTH, adrenocorticotrophic hormone; AGT, alanine glyoxylate aminotransferase; AVP, arginine vasopressin; BUN, blood urea; CORT, corticosterone; CRH, corticotrophin releasing hormone; DTH, delayed type hypersensitivity; EPI, epinephrine; GnRH, gonadotropin hormone releasing hormone; HPA, hypothalamic pituitary adrenal; HPG, hypothalamic pituitary gonadal; KoRV, koala retrovirus; LRC, leukocyte receptor complex; NE, norepinephrine; NKC, natural killer cells; ON, oxalate nephrosis; ROS, reactive oxygen species

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Availability of data and materials

This is a review and all data presented has been previously published and citations have been provided. The Adelaide Koala and Wildlife Hospital has been duly acknowledged for providing clinical data that have been adequately presented in graphs. Raw data may be requested through consent of the AKWH.

Authors' contributions

EN conceptualised the review paper and the Masters of Science Research Scholar (MW) conducted the literature collection and data collation. Both authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

Consent for publication
Not applicable.

Ethics approval and consent to participate
Ethics approval was not required for review article. Dr Narayan holds Charles Sturt University Animal Care and Ethics protocol (#A10644) for collaborative koala research with the Adelaide Koala and Wildlife Hospital.

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Report No. 13.2	**Byron Shire Council's Emssions Reporting 2015/16 and 2016/17**
Directorate:	Sustainable Environment and Economy
Report Author:	Kim Mallee, Sustainability Officer
File No:	I2017/1544
Theme:	Ecology Planning Policy and Natural Environment

Summary:

In March 2017 Byron Shire Council adopted a zero net emissions target for its operations which increased its ambition from the previous reduction target of 30%. Council has been actively implementing emission reduction strategies and reporting on emissions since 2004. This report details a new emissions baseline for the 2015/16 financial year and reports on the emissions profile of Council for the 2016/17 financial year.

Using the National Greenhouse and Energy Reporting (NGER) methodology emissions were calculated across Council's six sectors for scope 1 (eg. direct emissions such as burning diesel or unleaded fuels) and scope 2 emissions (eg. indirect emissions that come from using electricity produced by the burning of coal at another facility). From 2015/16 to 2016/17 Council experienced a net increase of emissions moving from 25,500 tonnes to 26,300 tonnes of equivalent carbon dioxide (t CO2e).

The development of an Emissions Reduction Strategy, which will replace the existing Low Carbon Strategy has commenced and is the subject of another report titled 'Emissions Reduction Strategy' to this Council meeting.

RECOMMENDATION:

1. **That Council note this report.**

2. **That the calculation of sewage treatment plant fugitive emissions be outsourced using Water and Sewer funds to create an excel model using the NGER methodology that can be used for future reporting years.**

Background

Byron Shire Council adopted the Low Carbon Strategy in 2014 which had the target of reducing Council emissions by 30% from the 2003-2004 levels by 2020. The Low Carbon Strategy identified ways for Council to pursue opportunities for a low carbon, less oil-reliant future. It contained 87 project actions that covered the following areas of carbon, energy efficiency, transport, staff and community engagement, waste, peak oil and water. 100% of the 35 Year 1 priority actions in the Low Carbon Strategy were completed or in progress. The remaining actions will be considered in the preparation of a new Emissions Reduction Strategy.

This report quantifies Council's emissions profile in order to create a new base line for the 2015/16 financial year to suit the Zero Emissions Target as well as report on the 2016/17 financial year emissions.

Zero Net Emissions Target

In March 2017 Council resolved (***Res. 17-086*** relevant parts):

3. That Council commits to achieving a 100% Net Zero Emissions Target by 2025 in collaboration with Zero Emissions Byron (ZEB).

5. That Council commit itself to source 100% of its energy through renewable energy within 10 years.

6. That Council supports the goals of Zero Emission Byron for a Net Zero Emissions Shire in the areas of building, energy, land use, transport and waste.

Adoption of baseline and National Greenhouse and Energy Reporting (NGER) methodology

To align with the Zero Emission Byron (ZEB) ambition, a base line of 2015/16 and a target year of 2025/26 were assigned for Council's emissions profile. To align with a national methodology for monitoring and reporting emissions that provides all relevant calculations and processes for a local government, the "National Greenhouse and Energy Reporting" (NGER) methodology was implemented. Zero Emissions Byron has advised that the NGER methodology will be compatible with their emissions profiling of the Byron Shire community.

Scope of Monitoring and Reporting

In line with the NGER methodology Council will be monitoring and reporting on Scope 1 and 2 emissions:

- **Scope 1** greenhouse gas emissions are the emissions released to the atmosphere as a direct result of an activity at a facility level. Scope 1 emissions are sometimes referred to as direct emissions. Examples are:

  a) emissions from the burning of diesel or unleaded fuel in vehicles
  b) fugitive emissions, such as methane emissions from landfills or sewage treatment plants

- **Scope 2** greenhouse gas emissions are the emissions released to the atmosphere from the indirect consumption of an energy commodity. For example, 'indirect emissions' come from the use of electricity produced by the burning of coal in another facility.

Apart from scope 1 and 2 emissions, there also exist scope 3 emissions in the running of any business. Scope 3 emissions come from indirect sources other than electricity. Some examples include contracted services and flying on a commercial airline by a person from another business. Scope 3 emissions will not be reported as part of Council's emissions profile due to the significant staff resourcing cost involved in trying to procure the data, and in some instances the lack of data available to report.

When Council made its first commitment to reducing greenhouse gas emissions in 2004 the *NGER Act 2007* did not exist. Hence emission sectors such as landfill and sewage treatment plant fugitive emissions were not included. Fugitive emissions are emissions of gases or vapours from pressurised equipment due to unintended or irregular releases of gases. Now with greater understanding of how emissions are created, Council has been able to calculate and include fugitive emissions in its profile to more holistically describe its emissions impact. The scope of Council's emission sectors will be categorised as follows:

a) General Electricity
b) Streetlights
c) Fleet
d) LPG Bottled Gas
e) Landfill Fugitive Emissions
f) Sewage Treatment Plant Fugitive Emissions.

Emissions Sectors of Byron Shire Council

Figures 1 and 2 below show percentage make up of each sector and the total emissions in tonnes for the two reporting years respectively. Together they show the significant contribution to Council's emissions profile from fugitive emissions escaping from the landfill and sewage treatment plants.

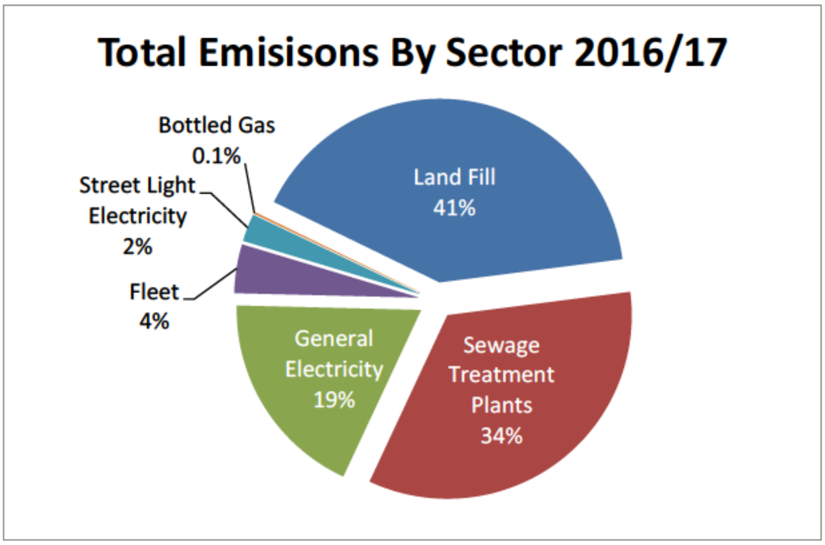

Figure 1 – Total Emissions by Sector 2016/17

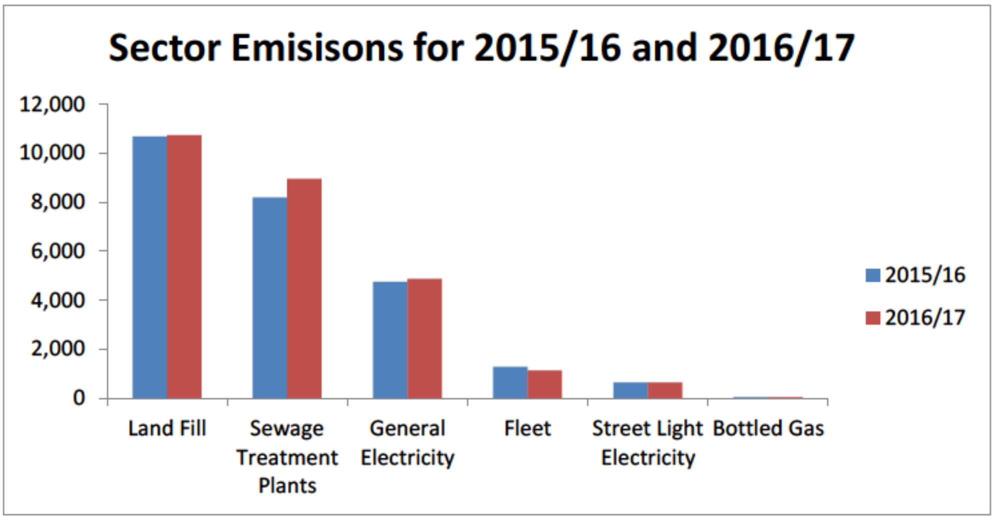

Figure 2 – Byron Shire Council Emissions by Sector

From the 2015/16 baseline to 2016/17 Byron Shire Council has experienced a net increase in emissions moving from approximately 25,500 tonnes to 26,300 tonnes of equivalent carbon dioxide (t CO_2e).

Figure 3 below displays the increase in context to the zero net emissions target. In all instances throughout this report the projections towards the zero net target has been displayed as linear. This is not to say that Council's journey towards the target will in fact be linear. At this stage it is impossible to accurately project the reduction path without the Emissions Reduction Strategy being written and key major projects defined and time lined. This report does not seek to outline in depth how the target will be reached but will provide the inventory of emissions for the baseline and current emissions profile so that such planning can occur meaningfully.

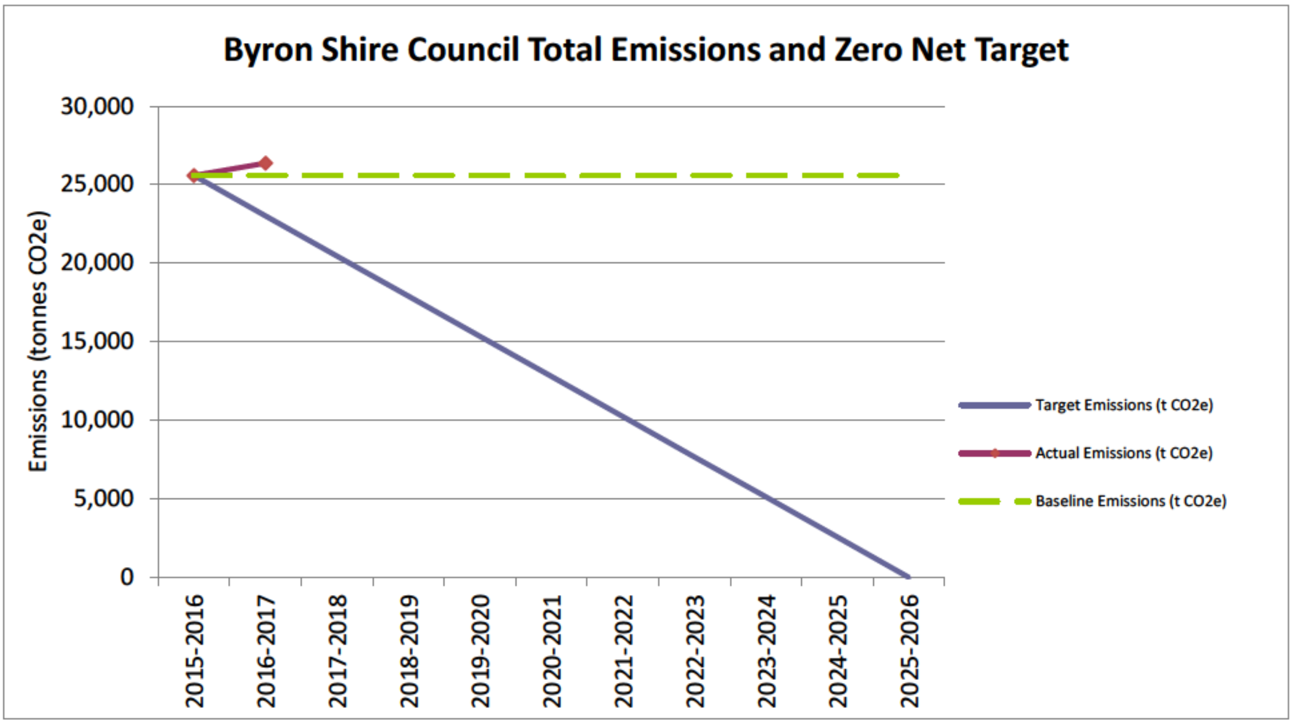

Figure 3 – Byron Shire Council total emissions and zero net target

a) General Electricity

The general electricity sector increased by approximately 137,000 kWh from 2015/16 to 2016/17. This 115 tonne increase has resulted in being 590 tonnes above the projected target of 4,275 tonnes for 2016/17. See Figure 4 and Table 1.

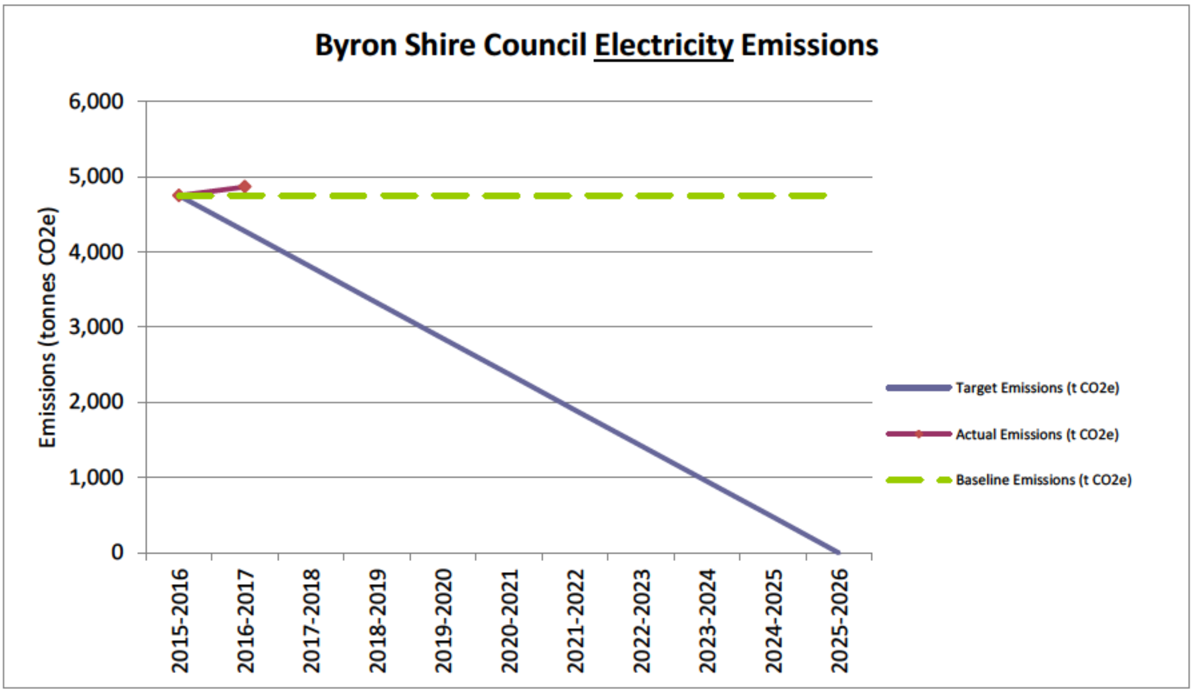

Figure 4 - Byron Shire Council Electricity Emissions

Table 1: Electricity Emissions

	2015-2016	2016-2017
Consumption (kWh)	5,654,481	5,791,542
Cost ($)	$1,155,601	$1,205,135
Base Line Emissions (t CO2e)	4,750	4,750
Target Emissions (t CO2e)	4,750	4,275
Actual Emissions (t CO2e)	4,750	4,865
Trending (t CO2e)		+590

Table 2 below shows the cost of electricity used across each Council asset type to put into perspective the cost of the emissions.

Table 2: Cost of Electricity by Asset Type

Asset Type	2016/17 Cost ($)	% of Total
Wastewater Collection & Treatment	$723,211	60
Administration Building	$108,485	9
Caravan Parks	$76,410	6
Pools	$48,536	4
Sports Fields	$48,444	4
Water Supply	$43,656	4
Libraries	$41,182	3
Community Buildings/Halls	$37,439	3
Other	$77,772	6

***NB Costs and consumption are not directly related due to the impact of demand charges and fees. (eg The water pumping infrastructure makes up 4% of Council's costs but not 4% of its electricity use).*

Figure 5 below shows the proportion of electricity used from each asset type with the waste water collection and treatment sector using 65% of the total. The significance of the waste waster sector dominates the energy story for Council and increases in this area can engulf savings in other areas rapidly. For example the West Byron Sewage Treatment Plant had a 128,947kWh increase between 2015/16 and 2016/17 from a combination of increased pumping of re-used water to Byron Bay, extra flows and the addition of treating landfill leachate. This increase hides the significant 7,445 kWh savings from the LED lighting retrofit program at the depot.

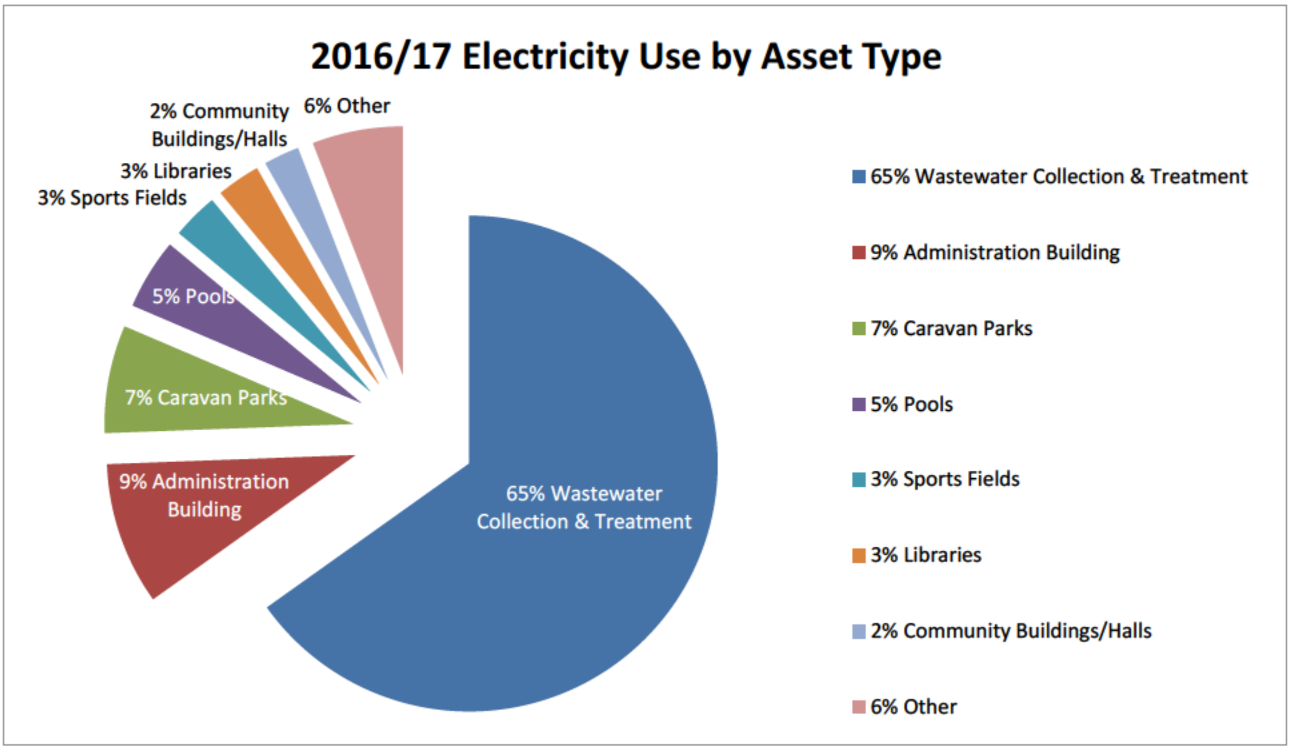

Figure 5 – 2016/2017 Electricity Use by Asset Type

Energy efficiency measures continued to be implemented across Council but it is apparent that savings created in the waste water collection and treatment sector are of high priority. There will always be a need for large energy consumption in this sector and a move to renewable energy sources will be a necessity to meet the zero net emissions target.

A detailed analysis of Council's available feedstocks for Bio Energy was undertaken in early 2017 which showed there are enough resources to warrant a facility in the Shire. A pre-feasibility study has been commissioned into the type of technology appropriate for Council's feedstocks and the projected cost benefit of such a project. The results of the pre-feasibility study are due in early 2018 and will be a critical part of the waste water collection and treatment sectors transition towards zero net emissions.

b) Streetlights

The streetlight sector is a significant user of electricity and is highly regulated via a service agreement with Essential Energy. The 8,200 kWh increase is attributed to a number of streetlights being installed in new subdivisions in Mullumbimby and Bangalow. As urban areas expand it will be important to ensure the most energy efficient option is chosen wherever possible.

Planned reduction measures in this sector include the commitment to a recent offer by Essential Energy to conduct a bulk replacement of streetlights to LED technology for Category P (low traffic residential) areas. Works are scheduled for November 2018 and will create a substantial energy saving but will not show a decrease in energy use until 2019.

Figure 6 and Table 3 show the emissions profile of the streetlight sector. Council is trending at 63 tonnes above the target emission of 572 tonnes CO2e for the 2016/17 financial year. The slight 1 tonne reduction in actual emissions, despite the increased consumption of kWh, is due to the lowering of the national emissions factor for grid purchased electricity due to more renewable energy being on the national network generally.

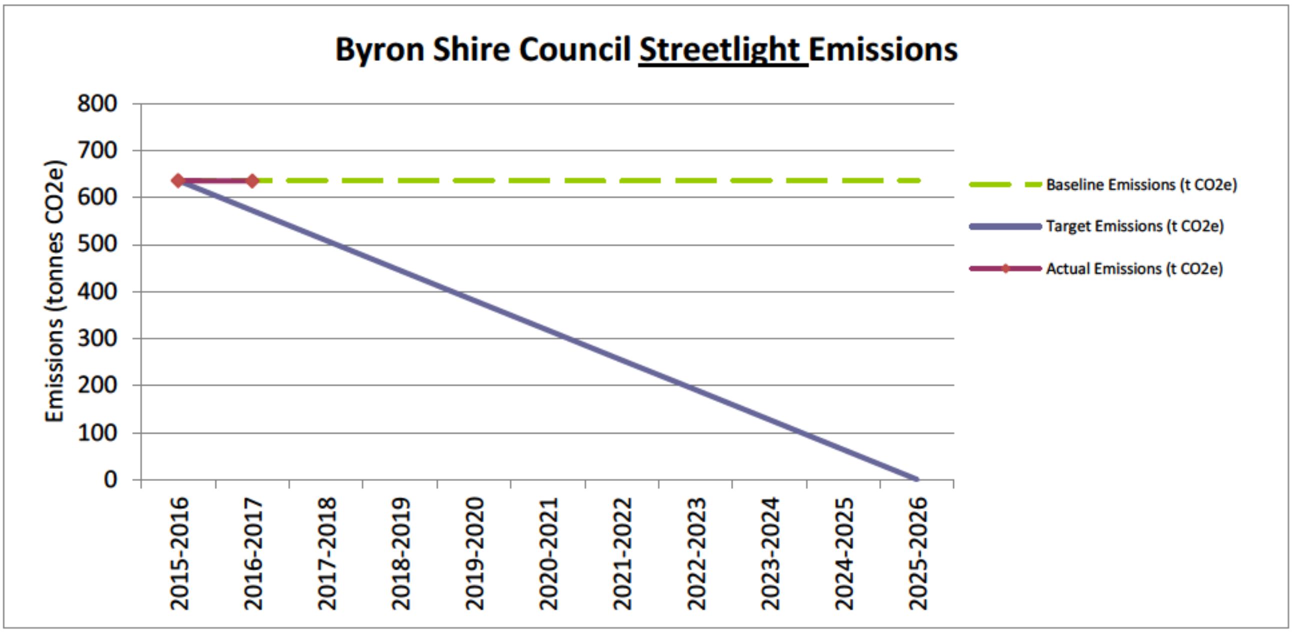

Figure 6 – 2016/2017 Byron Shire Council Streetlight Emissions

Table 3: Streetlight Emissions

	2015-2016	2016-2017
Consumption (kWh)	756,699	764,912
Cost ($)	$314,425	$336,809
Base Line Emissions (t CO2e)	636	636
Target Emissions (t CO2e)	636	572
Actual Emissions (t CO2e)	636	635
Trending (t CO2e)		+63

c) Fleet

Emissions from Council's fleet sector includes all diesel and unleaded petrol consumed from both the bulk fuel stores at the depot, quarry and landfill and the fuel used in the passenger vehicles issued via star cards at commercial fuel stations.

The emissions attributed to Council's fleet reduced from 1,279 tonnes to 1,128 tonnes. This 151 tonne decrease places this sector 23 tonnes ahead of the target projection for the 2016/17 financial year, refer to Figure 7 and Table 4.

When preparing this year's emissions inventory for the fleet sector, a major flaw in the Authority data capture function was identified for bulk fuel use, which removed the ability to attribute fuel issued to individual plant numbers. As such, the emissions for the bulk fuel had to be calculated from "delivery purchases" as opposed to "fuel stock issues". Unfortunately this has meant that it is impossible to drill down further to ascertain the reason for the reduction in fuel usage. Avenues are being investigated to rectify this situation and move to a more digital way of issuing fuel at the depot. This will enable more detailed analysis and tracking of Council's bulk fuel use in the next reporting year.

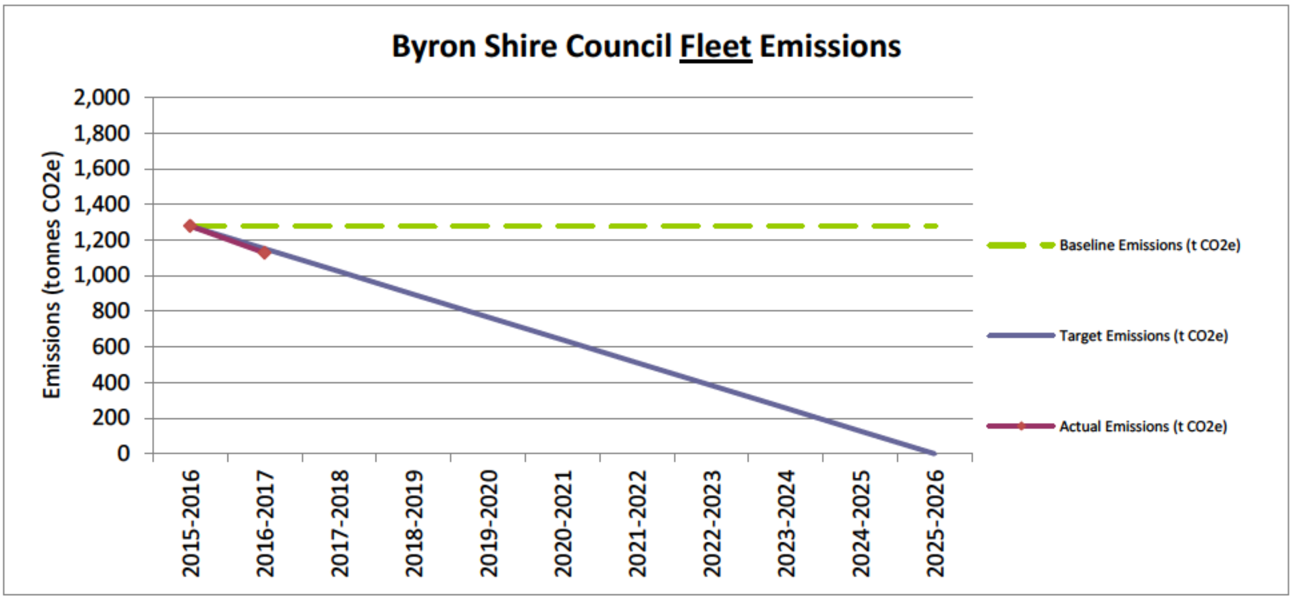

Figure 7 – 2016/2017 Byron Shire Council Fleet Emissions

Table 4: Fleet Emissions

	2015-2016	2016-2017
Consumption (kL)	482	427
Cost ($)	$482,922	$438,480
Base Line Emissions (t CO2e)	1,279	1,279
Target Emissions (t CO2e)	1,279	1,151
Actual Emissions (t CO2e)	1,279	1,128
Trending (t CO2e)		-23

d) LPG Bottled Gas

Byron Shire Council uses LPG bottled gas in both its holiday parks and at Sandhill's Child Care Centre. The emissions impact of bottled gas was 41 tonnes in the 2015/16 financial year reducing to 39 tonnes in 2016/17 shown in Figure 8 below. Despite the reduction it was not quite enough to meet the projected target of 37 tonnes for the 2016/17 financial year. The primary user of bottled gas is the First Sun Holiday Park which accounts for 75% of the total. Bottled gas is used for boosting the solar hot water system at the amenities block (installed 2014) and as instantaneous gas hot water heating in all the cabins. Water saving shower heads have already been installed and there is minimal other efficiencies to be gained.

For the minimal cost to Council for the gas and the minimal emissions impact of this sector, it is recommend that this sector be offset by the other renewable energy projects Council is pursuing.

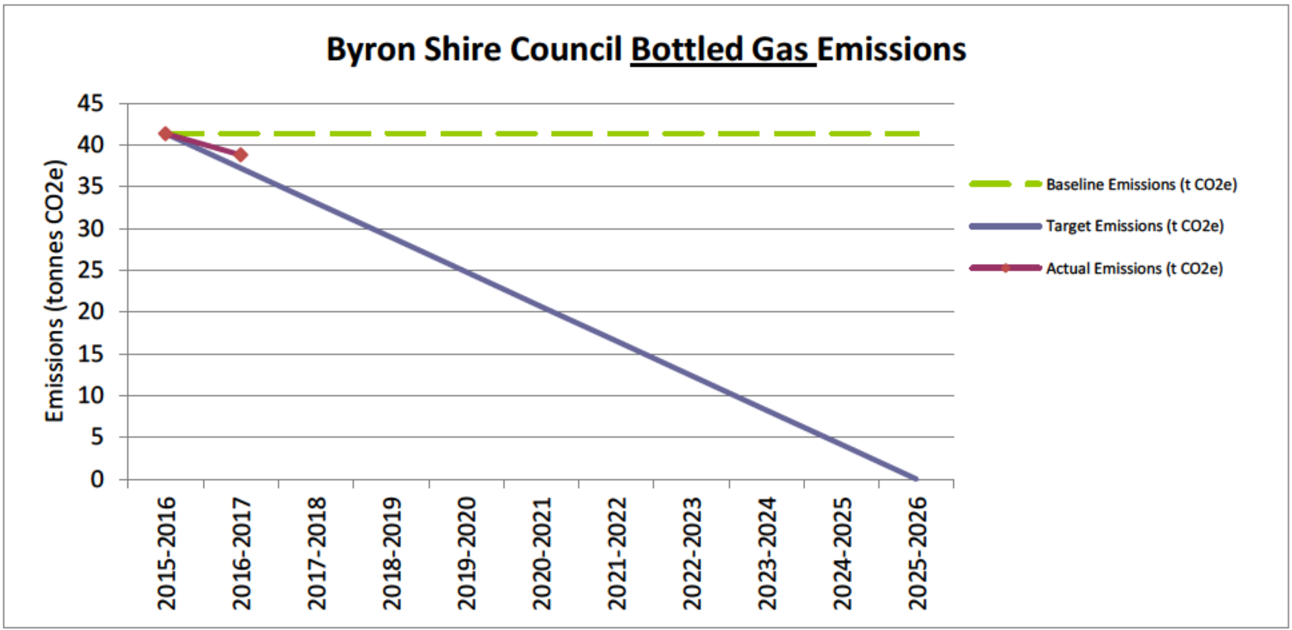

Figure 8 – 2016/2017 Byron Shire Council Bottled Gas Emissions

Table 5: Bottled Gas Emissions

	2015-2016	2016-2017
Consumption (L)	26,541	24,905
Cost ($)	$17,913	$14,931
Base Line Emissions (t CO2e)	41	41
Target Emissions (t CO2e)	41	37
Actual Emissions (t CO2e)	41	39
Trending (t CO2e)		+2

e) Landfill Fugitive Emissions and Flare

Emissions from Council's landfill are now being included in Council's emissions inventory. The fugitive emissions from the landfill are only the emissions released by the landfill itself. Emissions from running the landfill such as fuel in the heavy plant, or electricity to run pumps and lighting have been attributed to other sectors of the emissions inventory. The landfill fugitive emissions are significant at over 10,000 tonnes per annum which is greater than the electricity, streetlight, fleet and bottled gas sectors combined.

Council's landfill is not currently operational and has an interim cap applied to the most recently operated Southern Expansion cell (the remainder of the older landfill has had a final cap applied). Municipal residual waste is currently disposed of outside the Shire by a third party and therefore was not considered inside the definition of "operational control" of Council. The emissions from this waste are not monitored or reported on by Council. The NGER methodology was used to calculate the landfill's fugitive emissions out to the target year of 2025/26 because the landfill is closed. This is shown by the orange line in Figure 9.

Council operates a landfill gas capture and flare system at the Myocum landfill to minimise odour and reduce emissions. In 2015 Council entered into a Carbon Abatement Contract with the Australian Federal Government through the Carbon Farming Initiative to supply accredited carbon offsets form landfill gas flaring operations. This was part of the Australian Government's "direct action" plan to meet the national emission reduction targets of the Paris Climate Agreement. Council entered into a reverse auction contract to supply carbon offsets until 2022. Council can count the emission reduction made by the flare for the Myocum landfill for its own emissions target so long as it is clearly understood that this reduction is also being attributed to meeting the national target. That is to say, the flare related emission reduction is not additional to the national emissions reduction target, it is part of it.

The primary way of reducing the fugitive emissions is by way of methane capture and flaring. With the flare already installed and no plans to expand the capture system the amount of emissions able to be flared will reduce inline with the reducing fugitive emissions naturally occurring as the landfill ages. Large scale projects either through carbon sequesting tree planting or renewable energy projects will be necessary to offset the emissions from the landfill to achieve a zero net emissions target by 2025/26.

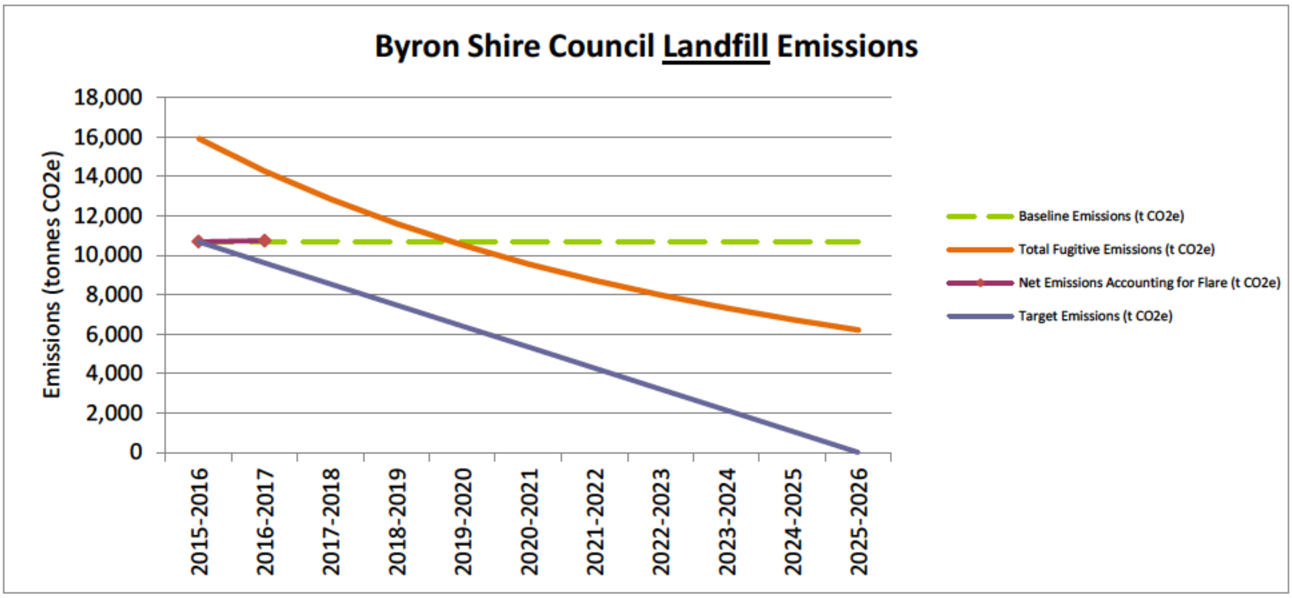

Figure 9 – 2016/2017 Byron Shire Council Landfill Emissions

Table 6: Landfill Fugitive Emissions

	2015-2016	2016-2017
Total fugitive emissions from landfill (t CO2e)	15,931	14,283
Emissions abated from flaring (t CO2e)	5,241	3,539
Base Line Emissions (t CO2e)	10,690	10,690
Target Emissions (t CO2e)	10,690	9,621
Net Emissions (t CO2e)	10,690	10,744
Trending (t CO2e)		+1,123

f) Sewage Treatment Plants – Fugitive emissions

Byron Shire Council owns and operates four sewage treatment plants. The treating of waste water is energy intensive as outlined previously in the electricity section of this report. In addition to the energy needed to run the facility, other emissions known as 'fugitive emissions' also occur. These fugitive emissions occur as a result of the organic matter in the waste water decomposing in the ponds as it is being treated.

The fugitive emissions of a facility are highly dependent on the volume of flow treated and the treatment methods used. Table 7 below shows that the fugitive emissions from the sewage treatment plants are almost as significant as the landfill fugitive emissions at over 8,000 tonnes per annum. As outlined earlier, the pre-feasibility study into bio energy potential at Council's sewage treatment plants will be critical in reducing and offsetting emissions from this sector by 2025/26. Additionally the next planned upgrade of the West Byron Sewage Treatment Plant is in 2025 where it will be upgraded to a covered anaerobic treatment system to capture biogas directly from the plant itself. By capturing the emissions directly from the ponds significant savings can be made.

Table 7: Sewage Treatment Fugitive Emissions

	2015-2016	2016-2017
Total Annual Flow Processed (kL)	3,254,852	3,541,529
Greenhouse Gas Emissions (t CO2e)	8,190	8,955
Base Line Emissions (t CO2e)	8,190	8,190
Target Emissions (t CO2e)	8,190	7,371
Trending (t CO2e)		+819

Due to resourcing issues, Council's Utilities Team were unable to complete the emissions calculations using the NGER methodology. An alternative methodology using IPCC Emissions Factors was used to prepare an indicative estimate of emissions from this sector. Moving forward it will be necessary to outsource the calculation of Council's Sewage Treatment Plant fugitive emissions to align with the NGER methodology and accurately set a meaningful baseline for this sector.

Financial Implications

Emissions reduction can both cost Council and save Council depending on the project and as such will need to be assessed on a case by case basis as part of the development of Council's Emissions Reduction Strategy.

Statutory and Policy Compliance Implications

Council has no statutory obligations to report its emissions inventory.