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ISSN 1327-8231

ECONOMICS, ECOLOGY AND THE ENVIRONMENT

Working Paper No. 200

Parochial Conservation Practices and the Decline of the Koala – A Draft

by

Clem Tisdell, Harriet Preece,
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October, 2015

THE UNIVERSITY OF QUEENSLAND

ISSN 1327-8231

WORKING PAPERS ON ECONOMICS, ECOLOGY AND THE ENVIRONMENT

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* Funding for H. Beyer's contribution was provided by an ARC Discovery Early Career Research Award.

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The *Economics, Environment and Ecology* set of working papers addresses issues involving environmental and ecological economics. It was preceded by a similar set of papers on *Biodiversity Conservation* and for a time, there was also a parallel series on *Animal Health Economics*, both of which were related to projects funded by ACIAR, the Australian Centre for International Agricultural Research. Working papers in *Economics, Environment and Ecology* are produced in the School of Economics at The University of Queensland and since 2011, have become associated with the Risk and Sustainable Management Group in this school.

Production of the *Economics Ecology and Environment* series and two additional sets were initiated by Professor Clem Tisdell. The other two sets are *Economic Theory, Applications and Issues* and *Social Economics, Policy and Development*. A full list of all papers in each set can be accessed at the following website:
http://www.uq.edu.au/economics/PDF/staff/Clem_Tisdell_WorkingPapers.pdf

For further information about the above, contact Clem Tisdell, Email: c.tisdell@economics.uq.edu.au

In addition, the following working papers are produced with the Risk and Sustainable Management Group and are available at the website indicated. *Murray-Darling Basin Program, Risk and Uncertainty Program, Australian Public Policy Program, Climate Change Program* :http://www.uq.edu.au/rsmg/working-papers-rsmg

For further information about these papers, contact Professor John Quiggin, Email: j.quiggin@uq.edu.au

Parochial Conservation Practices and the Decline of the Koala

ABSTRACT

Considerable resources are invested in conserving species that may be locally, but not globally, threatened. There are a variety of motivations for such parochial conservation practices and policies, though often they are likely to be ineffective or inefficient in achieving meaningful conservation outcomes at either local or broad scales. We examine the koala in Australia as a case study of this problem as it is a species that is highly valued by the public, is only threatened over a portion of its range, and yet attracts considerable conservation effort in the portions of its range where it is in decline, especially in urban areas. We identify several approaches to koala conservation that have been favoured for many years despite the fact that they are likely to be ineffective at advancing koala conservation and suggest possible reasons for their continued use. We also identify opportunities for relatively cost-effective rural conservation that have not been adequately explored. Explicitly clarifying specific goals and objectives of conservation actions and evaluating of their efficacy would facilitate more effective prioritisation of investment of resources to improve conservation outcomes.

Keywords: biodiversity conservation, ecological economics, ecological policy, environmental management, koala, spatial ecology.

JEL Classification: Q29, Q58, Q59.

Parochial Conservation Practices and the Decline of the Koala

1. Introduction

The koala (*Phascolaratos cinereus*) is a charismatic highly-liked species (Tisdell, 2014, Ch. 7) with a broad but patchy distribution across eastern Australia. The koala faces stark conservation challenges across its range with the northern populations experiencing severe population declines with localised extinctions and the southern populations requiring active management to reduce over-abundance in some areas. The northern koala populations, consisting of Queensland, New South Wales and the Australian Capital Territory are listed as vulnerable under national environmental law. However, the IUCN Red List of Threatened Species lists the conservation status of the koala as being of least concern (Gordon et al., 2008) because its southern population is secure. The objectives of this article include considering why, if the koala is secure in its southern Australian distribution, efforts are being made to conserve its northern populations, and why this is happening in areas and by means which are likely to be ineffective in achieving this and which do not minimize costs. Queensland's efforts are given most attention, particularly their spatial distribution. To date, there appears to have been no overall assessment of attempts to conserve the koala in the wild in this state.

Hunter and Hutchinson (1994) suggest that 'parochialism' is often a significant influence on decisions to conserve species which are locally rare but not rare or endangered when a broader spatial scale is taken into account. They point out how this can result in skewed conservation efforts and suggest some benefits and shortcomings of parochialism as a driver of conservation policies. In Australia, the koala provides an interesting case study of efforts to conserve a species locally that is not endangered nationally.

The difficulty of conserving the koala in Queensland and NSW has increased and can be expected to increase further due to a combination of climate and human demographic factors. Koala numbers at the western limit of their distribution have declined dramatically with Seabrook et al. (2011) reporting koala population numbers in South West Queensland have declined by about 80% since the mid-1990s. Moreover, as a result of climate change, it is predicted that the distribution of koalas will contract eastward to be confined to a relatively narrow band along Queensland's east coast by 2070 (Adams-Hosking et al., 2011). This is

precisely the area where koalas face increasing threat from expanding urbanization and increased intensity of land use. Importantly, if koalas are to be conserved in the wild in Queensland, it is imperative that greater attention be given to environmental planning in eastern Queensland, especially its south-eastern portion because contraction in the suitability of climatic conditions for koalas towards the south is also anticipated (Adams-Hosking et al., 2011).

This article is developed as follows: first, information is provided on the decline of koala populations in Queensland then about the declaration of the koala as vulnerable to extinction in Queensland, New South Wales and the Australian Capital Territory. Subsequently, various polices to conserve the koala are considered. These include:

- The possibility of extending existing protected areas or creating new areas to conserve koalas; and
- Measures to conserve koalas on private land both in rural and urban areas.

These are basically policies for providing habitat for this species. This discussion is followed by consideration of some costly and potentially ineffective measures for conserving koala populations. These include:

- The veterinary and hospital treatment of sick and injured koalas; and
- The immunisation of koalas against the disease chlamydiosis.

The problem and relevance of determining the minimum viable population (MVP) of koalas in fragmented landscape and related issues are discussed; and the spatial scale on which koalas should be conserved is analysed. For example, what is the possible rationale for trying to conserve koalas in NSW, Queensland and the ACT if their populations are secure in Victoria? What are the rationales of numerous local governments and local interest groups in Queensland trying to conserve koalas in their local areas?

2. Declining Populations of Koalas in Queensland

In the cases of NSW and Queensland, a key reason for the decline in koala populations has been the expansion of urban development in areas of prime koala habitat. In the South East Queensland (SE QLD) bioregion less than approximately 40% of remnant vegetation remains compared to the pre-clearing era (Wilson et al., 2002). Apart from the loss of trees that provide sustenance for koalas, this has fragmented their remaining habitats, resulting in

increased threats from car strikes and dog attacks as well as local extinction of koala from otherwise suitable habitat patches that are now too small to support a population.

In fact, the overall koala population decline in Queensland was estimated to be 43% (range 39–46%) over 20 years with larger declines in some areas, including a greater than 90% decline over 17 years in the Springsure region of Central Queensland; 80% decline in the Mulgalands Bioregion over 14 years (already mentioned); 65% decline in the Koala Coast over 20 years; and 40-50% decline in Pine Rivers, South East Queensland Bioregion (Threatened Species Scientific Committee, 2011).

A second contributor to the declining population of koalas has been the loss of tree cover on rural properties. Vegetation has been removed to favour grass cover for livestock and to enable cropping to occur (e.g. McAlpine et al., 2002). Increasing agricultural intensification has been unfavourable to the survival of the koala, for example, in many parts of South East Queensland.

3. The Declaration of the Koala as Vulnerable in Queensland and New South Wales

The rapid decline in koala populations in Queensland and New South Wales (NSW) has resulted in environmental groups lobbying government bodies in these states to adopt policies to help conserve this iconic species. Consequently, the koala has been listed as vulnerable to extinction in NSW, Queensland and the Australian Capital Territory (see Table 1). On the other hand, taking an Australia-wide/global perspective, the IUCN lists the koala conservation status as being of least concern (see Table 1).

Table 1. Chronology of legislation and assessments (global and local) relevant to the changing conservation status of the koala

Year	Relevant act	Jurisdiction or agency	Koala conservation status/action
1995	*Threatened Species Conservation Act 1995*.	NSW Government	'Vulnerable' species (Schedule 2)
1996	None	IUCN assessment	Lower Risk/near threatened
2000	*United States Endangered Species Act 1973*	The United States Fish and Wildlife Service	Threatened
2004	*Nature Conservation Act 1992*	Queensland Government	Changed from "common" to "vulnerable" wildlife in the South East Queensland Bioregion
2008	None	IUCN assessment	'Least Concern' (Gordon et al., 2008)
2008	–	Queensland Government	Draft of measures (in response to the koala crisis) to protect South East Queensland's koala population
2012	*Environment Protection and Biodiversity Conservation Act 1999*	Australian Government	Listed as vulnerable for the combined populations of Queensland, NSW and the Australian Capital Territory
2015	*Nature Conservation Act 1992.*	Queensland Government	Vulnerable

Legislative changes have resulted not only in Australian federal government and state governments developing new policies to protect the koala but also in several local governments drawing up plans to conserve koalas within their jurisdiction, for example, the Sunshine Coast Council in Queensland. This is an interesting situation because communal decisions are being made with the aim of conserving the koala not only at the national level but also at the state-level in Queensland and NSW as well as in several local areas. Therefore, it is not just the continuing existence of the koala as a species which is of concern to members of the public but also the spatial scale on which it continues to exist.

If the sole purpose of declaring the koala as vulnerable in Queensland and NSW was to facilitate the adoption of policies for its conservation, then presumably there would have been no need for this declaration if the protected area networks in these states were sufficient to conserve koalas in each of these states. The extent to which existing protected areas are suitable for conserving the koala in these states does not seem to be well known, though many protected areas occur in higher elevation areas that are unsuitable for other land uses and are likely to be of poor habitat quality for koalas. Assuming that these existing areas are inadequate, two different types of habitat-type strategies can be adopted to conserve koalas:

1) Add suitable areas of habitat to existing protected areas and/or create suitable new protected areas; and
2) Adopt policies to conserve koalas outside protected areas on private landholdings, in urban or rural environments.

These alternatives represent land sparing and land sharing strategies respectively (Phalan et al., 2011). Let us consider each of these strategies.

4. Extending Existing Protected Areas or Creating New Ones to Conserve Koalas

While extending or creating new protected areas to conserve koalas should be considered, extending protected areas where koalas now occur is likely to be costly because the surrounding land is usually sought after for urban development and for agricultural use. It also seems probable that the opportunity cost of creating new protected areas with the particular purpose of conserving koalas is likely to be high for similar reasons. Consequently, the cost of acquiring land to implement this strategy can be expected to be high.

In both cases, it is important to bear in mind that the relative opportunity cost of conserving koalas is the appropriate economic criterion to apply in either extending existing protected areas or creating new ones. (Tisdell, 2005, pp. 35-37). It can be more economic to acquire land for koala conservation which is more expensive per ha than land that is less expensive, if the former type of land can support a sufficiently larger density of koalas. If it does, the opportunity cost per koala conserved will be lower than if less expensive land is protected.[1]

A major problem, however, is that governments may be reluctant to add to or create new protected areas for the following reasons:

- Government budgets are constrained. Deficits are considered to be a problem in QLD. Nature conservation may not be a high priority.
- It may be considered less costly to ameliorate the concerns of conservationists by adopting other policies even if they are ineffective.
- Adding to existing protected areas may involve forced land acquisition. The exercise of the principle of eminent domain can result in considerable social and political backlash.

5. Policies for Conserving Habitat Suitable for Koalas and Private Land

It is useful to distinguish between public policies to conserve koalas in urban areas and agricultural spaces in rural areas. Currently, much greater attention is being given to conserving koalas in areas subject to increased urbanisation than in rural areas; even though it is likely to be less costly to conserve their habitat in rural areas. This emphasis seems to arise for several reasons:

- The decline in koala population is most marked in urban areas undergoing expansion. Much of this area in Queensland and New South Wales is prime koala habitat.
- As far as the general public is concerned, the decline of koala population is much more evident in urban than rural areas.
- Several locally based urban conservation groups have emerged with the specific aim of fostering koala conservation in their local area. Examples of grass-roots urban-based koala conservation groups in Southeast Queensland:
    - Koala Action Group Qld Inc: http://www.koalagroup.asn.au
    - Koala Crusaders: http://www.koalacrusaders.org.au/
    - Pine Rivers Koala Care: http://www.prkoalacare.com.au/ ;
- Conservation efforts are more obvious in urban areas, generating a more positive public perception of a governments' contribution to koala conservation.

Policies for conserving the habitat of the koala on private land may be prescriptive, may rely on economic incentives or on a combination of these approaches.[2] Consider first policies for habitat preservation which could be adopted in rural areas and then those in urban areas.

5.1 Conserving habitat in rural areas

The comparative cost of conserving koalas in rural areas varies. Agricultural land with the lowest opportunity cost per koala conserved should be targeted for habitat protection. In most areas, this will be land used for extensive agriculture (for example, livestock grazing) rather than intensive agriculture (for example, cropping).

Prescriptive policies could take the following form:

- Restrictions on clearing trees that constitute koala habitat;

- Mandatory requirements to revegetate areas along watercourses or in other specified locations, including tree species that are preferred by koalas.

Although landholders may oppose such policies on the grounds that they reduce their property rights, most governments do adopt such policies to some extent.

Governments may also adopt the following policies (encouraging voluntary compliance) to motivate rural landholders to conserve habitat favourable to koala conservation:

- The payment of subsidies, grants or the provision of tax concessions for conservation of tree species favourable to koalas and other species and ecosystems.
- The provision of information which shows that a certain amount of tree cover can increase the productivity of livestock and/or the market acceptability of the production of livestock maintained in conditions which provide them with adequate shade and shelter from the elements. The latter takes into account the animal welfare concerns of some members of the public.[3]

The first of these policies, however, is likely to involve considerable monitoring costs and some moral hazard, especially if the spatial patterns and species of trees is specified (Tisdell, 2015, Ch. 14). Moral hazard can arise when the provision of economic benefits can only imperfectly observe the actions of who may take advantage of that to cheat. Transaction costs will be involved, for example, in selecting conservation projects for grants and for monitoring compliances. Both the government agency responsible for giving grants and the applicants for these will incur transaction costs.

Non-government initiatives may also be adopted to encourage farmers to retain or plant tree-cover to support koala conservation. These initiatives could include the following:

- Conservation organisations, such as *Land for Wildlife*, might recruit private landholders to voluntarily participate in habitat protection and restoration programmes that benefit a wide variety of species.
- Conservation organizations, such as the Australian Koala Foundation, might disseminate information to graziers pointing out the economic benefits to them of retaining tree cover favourable to koalas.[4]
- Koala friendly agricultural production might be certified by an organization such as the Australian Koala Foundation, or as part of the identification of wildlife friendly

agriculture production. Whether this produce would obtain a price premium is difficult to say but it is possible. It would be a different identifier to organic labelling.[5]

- Promotion of wildlife friendly products by retailers. There appears, for example, to be a desire of some food chains to market food that can be identified as environmentally friendly. A senior United States executive of McDonald's (hamburger chain) has expressed interest in this relation to its beef supplies.[6] It currently markets 'rainforest friendly coffee'.

An increasing number of Australian farmers have become involved in farm-based tourism as a means of achieving economic diversification. The presence of koalas on their properties can be an important drawcard for tourists. While there are opportunities to see koalas in captivity in zoos, seeing them in the wild is highly valued by ecotourists and others. There is considerable evidence that watching/interacting with wildlife in captivity is far from a perfect substitute for experiencing it in the wild. There is specific evidence for this for many species e.g. saltwater crocodiles, elephants, porpoises. This statement is supported by the considerable demand that exists for wildlife-based tourism (Tisdell and Wilson, 2012) and by the observations of Ryan (1998) and Ryan and Harvey (2000). Seeing wildlife in the wild attracts an economic premium, in most cases. A demand exists both for tourism based or captive wildlife and their presence in the wild. Many tourists like to observe wildlife in both situations as for example, is clear from the watching of saltwater crocodiles in the Northern Territory.

5.2 Conserving koala habitat in urban areas

Conserving koala habitat in expanding urban areas in Australia faces many obstacles. This is mainly as a result of:

- Increases in Australia's population;
- Associated demand for expanded land-use in urban areas which also coincides with prime koala habitat; and
- The continuing high ratio of Australian urban dwellers compared to rural dwellers.
- The high and increasing concentration of Australia's population near the coast in areas of koala habitat.[7]

Furthermore, despite the fact that the density of Australia's urban dwellers is increasing due to the building of more high rise apartment blocks and smaller residential blocks, considerable demand still exists for the 'release' of land for residential purposes on the

fringes of existing urban settlements and the subdivision of land within urban areas for housing construction. Much of this land contains prime habitat for koalas.

Release of land for urban development can take three different forms. These are:

- The reclassification (mainly by local government) of the purposes for which land can be used. For example, a change from an agricultural classification to a classification for urban dwellings.
- The sale of crown lands and their reclassification for urban development.
- Permission to increase the density of land use by allowing greater subdivision of blocks of land for housing.

Given the high cost of available blocks of land for residential development in the major population centres of Australia, there is strong political lobbying for the release of land for urban uses. In cases where this release would compromise the continuing existence of koala populations, local governments are confronted by a quandary, namely the immediate and certain benefit of providing more affordable housing for increased urban populations versus the potentially increasing likelihood of the loss of koala population in the future.

To a large extent, the use of land in Australia's urban areas is not determined by market forces; at least, not directly. It is primarily a result of planning decisions by local governments based on the zoning of land uses and the provision of infrastructure. Local councils have considerable power to determine how urban land is to be used and developed. Most aspects of urban development are subject to council approvals. Consequently, they may exercise their powers in the following ways to conserve koala habitat in their local council area:

- Not permit the re-zoning of land use where this would have important detrimental impacts on koala populations;
- Permit changes in land use subject to requirements being satisfied to support koala conservation. For example, offset conditions may need to be satisfied. Developers may, for instance, be required to set aside land and revegetate it so that the total population of koalas supported in the local area is not reduced ('no net less' offsetting; Gibbons and Lindenmayer, 2007). Other requirements could include the provision of corridors suitable for the dispersal of koalas.

- There may also be a requirement for infrastructure to be developed that assists the survival of koalas. This can include overpasses and under passes traversing busy roads as well as speed bumps to slow traffic movement. Also, including buffer zones where there are restrictions of infrastructure near or close to koala areas.

However, all these measures will add to the cost of urban development, are likely to be opposed by developers and will add to the cost of blocks of land in areas with significant populations of koalas. The economic returns of developers from investment in urban development from land subject to these conditions will fall unless buyers are prepared to pay a sufficient provision for land subject to these development requirements. It is possible that some buyers of residential land would be prepared to do this because they may prefer to live in a 'leafy' environment and be supportive of nature conservation in their neighbourhood. There are no existing studies of this possibility.

Unfortunately, in many cases environmental conditions placed on urban developers in undertaking the development of land areas for housing amount to little more than window dressing. The required offsets in many cases do not compensate for the increased threats to koalas from urban development (Gordon et al., 2015). Although offset policies seem to be appealing in principle, they rarely compensate for the koala-preferred habitat which is lost as a result of urban development. Often, this offset area is too small and its habitat inferior in comparison to the area lost to economic development. Politically, however, offset policies may have support because they give the appearance of protecting koalas, even if they fail in their purported aim.

6. Ineffective and Costly Measures for Conserving Koalas

In several urban areas, policies are being adopted or proposed for koala conservation which are costly and likely to be ineffective for this purpose. These include:

- The hospitalization and treatment of injured and sick koalas.
- Proposals for the vaccination of wild koalas against chlamydiosis.

The hospitalization and treatment of injured and sick koalas is very costly. The cost to treat one animal normally ranges from $380 - $1500 and can be up to $5000 for one koala (http://wildlifewarriors.org.au/conservation-projects/australia-zoo-wildlife-hospital/ Accessed 20/9/2015). Facilities for the hospitalization and treatment of injured and sick

koalas exist in Southeast Queensland at the Mogill Koala Hospital, Australia Zoo Wildlife Hospital and the Currumbin Wildlife Hospital. The Moggill Koala Hospital, which is run by the Department of Environment and Heritage Protection, was established in 1991 and had an intake of 692 koalas in 2011. The department reported that in the first 20 years of its operation, about 7,000 koalas were released back into their natural habitat at, or as close as possible, to their point of rescue. Furthermore, it states: 'unlike other wildlife, the rehabilitation of a single koala into the wild can make a significant different to the survival of the Southeast Queensland koala population' (Department of Environment and Heritage Protection, 2015). However, this is an overly optimistic assessment of this policy because the underlying problems threatening koala populations in most of these areas have not been addressed. Risk associated with predator (e.g. domestic and wild dog) attacks, vehicle collisions and disease (particularly chlamydiosis) result in mortality rates that are likely to exceed birth rates (Rhodes et al., 2011), implying continued population declines. Moreover, irreversible infertility among adult female koalas is common in the advanced stages of chlamydial infection, further exacerbating the shortfall in birth rates required to stabilise a population. The prevalence of chlamydial infection in Queensland koala populations ranges from 10-87%, with reproductive disease rates in mature females of between 31-57% in three populations (Polkinghorne et al., 2013). Observed fecundity rates indicate this is likely to be an underestimate as reproductive disease is difficult to detect.

Returning a rehabilitated koala to an area where populations are declining may have very little conservation benefit. Furthermore, it is only the return of female koalas that is likely to have any potential benefit to reproduction as a small number of males are able to mate with a much larger number of females. Thus, in the context of population dynamics the return on investment for rehabilitating male koalas and retuning them to the wild is close to zero.

6.1 Koala deaths and rehabilitation success

Approximately 1,400 koalas are known to be killed or injured every year in South East Queensland (Figure 1). Less than 500 of these koalas are successfully rehabilitated and released back into the wild each year (Figure 1). The net loss of more than 1,000 koalas every year is an important component of continued decline of resident koala populations. Moreover, the fate of rehabilitated and released koalas is often not known. If they are naïve of threats in the area in which they are released they may have elevated rates of mortality compared to long term residents.

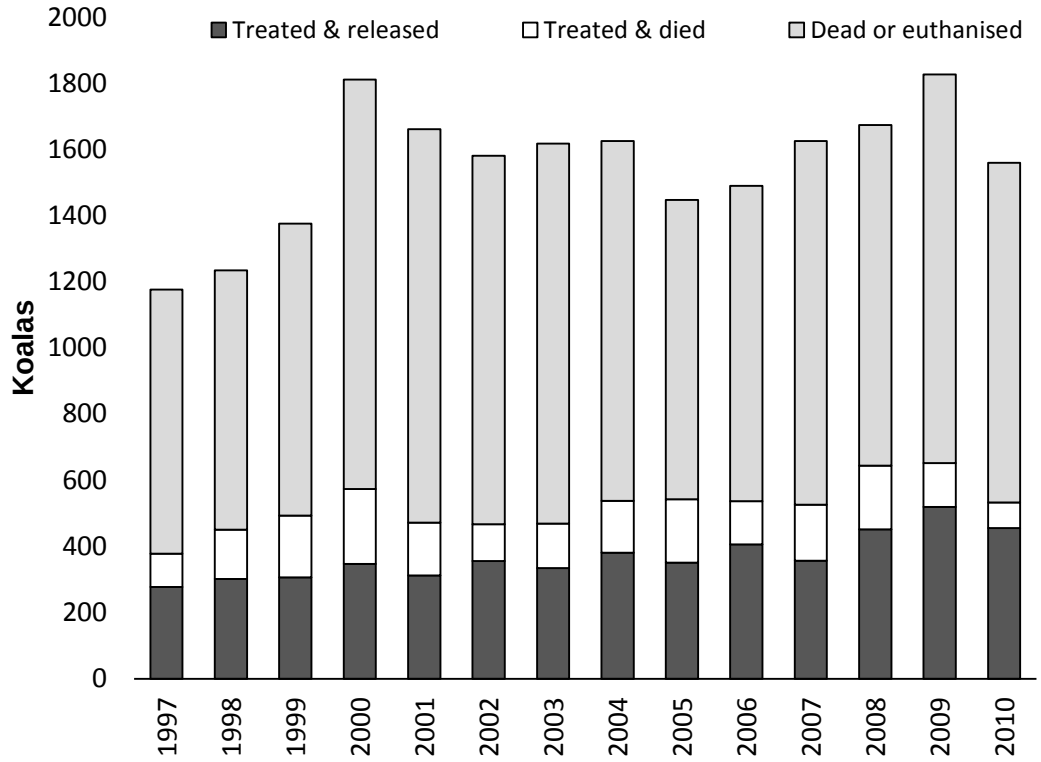

Figure 1. Koala deaths and rehabilitation success in South East Queensland (1997 – 2011). *This graph includes data from Moggill Koala Hospital; Australia Zoo Wildlife Hospital; and Currumbin Wildlife Hospital. It includes koalas that are dead on arrival; euthanised; or died in care. It does not include koalas that die and are not reported to the hospitals (such as koalas that are hit on roads & crawl into the bush to die).*

There are likely to be a variety of reasons why local communities might want to assist sick and injured koalas:

- There is likely to be considerable empathy with their plight because of their humanoid features.
- It may be believed that this will help to prevent local populations from extinction.

However, in relation to the last factor, saving injured and sick koalas may do little to prevent or slow the demise of koalas locally in urban areas, where koala populations are already in rapid decline as a result of habitat loss, domestic and feral dog attacks, and vehicle collisions (Rhodes et al., 2011). As discussed above, the available evidence indicates that the

hospitalization and treatment of sick and injured koalas is costly and ineffective as a conservation measure. Its main justification seems to be as an animal welfare measure.

A vaccine against chlamydial infection is in development (Carey et al., 2010) and initial trials are promising though strong evidence that the vaccine would protect wild koalas from infections is yet to be established (Polkinghorne et al., 2013). The vaccination of koala populations against chlamydiosis is likely to be costly and may not improve mortality and reproductive rates enough to stabilise koala populations in the context of other factors that contribute to high mortality rates (Rhodes et al., 2011), though this depends in part on the efficacy, longevity and delivery system of the vaccine. Capturing and vaccinating enough animals in an area to bring about the eventual local eradication of chlamydial infection would require intensive and expensive fieldwork and monitoring that would need to be repeated regularly to maintain high levels of vaccination coverage.

7. Issues Involving the Minimum Viable Population (MVP) of Koalas

Koala habitat conserved on private land needs to be suitably connected spatially to support an MVP of koalas. This may be difficult to achieve because it requires several (often many) adjoining landholders to adopt measures to conserve koalas on their properties. Therefore, a significant co-ordination problem exists. However, there may be some situations where protected areas contain a substantial population of koalas and if landholders bordering these areas adopt measures to conserve koalas, populations may reach a MVP level. Particular attention could be given to identifying these areas.

Considerable uncertainty exists about the ecological requirements for successfully conserving koalas in local areas. Opinions differ on the level of the MVP needed to conserve koalas in the long-term. General estimates vary from as few as 500 adult koalas to 5000.[8] While the higher values may reflect the desire for the conservation of koalas with a higher probability and for a greater length of time, it seems clear that considerable uncertainty surrounds required MVP values. In the case of koalas the MVP is most usefully quantified in terms of the number of reproductively viable adult females as variation in the number of males is unlikely to have a substantial impact on breeding rates and females are the limiting factor driving recruitment. In stable populations in which the average population growth rate is no less than 1 a smaller MVP size may be sufficient to ensure long-term persistence in the context of modest demographic stochasticity (random variation in population numbers arising

from variable environmental conditions). However, if the population is declining, a significant portion of females become infertile as a result of chlamydiosis, or demographic variability is extreme, a substantially larger number of females may be required to ensure long-term persistence. Estimating MVP size for the koala is complicated by the link between population dynamics and disease dynamics, which is currently poorly understood. However, some ecologists have used the 500 figure for planning advice to local councils (for instance, Ecosure, 2015).

The second environmental planning problem is determining accurately the size of a habitat area that needs to be preserved for koala conservation. This requires the carrying capacity to be estimated. This depends not only on the species of trees present, but also on their quality (for example, the nutrition in their leaves) and their density. Even if koala preferred tree species are present in an area, depending on their density and nutritional value for koalas, the area will support very different densities of koalas. The area of land required to support a population must also be based on the worst years, not average conditions. For example, portions of SE QLD were in drought for over a decade from 1994-2009. Clearly, long term viability depends on the population surviving such adverse years, which may require substantially more land area than that required to support the population during an average year.

A third problem is understanding the impact of habitat fragmentation on long-term viability. Habitat that is fragmented by roads and urban development is likely to be associated with increases in mortality rates of koalas (e.g. from vehicle collisions and dog attacks) and lower population persistence. As such, a great area of fragmented habitat is likely to be required to support a given population size compared to contiguous habitat.

A report has been prepared for the Sunshine Coast Council (Ecosure, 2015) to assist this council to plan its conservation of koalas within its jurisdiction. On the basis of the findings by McAlpine et al. (2007), this report states that a population of 500 breeding koalas needs 4000 ha of good quality habitat to maintain an MVP of koalas. Habitats of this size have rapidly disappeared in Southeast Queensland. There are few if any contiguous areas of habitat capable of supporting a population of 500 breeding koalas still existing in Southeast Queensland. The estimates of McAlpine et al. (2007) imply that on average 8 ha of suitable habitat is required to support each breeding koala.

8. A Discussion of the Spatial Scale and the Time-Scale on Which Koalas Should be Conserved

Although the koala is listed as vulnerable in QLD and NSW, in Australia as a whole the koala is classified by the IUCN as of least concern, primarily because its southern population is secure (Gordon et al., 2008). Why then are efforts being made to conserve it in Queensland and why should they be made? Historically, the species has been the taxonomic focus of conservation efforts, though as our understanding of patterns of genetic variability within species has improved it is increasingly common to target conservation at the subspecies or regional level. Genetic diversity provides the raw material for adaptation and may be particularly important to conserve, therefore, in the context of rapid climate change.

Not only are efforts being made to conserve koalas in Queensland and NSW as a whole but several local governments have an expressed aim of conserving koalas in their area of jurisdiction. Examples in Queensland include the following councils: Gold Coast, Logan, Redlands and Sunshine Coast. Furthermore, several local community groups (some were identified in Section 5) have been established with the purpose of championing koala conservation in their local areas. This indicates that there is a demand to conserve koalas in proximity to where individuals live in Queensland and NSW.

There is evidence to indicate that willingness of individuals to contribute to the conservation of liked species declines the further away the species are located from where the individuals live (see, for example, Tisdell and Wilson, 2012Chs. 7 and 9). This also implies that individuals are willing to pay more or to expend greater effort to conserve liked species the closer they are to where they live. This spatial gradient effect may be stronger for charismatic species, such as the koala. Reasons for this spatial effect might include the greater likelihood of interaction with populations of the species if they are nearby and an enhanced feeling of moral responsibility for conserving nearby species. Given the almost unique elevated status of the koala in the Australian psyche today, it may also be a matter of social prestige to conserve koalas in areas where they already exist.

Of course, it was not always the case that the koala had the high conservation status in Australia which it has today. It was once exploited on a large scale for its pelts (Moyal and Organ, 2008). The koala provides an excellent example of how community and global attitudes (valuation) of the conservation of wild species can alter in a relatively short period

of time, that is within a few human generations. Australians who were alive in the 1920s put little or no value on the conservation of the koala, and would have been hard pressed to imagine that less than one hundred years later that the koala would be a species highly valued for its non-use attributes. Its consumptive use now would be 'unthinkable'.

Now it seems clear that efforts are being made to conserve koalas in some local areas where (despite these efforts) they are doomed to disappear in a relatively short period of time. Why then is the effort being made? There are several possible explanations:

- Those engaged in these efforts may be unaware of this reality.
- They may believe (in some cases, correctly) that this effort will slow the demise of the koala in their local area. They may obtain some satisfaction from this. They and some successive generations may enjoy the koala's presence for somewhat longer than otherwise.[9]
- They may know that their actions will make little difference to the survival of koalas in their local area but nevertheless they may feel a moral compulsion to take this action. There is empirical evidence of individuals being willing to pay for the conservation of some species even though they know these are doomed (DeKay and McClelland, 1996).

Other reasons for this type of social behaviour might include the following:

- Attempts to conserve the familiar koala constitute a potentially popular cause. This may make it relatively easy to form new local conservation groups for this purpose.
- Once formed, conservation groups provide members with a social purpose and via social dynamics, create their own momentum. In other words, they give members a sense of belonging and of contributing to a 'higher' cause. Hence, facilitating social contacts among communities and/or neighbours.
- Some may believe that conserving the koala has the potential to benefit a wider range of other familiar species like birds and, even if the koala itself is doomed, are prepared to use it as a popular flagship species to further other conservation goals.

9. Conclusion

We have highlighted several possible motivations for local conservation of a species that may not be threatened at broader spatial scales. Although local conservation efforts may fulfil

many personal, social and political needs, they may be of limited value to the purported aim of species conservation. This is particularly true in the context of opportunity cost: if the resources invested in local species conservation were coordinated and strategically invested over wider areas, much more could potentially be achieved with respect to species conservation. It appears to be unlikely, however, that people would be willing to invest the same resources in non-local conservation, implying that such a shift would also be accompanied by a counterproductive reduction in funding.

Greater coordination of conservation effort among community groups, NGOs and government agencies could result in improved efficiency if barriers to collaboration (e.g. trust issues, non-identical goals) can be overcome. At the very least the explicit statement of the intended purpose of conservation actions and evaluation of their efficacy would be useful for prioritising investment of resources to improve conservation outcomes. In the case of the koala we suggest that there are opportunities for rural conservation that have not been adequately explored, and that hospitalisation of koalas serves an animal welfare purpose more than a conservation purpose.

Notes

1. See for example, Tisdell and Swarna Nantha (2011). Despite this, strong political opposition is likely to the reservation of land for nature conservation which has a high commercial value. This is mainly because most of the economic benefits from nature conservation cannot be marketed.
2. Kamal et al. (2014) provides a comprehensive (but general) outline of means by which conservation can be achieved on private land paying particular attention to voluntary and involuntary means. See, in particular, Figure 1 of this article for an overview.
3. There is considerable evidence that heat stress adversely affects the productivity (milk and meat production) and welfare of cattle (Schütz et al., 2010; Sullivan et al., 2011; Dairy Australia, 2012a; 2012b). Furthermore, up to a point, greater tree cover by providing shade and shelter adds to the productivity and welfare of cattle (Dairy Australia, 2012c). However, it may not be the case that the species of trees which koalas require for their survival are the optimal ones to plant (or retain) to provide shade and shelter for cattle and to minimize loss of grass. There is no scientific study of the trade-off function involved of the type, for example, suggested by Tisdell (1973) for relationship

between kangaroos and livestock. An additional aspect which needs consideration is whether optimal the density of tree cover for grazing livestock would be adequate to support sustainable koala populations. In any case, clear felling of trees on rural properties in several parts of Queensland continues with little consideration of its consequences for environmental conservation (Maron et al., 2015)

4. This, however, may be ineffective since most graziers may mistrust information provided by conservation organizations and regard it as biased.
5. However, a certification scheme is likely to be costly.
6. This was mentioned at the Rockhampton Beef Expo in 2015. Gary Johnson of McDonald's in the US in an interview by Pip Courtney from ABC's Landline Program urged beef producers to start telling a sustainability story. In response Tracey Hayes, President of the Northern Territory Cattleman's Association said, 'We are looking for that from the beef sector in Australia. And so we're on the job, we're just not there yet and it's time we got it done'. (For a transcript of this interview see Courtney, 2015).
7. For example, in Queensland 87.6% of its population lived in 50kms of the coast in 2001 and between 1996 and 2001, the average growth in coastal population was higher in local government areas (LGAs) to the north and south of Brisbane in the proximity of 150 kms (or less) from Brisbane and 'significant growth was also recorded in a number of LGAs spread out along the remainder of Queensland's coast' (Australian Bureau of Statistics, 2003). This pattern of human settlement was a major contributor to declining koala numbers in Queensland.
8. Although the concept of the MVP of a species is commonly used for conservation management, it does not involve a hard-and-fast rule but depends on many factors, including the probability of the focal species surviving for a given period of time and the length of the period desired for that species' survival. An MVP of around 5000 breeding adults of a species was suggested by Traill et al. (2007) for mammals, reptiles and birds on the basis that this would allow them to exist for a very long time allowing them to undergo evolutionary adaptation. What is clear is that as the number of breeding koalas is reduced below 500 (and the carrying capacity of their habitat is correspondingly reduced), the period of time for which this population can be expected to survive falls.
9. Consequently, the extra benefit (utility) obtained from extending the period of survival of the koala locally can exceed the additional cost of doing this, even if the koala eventually disappears locally and prior to the maximum possible period of its survival locally.

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