

Feedback on Report of the Independent Review into the Decline of Koala Populations in Key Areas of NSW, NSW Chief Scientist & Engineer, December 2016.

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Introduction

The University of Sydney has a sustained record in research in koala disease and ecology. As a group we have a combined history in koala research and management that exceeds 60 years, and have substantial additional experience in wildlife disease and management beyond that. Areas of expertise include ecology, evaluation of koala management interventions, pathology and immunology (with particular expertise in *Chlamydia*, KoRV, *Cryptococcus*, and neoplasia and other non-infectious diseases), disease ecology and epidemiology, laboratory diagnostics, anaesthesia and field support, capture and translocation risk assessment, clinical and records-based research through koala rehabilitation facilities; with additional track record in genetics, stakeholder engagement and citizen science. We have active teaching and collaborative research programs across all of these areas.

Through our Masters of Wildlife Health and Population Management and our PhD students we supply a significant level of people power that supports ongoing research across a wide range of koala ecology and health related projects.

With sustained support, the Koala Health Hub (KHH), in the Faculty of Science at the University of Sydney, is in a position to assist in refining, achieving and disseminating outcomes of many of the proposed priority actions. The KHH engages with 200+ State and Federal Government, peak body, university, koala rehabilitation and community stakeholders to help guide or facilitate koala care, research, management and/or policy in NSW and interstate.

Current KHH activities include:

- Provision of free of charge expertise and diagnostic services to most koala rehabilitation groups and associated vets.
- Provision of diagnostic services, veterinary support, or disease expertise to several koala ecology projects across NSW and Qld, including two coordinated by NSW OEH:
 - *Chlamydia* testing, anaesthesia health assessment and sample collection, Southern Highlands Koala Project
 - Scat-based *Chlamydia* and KoRV testing, sex determination and genetic diversity of low-density populations on the far South Coast.

- Individual and workshop-based training in sample collection and koala necropsy
- Fostering communication and collaboration through
 - An annual national conference comprising Local, State and Federal Government, peak body, university, koala rehabilitation and community stakeholders
 - A quarterly email bulletin
 - A website due to launch this month, comprising: fact sheets; other training resources, policies, management plans and guidelines; online discussion forums; and news.
- Provision of direct care to koalas from Blue Mtns and southwest Sydney, at the Faculty's purpose built wildlife clinic at Camden.

General Feedback and recommendation

Though it will be challenging, we applaud the whole of government approach that underpins this strategy. In particular we support:

- Recognition of need for evidence base for planning and evaluating management
- Recognition that the role of rehabilitation groups goes beyond individual koala care, and the need to support rehabilitation groups in their work
- Recognition of the need for improved communication and coordination/ collaboration of efforts

And

- *“prioritise data gathering and research about populations, habitat and threats, including the cumulative impacts of multiple threats, to inform better planning and management decisions*
- *review and align the various legislative and management arrangements to ensure improved outcomes for koalas across different land uses and tenures*
- *work across tenures to identify and implement on-ground actions that improve connectivity and resilience against threats”*

The need for ongoing and inclusive consultation throughout planning and enactment of the strategy is highlighted by our feedback to this document and the proposed amendments to the Priorities Action Statement (see Appendix 1) regarding:

- The number of proposed activities that are already being conducted, to some extent, by our group and others
 - Duplication of effort is clearly not of benefit
 - There is significant opportunity to cost-effectively value-add to existing capacity
- The need for specialised input across a wider range of disciplines than has been achieved to date

We recommend: That a New South Wales Koala Management and Research Advisory Board or Steering Committee be established. It should be inclusive, which may mean that it would have a large membership (possibly with subcommittees), should meet at least once a year, and review all projects in NSW related to koalas and their effectiveness, review what research is being done and what needs to be done, and be used to facilitate collaboration. It would contain members of government, OEH, carers, councils and private and university researchers. There should be no compensation for being on the board and the recommendations might be nonbinding, but their report should go to all levels of the government and be made available to the public.

Specific Feedback and recommendations

Page v.

“- the community will feel confident that new development and ongoing land use will not threaten key koala populations”

Community confidence will not protect koala habitat.

We recommend: amending to *“- new development and ongoing land use will not threaten key koala populations”*

Page 7 under summary of threats

(Chlamydia) “is widespread in koala populations and symptoms of blindness, pain, incontinence and infertility are exacerbated when an individual is exposed to additional stressors such as loss of habitat, harassment by predators, heatwaves, nutritional stress or overcrowding (Waugh et al., 2016).”

Although this is a commonly supposed view, it would be more accurate to say “although it seems feasible that disease is *exacerbated when an individual is exposed to additional stressors such as loss of habitat, harassment by predators, heatwaves, nutritional stress or overcrowding*, the drivers of disease in koala populations have not been confirmed, and likely vary among populations. Additional hypothetical drivers include such factors as chlamydial strain virulence or transmission dynamics; co-infection with other agents, such as a range of possible koala retrovirus variants, herpesviruses or trypanosomes; host genetics; or exposure to dietary eucalypt compounds that may exceed behavioural or metabolic adaptations. **This is an area requiring research”**.

Recommendations 2 and 7

“That Government initiate a program to improve data on the number, location and occurrence of koalas in NSW, including trends over time, taking advantage of new sensor and communication technologies and data analytics within 12 months of receipt of this report”.

and

“That Government agencies identify priority areas of land across tenures to target for koala conservation management and threat mitigation.”

We have given detailed feedback in this areas to the Proposed Amendments to the Priorities Action Statement (see appendix 1). In summary:

1. **Tree use is very poorly understood** across the koala’s range and the distinction between day time (roosting) and night time (feeding) tree use has been understated and is inadequately understood. Our research has indicated that koalas need large trees, which ample canopy cover, to offload heat and take shelter. Other elements from the trees, such as moisture,

available nitrogen and concentrations of toxins such as tannins, FPCs and terpenes are also needed for the understanding of koala habitat.

We recommend: Studies also need to be combined with extensive tree surveys, to address not only tree species requirements of koalas, but physical attributes of the trees. Develop specific local strategies for tree planting and also assessing the effectiveness of tree planting and other habitat recovery projects.

2. **Disease assessment should be included as an intrinsic part of population surveys** whenever access to samples (visual data, scats, blood and/or swabs) is feasibly possible. Any capture and handling of animals for collaring or tagging is also a rare opportunity to collect data on genetics and disease. Collection of samples for genetic studies has been identified as a priority, but not for disease (ie infectious agents).
 - a. The presence of infectious agents, and other factors with potential to affect fecundity or survival, potentially affect population viability and should therefore be considered a fundamental attribute of any population being assessed;
 - b. Translocation or corridor construction should be accompanied by a disease risk assessment in line with IUCN guidelines due to risk of transfer of novel pathogens or strains; absence of information in this area therefore impedes management planning. For example, *Chlamydia* has caused significant mortality events in a small intensively monitored population of koalas in Canyonleigh and in koalas translocated to Tarlo National Park. Thus, an understanding of diseases in source and recipient populations is essential to balancing land management with conservation.
 - c. Identification of pathogen-free populations. Aside from direct management implications, determining the impact of infectious diseases on koala populations would be assisted greatly by identification of baseline populations that are free of the disease of interest.
 - d. Ability to interpret the relevance of proposed faecal stress hormone studies to koala health is very limited without validation against immunological, parasite/ pathogen load or disease data to determine what changes are biologically significant.

We recommend: that capture opportunities for placement of collars or tags should be used to collect samples for disease studies. Operational staff should be supported with protocols, training and equipment, and/ or provided with veterinary support. The Koala Health Hub currently supports collection and analysis of such samples (blood, swabs, scats) through provision of expertise, field support, sampling equipment, training, and development and validation of techniques and, with some additional support, could do so on a broader scale.

Recommendations 4, 5, 6

“That Government improve outcomes for koalas through changes to the planning system.

That Government improve outcomes for koalas through the Biodiversity Conservation Bill and associated Regulations.

That Government investigate models for guiding and incentivising collaborative best practice for new development and ongoing land use occurring in areas of known koala populations across tenures, industries and land users.”

These largely fall outside the expertise of our group

Recommendation 8

“That Government, through the Office of Environment and Heritage, convene two symposia within 12 months of receiving this report: one for scientists active in koala research and land managers to develop a koala research plan; and one focussed on koala rehabilitation to identify actions to optimise the delivery of and support for the network of koala rehabilitation groups and carers”.

We support this action as a means to establish connections with these groups and obtain initial direction; the **Koala Health Hub currently runs an annual conference/ workshop** to foster communication and collaboration among these groups and has expressed a willingness to assist with co-hosting the koala research plan symposium.

However **complete inclusion of all relevant expertise will require ongoing consultation at all levels of planning.**

For example:

- *“results from the Koala Genome Consortium to better inform disease research, including chlamydia and koala retrovirus (KoRV)” page 38*

The Koala Genome Consortium, as the name suggests, are far from being the only, or even primary, source of information on, or for, koala disease research. There is a broad community of koala disease researchers, many (or most) of whom are not members of the genome consortium, and these lie within an even broader wildlife disease and ecology community. Genomics is able to support disease research in several ways but is one discipline among pathology, microbiology/ virology/parasitology, immunology, clinical science, epidemiology, and disease ecology, and koala disease research should be informed by these, as well as those managing koalas, either clinically or as populations.

We recommend: This point should identify disease-associated knowledge gaps, not outputs from one group or discipline. Priority knowledge gaps should include: Distribution and prevalence of infectious agents; determinants (host, pathogen or environmental) and impact of disease; relative importance of diseases in different populations, and why it differs; development of tools for predicting disease-associated risk. Chlamydia and KoRV would be priority infectious agents to investigate, but others could be important through synergistic effects, or as indicators of population health (eg herpesviruses, trypanosomes or *Cryptococcus*).

The **need for ongoing and inclusive consultation across the board** is highlighted in our feedback to the Proposed Amendments to Priorities Action Statement (Appendix 1) regarding:

- The number of proposed activities that are already being conducted, to some extent, by our group and others
 - Duplication of effort is clearly not of benefit
 - There is significant opportunity to cost-effectively value-add to existing capacity
- The need for specialised input across a wider range of disciplines than has been achieved to date

We recommend: That a New South Wales Koala Management and Research Advisory Board or Steering Committee be established. It should be inclusive, which may mean that it would have a large membership (possibly with subcommittees), should meet at least once a year, and review all projects in NSW related to koalas and their effectiveness, review what research is being done and what needs to be done, and be used to facilitate collaboration. It would contain members of government, OEH, carers, councils and private and university researchers. There should be no compensation for being on the board and the recommendations might be nonbinding, but their report should go to all levels of the government and be made available to the public.

Recommendation 9

“That Government establish the Australian Museum as a preferred repository for koala genetic samples in NSW, and all data and metadata associated with these samples should be deposited into the SEED Environmental Data Portal (extended if necessary to include flora and fauna).”

And Page 39 *“Government should develop and fund a program to collect genetic information from tissue samples taken from all injured and deceased koalas across the state for analysis in accordance with an agreed protocol. The program should be administered and implemented by OEH and provide the necessary protocols, funding, training, veterinary support, transport arrangements and other necessary support for carers and researchers to take and deliver samples to the Australian Museum. The koala carer guidelines produced by the National Parks and Wildlife Service should be amended to support this program, and a similar protocol put in place for ecological consultants under the NPWS’s Scientific Licensing arrangements.”*

We recognise the need for better understanding of the genetics of koala populations and agree that sampling opportunities (ie access to animals or scats) are currently being missed. **Equally important, and not considered equally in this report, is the need to obtain information on the distribution and prevalence of infectious agents (chlamydial strains, KoRV variants, and others). There is virtually nothing known on this across the majority of the state,** and this is vital information when planning translocations or corridors between populations, identifying valuable disease-free populations or assessing population trajectory. Data being generated by the Koala Health Hub is making a significant contribution to characterising and managing populations such as the Southern Highlands, far south coast, and Blue Mtns, Campbelltown and Georges River. In response to the following *“Currently, it is not*

known if there are any populations free of *Chlamydia* in NSW” (Page 29); in collaboration with OEH and other researchers the KHH has identified one, and possibly another, *Chlamydia*- free population.

This is also of relevance to **Recommendations 2 and 7**, and:

*“Where more than one threat impacts a species in a particular area, **understanding the cumulative and synergistic impacts of the threats is crucial**. This is particularly important where the impact of each individual threat is small, but the cumulative impacts are large”* (Page 13)

*“To achieve this, the strategy needs to start from a strong evidence base including direct detection, mapping existing koala habitat, likelihood of occurrence data and **threat mapping**. The strategy should present this information as its base case or starting point.”* (Page 24)

*“The NSW koala strategy should prioritise gathering better data about the number, location and abundance of koalas, and their habitat, as the basis for better management and decision-making. In particular, new **sensor technologies** and data analytics can be employed, in combination with data gathered through EISs, citizen science and traditional survey methods such as **scat surveys**, to build a much richer picture of koala occurrence”* (Page 25) (Tag and telemetry device attachment, and scat collection, both comprise opportunities for collection of disease samples)

We recommend: Disease samples (visual data, scats, blood, and/or swabs) should be included in such opportunistic sampling whenever feasibly possible, with similar provision of protocols, funding, training, veterinary support, transport arrangements and other necessary support.

The provision of resourced protocols, training and veterinary support is vital to this exercise. The Koala Health Hub and associated researchers have a long track record in obtaining opportunistic samples from field researchers and koala care groups, providing support individually, through training workshops and, in the near future, as online resources on our website.

Though we support the move towards establishing a systemic framework to facilitate collection of genetic and disease samples, **it should also be recognised that collection of these samples places significant demand on already under-resourced groups.**

We recommend: The strategy for sampling should be developed in consultation with those groups and researchers with the relevant expertise- it is likely that targeted sampling will prove more efficient than a demand for blanket obligatory sample collection.

We also agree that **long term archiving of samples** is currently inadequate and recognise the credentials of the Australian Museum in this area. However, the road forward with this issue (for both genetics and disease samples) **requires broader consultation** to ensure the full range of research approaches and expertise are able to be harnessed, through access of all appropriate groups to samples. It should be considered whether this is best done through a central repository, or a central register; how access to

samples is to be governed; and whether samples should go directly to the Australian Museum, or be archived there after analysis by appropriate groups. We recognise the credentials of the Australian Museum in genetics, but **there are other equally important genetics groups** in the country. Similarly with disease, the **lead capacity for koala disease research in NSW is the Koala Health Hub**, but other groups exist nationally and their contribution should be considered.

Alternative databases exist and should be considered. For example, the main database for wildlife disease data and samples resides at the Australian Registry of Wildlife Health. It is based on the database of the Canadian Wildlife Health Cooperative and has a range of capabilities for data retrieval and analysis. This may be applicable to both disease and genetics-related samples.

We recommend: That the plan for a systemic framework to facilitate collection and archiving of samples for genetics and disease studies be formulated in inclusive consultation with relevant researchers and operational personnel.

Recommendations 10 and 11

“That Government facilitate the exchange of information among land managers, local government, the research community and the broader community.”

And

“That Government draws on knowledge and shares information with local community members through a program that supports localised engagement between liaison people and residents and industry.”

Koala rehabilitation groups should be mentioned explicitly as an important channel for community engagement. They commonly have strong ties in the community and play the role of both representing community concerns and coordinating community activities.

With appropriate support, the Koala Health Hub has potential to play a role in facilitating communication between rehabilitation groups and the research, veterinary and government communities. We have an existing communication program that comprises:

- An annual national conference comprising Local, State and Federal Government, peak body, university, koala rehabilitation and community stakeholders
- A quarterly email bulletin
- A website due to launch this month, comprising: fact sheets; other training resources, policies, management plans and guidelines; online discussion forums; and news.

KHH can also play a significant role in engaging community in koala conservation by increasing awareness of disease and providing support to community groups, researchers and veterinary profession. The existing collaborative, community-engaged research projects at Gunnedah, Southern Highlands and South Coast provide the information to drive conservation/recovery actions and, with appropriate support, could include more citizen science and landholder engagement.

APPENDIX 1

Feedback on Proposed Amendment to the Priorities Action Statement for the koala.

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General Feedback

Though it will be challenging, we applaud the whole of government approach that underpins this strategy. In particular we support:

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- Recognition that the role of rehabilitation groups goes beyond individual koala care, and the need to support rehabilitation groups in their work
- Recognition of the need for improved communication and coordination/ collaboration of efforts

The need for ongoing and inclusive consultation is highlighted by:

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Specific Feedback and Recommendations

Loss, modification and fragmentation of habitat

“In areas where a koala population is present, undertake planting to restore and increase the area of koala habitat. Restoration and augmentation planting and/or direct seeding should use appropriate feed and shelter tree species in areas of degraded and/or potentially suitable habitat. Revegetation should focus on expanding existing smaller areas of known occupied habitat, including private land, and connecting areas of suitable habitat to create corridors for movement. Resources for long-term monitoring and management of revegetated areas should be included”.

Tree use is very poorly understood across the koala’s range and the distinction between day time (roosting) and night time (feeding) tree use has been understated and is inadequately understood.

We recommend: Develop specific local strategies for tree planting and also assessing the effectiveness of tree planting and other habitat recovery projects. We are helping to do this with our collaborative work with OEH in the Southern Highlands, with Citizens for Science and OEH in South East NSW, with input from our wildlife masters students (through our Masters of Wildlife Health and Population Management and our PhD students we supply a significant level of people power that support ongoing research across a wide range of koala ecology and health related projects).

Activities in this area obviously need to be guided by *“Lack of knowledge (poor understanding of animal movements and use of habitat)”*- see that section below.

Koala disease

“Improve understanding of the role of chlamydia in koala population dynamics and mortality, including baseline genetic information and links between habitat disturbance and disease-related morbidity, by conducting research in collaboration with universities, vets and ecologists”.

We support this action. Chlamydial infertility is widely considered to be the most important infectious disease of koalas (e.g. Polkinghorne et al 2013, Griffith et al 2013) and its control has been identified as the key component in long term survival of some threatened northern koala populations in New South Wales and Queensland (Rhodes et al 2011, Wilson et al 2015). Its significance in most others is unknown.

However, there are two ways in which this should be amended.

We recommend:

1. Disease investigation should not be restricted to chlamydial disease because:
 - a. Other infectious agents may be important drivers of chlamydial disease outcomes
 - b. Other infectious disease may have an additive effect on morbidity and mortality
 - c. Prevalence and loads of infectious agents or disease are commonly useful indicators of ecosystem/ population health (as a manifestation of changes to stress hormones or immune function)

- d. With population decline, increased fragmentation of populations, and climatic change, disease dynamics have a significant potential to change rapidly, therefore an understanding of multiple disease entities is wise.

Among 296 wild-caught koalas from south-east Queensland, 8% had lesions or syndromes considered consistent with retroviral disease in other species, including AIDS-like condition/immunodeficiency disorder, myelodysplasia, neoplasia, and severe chlamydiosis. From longitudinal data, the incidence (new occurrences each year) of these diseases in the population was 12.5% (Hanger and Loader, 2014). Among captive koalas, bone marrow conditions (14%) and AIDS-like syndromes (20%) contribute significantly to mortality (Gillett, 2014). Koalas in some areas of NSW, particularly in the north of the state, are also reported to suffer frequently from a spectrum of diseases that include a range of immunosuppression-like, opportunistic infectious diseases, blood and bone marrow disorders (myelodysplasia) and cancers (e.g. lymphoma and leukaemia, mesothelial and craniofacial tumours). These are widely assumed to be associated with koala retrovirus, but this is not proven and doing so will require more rigorous definition of many of these diseases, with concurrent immunological and virological assessment, to develop predictive indicators of disease risk in individuals or populations. Given recent research has indicated association of some common KoRV subtypes with disease and immune changes in free-ranging Victorian and captive koalas (Maher et al 2016, Maher et al unpublished, Legione et al 2017), investigation of KoRV and this group of diseases should be included in this research priority to evaluate their importance or otherwise.

Only limited work has been done on the significance of lesser known infectious agents of koalas. Cryptococcosis occurs sporadically across the koala's range, but associated drivers are poorly understood and, while the disease is unlikely to have a population impact, along with other diseases it may serve as an indicator of ecosystem health. The impact of recently discovered infectious agents such as Koala herpesvirus and multiple *Trypanosoma* species is even less understood, as Koala herpesvirus has only been identified in a few Victorian koalas and trypanosomes have only been studied in Queensland koalas (8,10). Similar agents play a synergistic role in exacerbating disease, or can be useful as indicators of population health, in other species.

Decision making for population management or rehabilitation requires better understanding of the distribution, interactions, drivers and impact of the multiple agents. Given the paucity of knowledge on disease in free-ranging koala populations, samples (scats, blood, and/ or swabs) should be collected at every opportunity during surveys and capture events, as has been proposed for genetic studies, and development of improved assays for use on the more easily collected samples, should be supported.

2. Disease assessment should be included as an intrinsic part of population surveys whenever access to samples (visual data, scats, blood and/or swabs) is feasibly possible.
 - a. The presence of infectious agents, and other factors with potential to affect fecundity or survival, potentially affect population viability and should therefore be considered a fundamental attribute of any population being assessed;

- b. Translocation or corridor construction should be accompanied by a disease risk assessment in line with IUCN guidelines due to risk of transfer of novel pathogens or strains; absence of information in this area therefore impedes management planning. For example, *Chlamydia* has caused significant mortality events in a small intensively monitored population of koalas in Canyonleigh and in koalas translocated to Tarlo National Park. Thus, an understanding of diseases in source and recipient populations is essential to balancing land management with conservation.
- c. Identification of pathogen-free populations. Aside from direct management implications, determining the impact of infectious diseases on koala populations would be assisted greatly by identification of baseline populations that are free of the disease of interest.

The Koala Health Hub is able to support both areas. We are currently engaged in these areas, through independent and collaborative research, analysis and archival of diagnostic samples from koala hospitals and field researchers, and commissioned research for the Office of Environment and Heritage, NSW. KHH currently supports collection and analysis of relevant samples (blood, swabs, scats) through provision of expertise, sampling equipment, training, and development and validation of techniques and, with appropriate support, could do so on a broader scale.

Heat stress through drought and heatwaves

“Research and trial adaptation management actions such as installation of artificial water sources and the establishment of refuge habitat and promote connectivity through habitat restoration.”

This type of mitigation measure has already been trialled in the same area proposed by OEH and almost in the same way (by our research team) and some results are already available.

Water stations are a potential practical solution that *might* be beneficial for koala populations. So far we (USyd) have proven that koalas use these stations extensively, even in cooler months, and that the intensity of their use by koalas is dependent on rainfall. We do not know yet if the drinkers will enhance koala survival.

Questions that need to be answered are:

- Would multiple koalas visit a single water station? This is central for the SOS koala project because if water stations benefit only a few individuals, then they are not a viable solution to enhance koala numbers.
- Will koalas move away from their home range to seek water? This is fundamental to understand how far apart water stations should be placed for the SOS water supplementation project.
- What is the effect of this intervention with regards habitat resilience, disease transmission and predation risk? For instance it is possible that the location of water sources may put extra pressure on habitat in a small radius around water and have unintended effects; there is a possibility of increased density and therefore increased risk of disease transmission events. Obviously it would also be wise to assess the effect of this intervention to determine whether it significantly influences population size / demographics / health. In addition, water stations

attract a variety of wildlife and may inadvertently act as a focal point of interest for predators. Therefore, more research is needed to determine the possible negative impacts of providing water stations for koalas.

- Do koalas always need free water or only in particular circumstances? If the moisture in the leaves that koalas eat is good, they might not need water supplementation. This is important for the SOS project so valuable resources are not wasted. A framework should be developed to determine when to deploy watering points e.g. leaf moisture, rainfall events, soil moisture etc.
- Can we relate use of water stations to koala survival?

Answering these questions is crucial for what the SOS koala project wants to achieve.

We recommend: We (USyd) could play an essential role in the SOS project by answering these questions because our koala water supplementation in Gunnedah is on-going and has already been running for a year.

Inadequate support for fauna rehabilitation

We support all actions in this area. Rehabilitation groups and associated vets, with the correct support, can play a key role in community and local government engagement, data and sample collection, passive disease surveillance, support of local koala populations, and guiding research and management actions.

The Koala Health Hub currently supports care groups and associated vets with research evidence-based expertise and laboratory diagnostics, as well as communication, education and training through fact sheets, bulletins, statewide and national conferences, and individual and group training in necropsy and sample collection for genetic and disease studies. A website comprising training and other resources, news, discussion forums and links to groups and projects, is to be launched within the month. With appropriate support, these activities can be maintained and expanded.

“Support koala rehabilitation groups and vets to rehabilitate sick and injured koalas through training, provision of materials, and promotion of state-wide protocols including for rehabilitation, genetic profiling, record-keeping and release to the wild”.

We recommend: Disease information is of equal importance to genetic information and protocols and training for collection of samples for disease studies should be included.

“Develop standardised method and reporting for monitoring change in koala populations and distribution through time and contribute survey data to centralised database. Include genetic information where possible.”

We recommend: Disease information is of equal importance to genetic information and should also be included.

“Lack of knowledge (poor understanding of sources of trauma and mortality): Engage with koala rehabilitation groups and other information sources to better understand the causes of koala trauma and mortality. Collate and map the results.”

A major impediment to this currently is a lack of standardization and compatibility of record systems used by the various koala care groups and associated vets, and incomplete entry of data. The result is that extremely valuable data, gained by significant investment, is being lost.

We recommend: Investment in liaison and coordination, database refinement in consultation with end-users, and resourcing of groups to support compliance, would comprise value for money. As a result of its long history of conducting research with koala care groups the Koala Health Hub has the understanding of these issues, and strong end-user relationships necessary to facilitate this activity, with appropriate funding support.

Lack of knowledge (poor understanding of animal movements and use of habitat)

“Improve understanding of koala movements and use of their habitat in the landscape by conducting targeted research on individuals using GPS collars and mark-recapture techniques.”

3. Our research has indicated that koalas need large trees, which ample canopy cover, to offload heat and take shelter. Other elements from the trees, such as moisture, available nitrogen and concentrations of toxins such as tannins, FPCs and terpenes are also needed the understanding of koala habitat.

We recommend: Studies also need to be combined with extensive tree surveys, to address not only tree species requirements of koalas, but physical attributes of the trees

4. Tracking and mark-recapture data is also essential for demographic profiles of populations. Ages, sex ratios, number of offspring, as well as sources of mortality, are needed for an understanding of current population trends.

We recommend: Demographic data be collected in these studies.

5. Any capture and handling of animals for collaring or tagging is also a rare opportunity to collect data on genetics and disease. Collection of samples for genetic studies has been identified as a priority, but not for disease (ie infectious agents).
 - Our existing knowledge of the distribution and prevalence of infectious agents in koalas in most of NSW is minimal.
 - Ability to interpret the relevance of proposed faecal stress hormone studies to koala health is very limited without validation against immunological, parasite/ pathogen load or disease data to determine what changes are biologically significant.

We recommend: that capture opportunities for placement of collars or tags should be used to collect samples for disease studies. Operational staff should be supported with protocols, training and equipment, and/ or provided with veterinary support. The Koala Health Hub currently supports collection and analysis of such samples (blood, swabs, scats) through provision of expertise, sampling equipment, training, and development and validation of techniques and, with some additional support, could do so on a broader scale.

- Capture and collar, sample or translocate projects have a range of ethical, welfare and technical issues associated. They also comprise a rare opportunity for disease survey work to be conducted. Both benefit greatly from (or, arguably, require) specialized wildlife veterinary and epidemiological input in design and execution.

We recommend: that wildlife veterinary and epidemiological input be obtained for design and execution of capture studies. The Koala Health Hub currently provides this support to OEH associated projects in the Southern Highlands and South Coast, as well as to other projects in the Sydney area, with significant benefit to those projects. With support, these activities could be expanded.

Getting the community engaged in koala conservation

“Use multiple channels to engage the community in koala conservation and recovery actions across the state. This includes communication strategies, citizen science, volunteers, on-ground conservation actions, awareness programs, and landholder engagement”.

Koala rehabilitation groups should be mentioned explicitly as an important channel for community engagement. They commonly have strong ties in the community and play the role of both representing community concerns and coordinating community activities.

With appropriate support, the Koala Health Hub has potential to play a role in facilitating communication between rehabilitation groups and the research, veterinary and government communities.

KHH can also play a significant role in engaging community in koala conservation by increasing awareness of disease and providing support to community groups, researchers and veterinary profession. The existing collaborative, community-engaged research projects at Gunnedah, Southern Highlands and South Coast provide the information to drive conservation/recovery actions and, with appropriate support, could include more citizen science and landholder engagement.