INFFER analysis – Koala Conservation

Final Report

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This report presents the results of the INFFER analysis to guide the Australian government's investment in Environment Restoration Fund project, *Protecting Koalas of South East Queensland and Northern New South Wales (*the project).

As part of project design and planning, Natural Decisions has been engaged to conduct the INFFER (Investment Framework for Environmental Resources) assessment. Natural Decisions has expertise in environmental and natural resource economics, ecology, land and water management & agricultural science. Natural Decisions is the architect of INFFER and designed the framework specifically for the purpose of helping integrate economic, socio-political and biophysical factors into decision making. INFFER is based on benefit:cost analysis principles and is now widely used by both economists and non-economists.

The key steps that have been undertaken to inform the analysis have been:
- Preparation of a Background Paper
- INFFER Workshop #1, held in Brisbane on 21st November 2019
- Discussions with key informants and subject matter experts from relevant agencies and stakeholder groups involved in the project
- Compilation of detailed works and actions, including costings
- Development of Preliminary Results Report that was presented and discussed at INFFER Workshop #2 held in Sydney on 5th February 2020
- Additional feedback and information provision following Workshop #2, especially with respect to identification and ranking of priority areas in SE Queensland.

Introduction and context

The Australian Government has commissioned an INFFER analysis for the Environment Restoration Fund project, Protecting Koalas of South East Queensland and Northern New South Wales (the project). The project was commissioned to fulfil an election commitment for $3M to be spent on koala protection in northern NSW and southern Queensland. The project will engage with relevant organisations with expertise to help provide information to inform the analysis. The analysis seeks to achieve the most realistic, feasible and cost-effective outcomes for koala populations that can be achieved within any constraints that may have been made as part of the election commitment.

For more information on INFFER see Appendix 1.

The Asset – Koala[1]

The koala *Phascolarctos cinereus*, Family *Phascolarctidae*, is a tree-dwelling, medium-sized marsupial with a stocky body, large rounded ears, sharp claws and variable but predominantly grey-coloured fur. It is one of Australia's most distinctive and iconic wildlife species. Koala habitat (and areas where the Koala is likely to occur) is shown in Figure 1.

Conservation status

The koala (combined populations in Queensland, New South Wales and the Australian Capital Territory) have been declared to be a species for the purposes of the Environment Protection and Biodiversity Conservation Act 1999 (Cwlth) (EPBC Act) under s517 of the Act. This entity is listed as vulnerable as it has undergone a substantial decline over three generations, due to the combination of a range of factors, including habitat loss, disease and interactions with humans. In Queensland, New South Wales and the Australian Capital Territory the koala has an extensive but patchy distribution. Across this range, individual populations vary considerably in trends, and the mixture of threats faced.

The species is also listed in other jurisdictions as follows (summarised in Table 1):

• Queensland - vulnerable under the Nature Conservation Act 1992.

• New South Wales - vulnerable under the Biodiversity Conservation Act 2016. Three populations are listed as endangered; one in the Hawks Nest and Tea Gardens area of Great Lakes local government area, one in the Pittwater area of Warringah local government area, and one between the Tweed River and Brunswick River east of the Pacific Highway in the Tweed and Byron local government areas

The koala is not listed as threatened in Victoria or South Australia.

The koala is considered 'vulnerable' on the IUCN Red List of Threatened Species, and is listed as threatened on the US Endangered Species Act 1973.

Table 1: Summary of koala conservation status across the various jurisdictions

Asset	Description/link to further information
Koalas – Australian Government	After considering scientific advice from the Threatened Species Scientific Committee, the Environment Minister has listed the Queensland, New South Wales and Australian Capital Territory koala populations as vulnerable under national environment law. A recovery plan has been recommended under the EPBC Act and will be prepared for the combined koala populations in Queensland, New South Wales and the Australian Capital Territory. The recovery plan will commence following the expiration of the National Koala Conservation and Management Strategy in 2014 for the combined populations of Queensland, New South Wales and the Australian Capital Territory.
Koalas – NSW	The koala has suffered a dramatic decline in numbers and distribution since the arrival of Europeans. Surveys in NSW indicate that since 1949, populations of koalas have been lost from many localities. Most populations in NSW now survive in fragmented and isolated habitat and many of the areas in which koalas are most abundant are subject to intense and ongoing pressures.

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[1] Information taken largely from Australian Government Conservation advice

Asset	Description/link to further information
	The koala is listed as 'vulnerable to extinction' under the Biodiversity Conservation Act 2016 because of declining numbers and the ongoing pressure of threats. Such listing gives the species more protection and attention, and means proposals for development that will affect koala habitat are rigorously assessed.
Koalas - Queensland	The koala was listed as vulnerable to extinction across its full range in Queensland under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) in 2012 and under the Queensland Nature Conservation Act 1992 (NC Act) in 2015. From 2005 to 2015, the koala was listed under the NC Act as vulnerable in southern areas of the State only. The reclassification of the koala to vulnerable across its entire range was a result of improved knowledge of the species' status in Queensland, and to align with its listing under the EPBC Act. This, and State monitoring data providing evidence of continued declines in key peri-urban populations around Brisbane, led to conservation effort being heavily focused on eight coastal local government areas from Noosa to the Gold Coast.

INDICATIVE MAP ONLY

Habitat distributions are compiled using a range of datasets of varying quality and should only be used as a guide. The presence of the species or its habitat should be confirmed by using local information sources. Further information is available through the department's Protected Matters Search Tool www.environment.gov.au/epbc/pmst/index.html

Koala Habitat (species listed as Vulnerable)
- known to occur
- likely to occur
- may occur

Koala Habitat (species not listed)
- known to occur
- likely to occur
- may occur

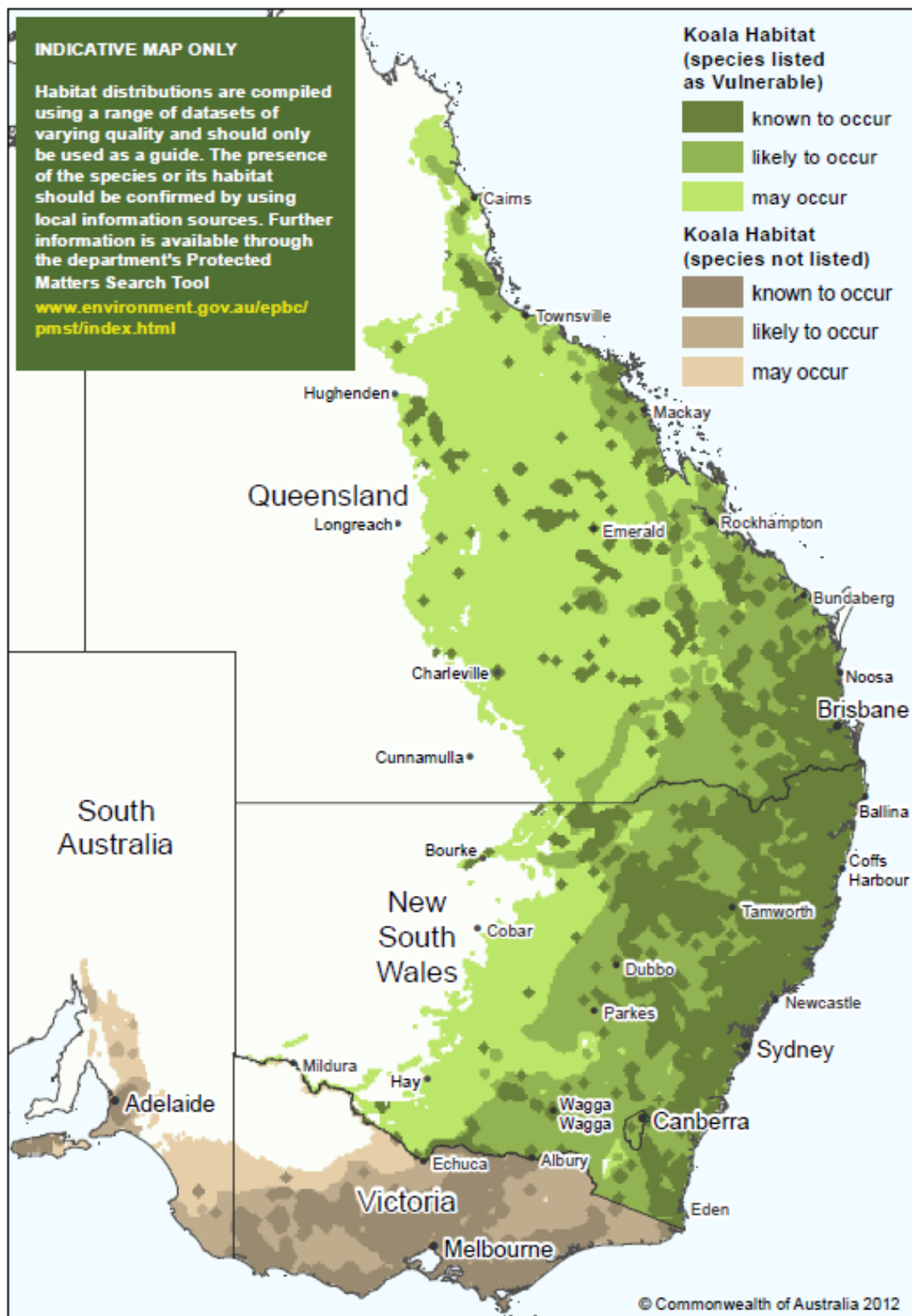© Commonwealth of Australia 2012

Figure 1: The map above shows what we know about where koala habitat exists in these states, which is a good indication of where they are likely to occur.

Preliminary Results

Asset identification

INFFER is an asset-based approach. To properly structure the assessment, it is crucial to be clear about how the asset (or assets) is defined. The environmental assets that are the focus of the investment in this project can be defined in a number of ways, some of which are overlapping. All these assets have a range of ecological, socio-cultural and economic values.

It is important from the outset to clearly describe the geographic scope of the assessment as this will have implications for assessment of all parameter values. There are a number of ways to think about the asset, firstly in terms of recorded distribution from known records and secondly in terms of suitable habitat. Modelling of current and potential habitat suitability can be a very useful input to the INFFER analysis.

Koala significance

Any benefit:cost analysis approach requires a value to be put on the benefits that will be achieved from the project. The significance or value of koalas encompasses environmental, social and economic values, to the extent that they are relevant. It can include public and private values of the asset(s) that the project aims to protect or enhance. To estimate the relative benefits of different projects it is important to be able to express the values of different natural assets. Currently there is no agreed system to value assets at either a state or national level and therefore valuation of koalas requires us to use existing studies and information.

In the absence of an agreed asset valuing system, we provide a simple scoring system for use in INFFER (See Appendix 1). This system enables projects to be compared within a region, within a state or nationally. This scoring system can be used if there are no additional non-market valuation studies which put a value on a koala population.

Valuing the asset should be done assuming it is in benchmark condition[2]. If the asset for this project is defined as a proportion of a larger asset, the score should be scaled down accordingly. For example, if the entire asset (namely the koala population across all of Queensland, NSW and the ACT) would have a score of 50[3], a project focussed on protecting half of the asset might have a score of 25 (assuming that all parts of the asset are equally valuable). With reference to the INFFER asset scoring system it is suggested that the asset value for the Koala (across the entire national population) is of high national significance (V = ~ 100)[4].

Clarifying the geographic extent of the analysis will be required to assign an appropriate V score. There are two possible approaches:

- Assign V based on the entire national distribution of the koala. With this approach the V score will be high (say 50) but the impact of works (the W parameter in the BCR) will be considered in terms of the overall effect on asset value from the works undertaken within the project area, bearing in mind that threats to the asset value outside the project area are not being dealt with. It means that impact (W) will be lower than under the second approach.

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[2] The benchmark **is** used as a point of reference when you value the asset and when you quantify the impacts of works. Various benchmark conditions can be defined; with one being the benchmark condition defined as the condition the asset would be in if all of the goals for this project were fully achieved. The benchmark condition will be discussed at Workshop #1 and it is important to define it in a way that people understand and that the impact of works (W) can be assessed relative to it.

[3] Noting that a score of 50 can also be expressed in dollar terms, where 1 INFFER point is $20Million. If the entire koala population is valued at INFFER V score 50 this equates to a value of $1Billion.

[4] See Background Paper for further information.

- Assign V based on geographic scope of the analysis. With this approach the V score will be a proportion of that assigned for the entire asset (that is a fraction of 50), based on the relative significance of the project area to koalas overall. However, the impact of works will be proportionately higher than in the first approach.

From our experience this second approach is preferable as it is easier for informants to estimate the effect of interventions across the project area.

It is also worth noting that agreeing on the actual number for the value for this project is less critical than for many other projects we have done. This is because the money has already been committed to protect koalas and therefore we only need to compare different options but the project is always about protecting koalas.

We have found three readily available pieces of information to put a value on the Australia-wide koala population:

- INFFER V score, suggested initially to be 50 (equates to $1Billion)
- $1.15Billion annual estimated annual willingness to pay (WTP) nationally to protect koalas (Tisdell and Nantha, 2007)
- $3.2Billion based on the economic value of koalas (Conrad 2014)
- The contribution of koalas to the revenue of the Australian tourism industry in 1996 was Aus$1.1 BN (Hundloe and Hamilton, 1997, cited by Tisdell and Nantha, 2007)

Conrad's work is not peer reviewed and funded by the Australian Koala Foundation, which may well lead to some upward bias. Tisdell and Nantha is peer-reviewed but it is acknowledged that the WTP figures may overstate what respondents are really willing to pay.

Our suggestion is to value the Australian koala population at V score 100.

Project Goals

INFFER requires the specification of SMART goals[5]. Table 2 describes goals articulated in the most recent state-level strategies and plans.

Table 2: Goals for Koala conservation across jurisdictions relevant to the INFFER assessment

Jurisdiction	Goal/target/conservation objective	Comment
Commonwealth	None stated	
NSW	**Long-term vision/goal/objective is** to first stabilise, then increase, koala population numbers across the State (NSW Koala strategy).	The currently stated conservation goals do not meet the SMART criteria. For example a SMART goal for the NSW population would be 'Achieve a stabilised koala population of XXXXXX (based on a moving 5 year average) by 2040 across NSW'.

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[5] "Specific" means that the goal is described in a precise and unambiguous way. "Measurable" means that the goal definition is based on a variable which is able to be monitored and recorded reliably and without going to unreasonable expense to do so. "Attainable" – A goal is more likely to be attainable when you plan your steps wisely and establish a time frame that allows you to carry out those steps. Thinking about attainable and realistic goals at the same time is useful. "Realistic" – To be realistic, a goal must represent an objective toward which everyone is both willing and able to work. A goal can be both high and realistic; be sure that the goal represents substantial progress. "Time-bound" means that a particular date is provided by which time the goal will have been achieved. The time frame for the goal can be of any relevant duration. The time-frame of achieving goals is related to the time for reasonable ecosystem response and costs.

Queensland	**Vision:** A sustainable koala population in the wild in South East Queensland that is supported by a coordinated and strategic approach to habitat protection, habitat enhancement and threat reduction (Draft SEQ Koala Conservation Strategy 2019-2024) **Note:** Sustainable refers to a koala population that is able to be maintained at least at its current density levels. **Targets:** • No decline in total area of core koala habitat in SEQ from 2017 levels • Commence rehabilitation to restore 1000 ha of cleared habitat • No long-term decline in koala population numbers in SEQ • Threat reduction: 25% reduction of injury and mortality across ten sites	Vision and targets (population and habitat elements) meet SMT criteria but feasibility/achievability is questionable. Q: What are the current density levels and what is the level of confidence?

Initial assessment of threats, works and actions

Based on the discussion at Workshop #1 an initial assessment of the key threats was undertaken. This is summarised in Table 3 below.

Table 3: Overview of threats to koalas across NSW and Qld focus areas and general works and actions proposed

Threat	Description/impact[6]	Level of threat			Will the project address the threat?	Works and actions
		NSW - Tablelands	NSW – North Coast	South-east Queensland		
Direct habitat loss/clearing	Land clearing is focussed disproportionately on flatter, more fertile areas, which constitute high quality habitat for koalas, so that what remains is often the poorer quality habitat on steep terrain and/or poorer soils. Urban expansion continues to threaten koalas, particularly in coastal regions.	Moderate	Low	Very high	Possibly	• Covenanting • Voluntary management agreements • Land acquisition
Fragmentation	Past clearing for agricultural/urban development has created a legacy of fragmented, isolated and small patches of habitat. Habitat fragmentation may also impede post-drought recovery of koala populations.	High	High	High	Yes	• Revegetation • Enable natural regeneration
Degradation of existing habitat	Habitat quality may be affected by a suite of interacting factors, including: drought, wildfire, overgrazing, weed invasion and altered habitat structure from disrupted ecological; processes (e.g. changed fire regimes, hydrological change)	Very high	Very high	Very high	Yes	• Weed management • Sustainable grazing • Ecological burning • Cultural burning • Firebreaks • Ecological burning
Wildfire	Climate change is a potential threat to the koala, as it is expected to lead to increased temperatures, changes to	Moderate	Moderate	Moderate	Yes	• Ecological burning • Cultural burning • Firebreaks

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[6] Source: *Phascolarctos cinereus* (Koala) Listing Advice

Drought/Heat Stress	rainfall, increasing frequency and intensity of droughts and increased fire risk.	High	Moderate	Moderate	Yes	• Restoration (shelter and habitat trees) and protection of priority refugia
Climate Change		Moderate	Moderate	Moderate	Indirectly	No direct actions
Dog attack	Dogs and cars are two threats to koalas that are closely associated with urban expansion, with exposure to both increasing as land adjacent to koala habitat is developed and occupied.	Low	Moderate	Moderate	No	N/A
Road fatalities		Low	Moderate	Moderate	No	N/A
Disease	Main disease threat is chlamydia - can lead to infertility in female koalas Evidence that chlamydiosis might increase in response to environmental stresses such as overcrowding and poor nutrition and may contribute to local declines or extinctions in small, isolated populations, where recruitment rates between populations are low and mortalities from other threats are high.	Not assessed	Not assessed	Not assessed	No	N/A
Loss of genetic diversity	Associated with other threats. Genetic diversity a symptom of e.g. fragmentation	Not assessed	Not assessed	Not assessed	No	N/A

Identification of priority areas

In both NSW and Queensland significant work has already been undertaken to identify priority areas for targeting of actions to improve koala conservation outcomes. This work has been used as a key input to the INFFER analysis.

NSW

In NSW Areas of Koala Significance (ARKS[7]) have been spatially identified to support consideration of priority management responses to the threats faced by koalas in different regions. Figure 2 shows the location and extent of the NSW ARKS.
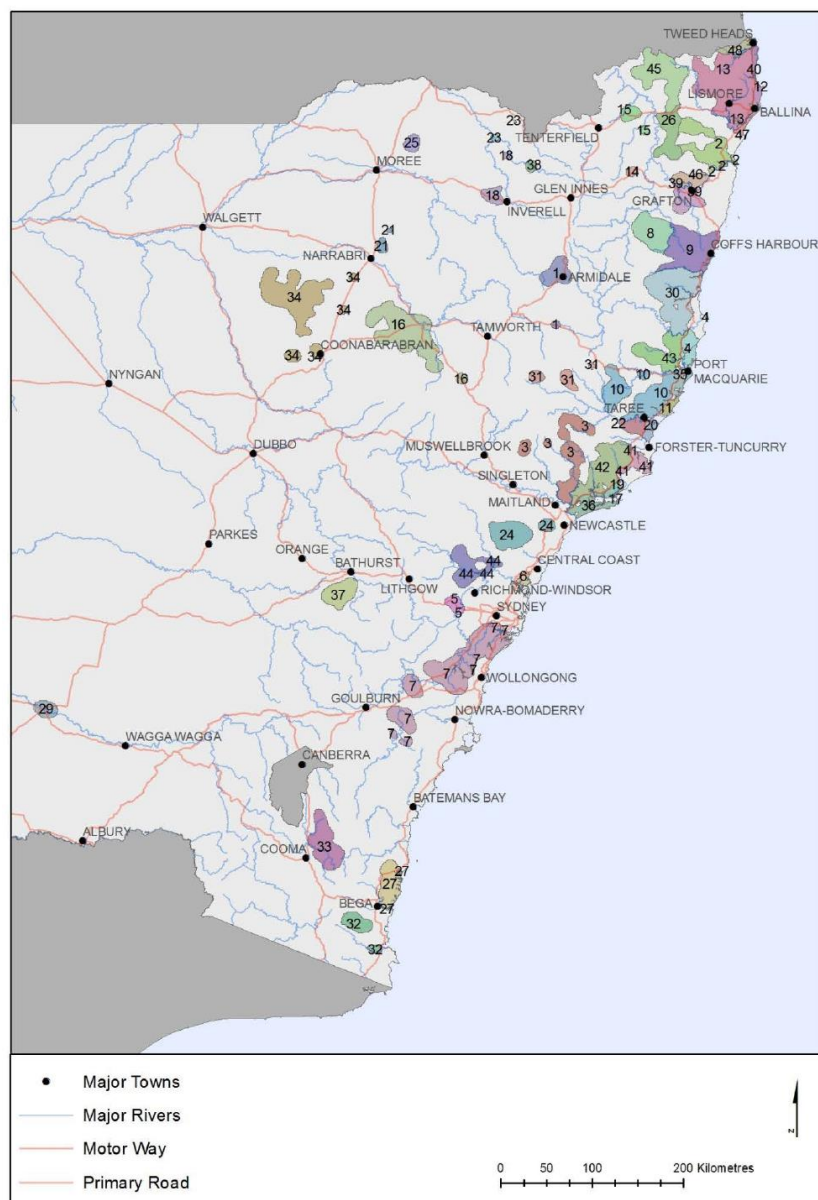

Figure 2: Areas of Regional Koala Significance in New South Wales (from p23 of Framework for Spatial Prioritisation of Koala Conservation Actions in NSW).

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[7] See Framework for Spatial Prioritisation of Koala Conservation Actions in NSW

The objectives of the ARKS include:

- identification of key koala populations and management areas which have potential for long-term koala security and viability
- identification of priority threats to key koala populations at the regional scale.

Across both LLS regions 25 ARKS have been identified by NSW DPIE; 6 in Northern Tablelands LLS region and 19 in the North Coast LLS region. Figure 3 shows the relationship between the 25 ARKS and the two LLS regions (North Coast and Northern Tablelands), including the 13 priority areas suggested for this project based on advice from NSW Department of Planning, Industry and Environment (Mike Roache and John Turbill) and with subsequent input from Northern Tablelands LLS.
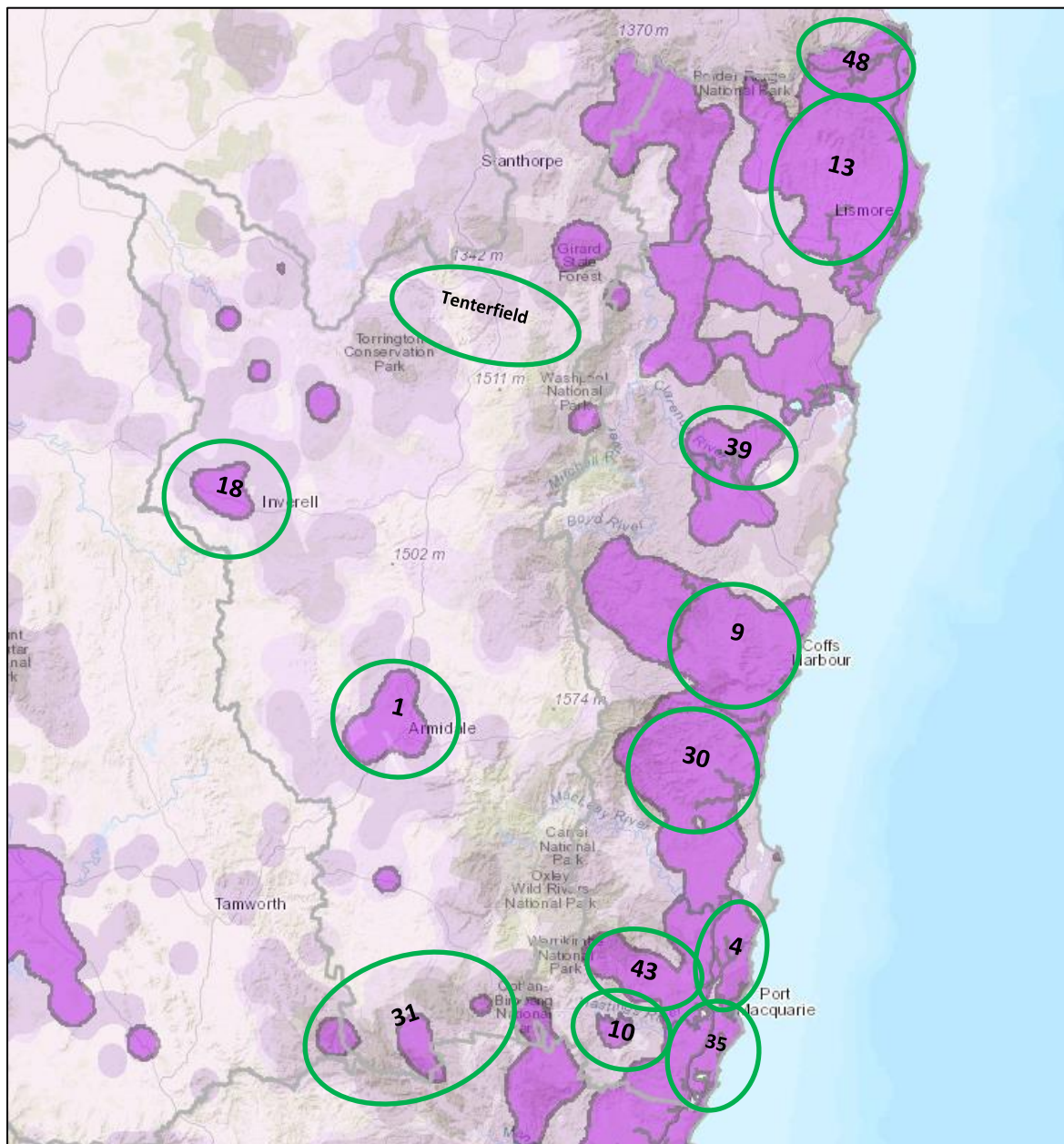

Figure 3: ARKS and LLS regions with priority areas circled (Green). ARKS Codes: 1 (Armidale), 4 (Belmore River), 9 (Coffs Harbour - North Bellingen), 10 (Comboyne), 13 (Far north-east Hinterland), 18 (Inverell), 30 (North Macleay –

Priority ARKS characterisation

On the basis that funding is limited we initially consulted with NSW DPIE (Mike Roache and John Turbill) with the aim of selecting a subset of ARKS that were considered to be of higher priority for intervention and funding. Detailed spatial analysis and modelling has been undertaken across NSW to identify the ARKS, with a number of key attributes used for this stage of the INFFER analysis to identify priorities. These include:

- Total area of the ARKS
- 2019/20 Fire impact
- Resilience class rating - a function of the values (habitat and occupancy) and the level of risk they are exposed to by threatening processes. Resilience is an overall estimate of the likelihood of koalas persisting across a region (averaged for the ARKS) given current and future values and threats. Resilience, together with security class, is designed to be a surrogate for a viability assessment in lieu of accurate koala population data. As accurate koala population information is not widely available across New South Wales, resilience class is not a measure of population viability; that is, a low resilience class cannot translate directly to mean a 'low viability' population. The resilience class is an area scale measure of the future predicted ability of koala areas to withstand loss of habitat and occupancy from threatening processes.
- Security class - a function of the koala population's sensitivity to loss and the protection afforded to koalas in an area or region based on tenure (koalas in and outside of lands managed for conservation). Sensitivity to loss has been calculated based on the available functional habitat to support a minimum of 50 breeding females. Secure areas are deemed to be areas of larger size and landscape functionality, where a higher proportion of koalas are recorded within lands managed for conservation. Low security areas, conversely, are those which are smaller, have a lower overall functionality, and in which a higher proportion of koalas are recorded outside lands managed for conservation.
- Extent and functionality of habitat
- Threat rating – fragmentation, wildfire, heat stress etc.
- Koala records – total number and a series of indices to enable comparison across priority areas (e.g. density of records/ARKS area)

Further information on the ARKS associated with both regions can be found in Appendix 3.

Preliminary budget development

For an initial 10 ARKS (noting that an additional 3 were later added based on advice from LLS regions) identified by DPIE an estimate of works and actions, and costs (see Table A4.1 in Appendix 4) were made. The quantity of effort was estimated on the basis of what it would require to have a **significant impact,** that is the investment would address all significant agreed threats[8] to the values

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[8] Note that it was agreed at Workshop #1 that while both dog attack and vehicle strike are significant threats in some areas they would not addressed in this assessment, but that the project would be supportive of relevant local initiatives where appropriate.

(albeit still recognising that funding will be limited) in each ARKS, not based on what has been spent historically, or what may be notionally available.

The initial costings for the ARKS range from ~ $1.5M (Port Macquarie – a relatively small area) to ~$29M (Coffs Harbour-Bellingen and North Macleay-Nambucca – very large areas), highlighting the need to undertake further prioritisation of both interventions and areas.

Prioritisation of ARKS in recognition of limited funding

Given the budget for the project it was agreed that not all priority areas could be funded, and that further prioritisation was required to identify the relative cost-effectiveness of investment in each ARKS.

The 13 priority ARKS identified are shown in Table 4 along with a summary of key attributes.

Ranking of the 13[9] priority ARKS was undertaken using the INFFER BCR calculator. Firstly each ARKS was assigned an INFFER V score relative to ARKS area number 13; this being the Far north-east Hinterland which was assigned a maximum score of 10 because it was considered to have the highest overall significance.

To aid the prioritisation process a notional constrained budget of $3M per ARK was used. The $3M figure also enabled a high but feasible amount of works (500 ha of habitat protection over 3 years to be achieved). The BCR parameter values were then assigned based on the amount of activity occurring in each priority area). An indicative package of actions for each ARK is described in Table 5 based on cost assumptions (Table 6, noting that not all costs in Table 6 were used to inform the works and actions) for a range of direct works and actions that were discussed and agreed at Workshop #2.

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[9] The initial set of 10 priority ARKS identified by DPIE was expanded to 13 with advice from Northern Tablelands LLS. Subsequently, for completeness, all 25 ARKS were assessed (with the results shown in Appendix 7).

Table 4: NSW identified priority areas and associated key attributes for improving koala habitat based input from NSW DPIE and LLS

ARKS Name	1. Armidale	4. Belmore River	9. Coffs Harbour - North Bellingen	10. Comboyne	13. Far north-east Hinterland	30. North Macleay - Nambucca	35. Port Macquarie	39. Southern Clarence	43. Wilson River	48. Tweed Ranges	18. Inverell	31. Nowendoc	Tenterfield
2019 Fire Impact	Nil	Nil	10-25%	25-50%	<10%	10-25%	25-50%	10-25%	25-50%	Nil	Nil	<10%	
Resilience Class	LOW	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE	LOW	MODERATE	MODERATE	LOW	MODERATE	
High Function Habitat - ha	4,017	19,788	42,337	53,499	39,720	37,384	6,299	2,221	18,997	2,598	50	7,317	
High Functional Habitat - %	0.06	0.41	0.22	0.24	0.12	0.15	0.25	0.04	0.17	0.08	0	0.17	
Total Area of ARKS	70,509	48,027	190,531	220,554	339,862	242,233	25,140	63,164	112,432	32,043	35,407	42,505	
Habitat Fragmentation Risk	High	Moderate	High	High	Moderate	High	High	High	High	Moderate	Moderate	Moderate	TBA
Wildfire Risk	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	High	Moderate	Low	Moderate	High	
Vehicle Strike Risk	Moderate	Moderate	Moderate	Moderate	High	Moderate	Very High	Moderate	Moderate	Very High	Moderate	Moderate	
Heat Stress Risk	Low	Low	Moderate	Moderate	Moderate	Moderate	Low	High	Moderate	Moderate	Very High	Moderate	
Dog Attack Risk	High	High	High	High	High	High	High	High	High	High	High	High	
All Records of koalas	679	198	1,494	479	2,729	571	1,910	260	263	114	40	53	
Area relative to FNEH[10]	20.75	14.13	56.06	64.90	100.00	71.27	7.40	18.59	33.08	9.43	10.4	12.5	
Records relative to FNEH	24.88	7.26	54.75	17.55	100	20.92	69.99	9.53	9.64	4.18	1.4	1.9	
Record density – ARKS area/koala records	0.96	0.41	0.78	0.22	0.80	0.24	7.60	0.41	0.23	0.36	0.11	0.12	

Note: The Tenterfield area has been identified as a priority area and further advice is required regarding its exact location and boundary, as well as data on key attributes.

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[10] FNEH = Far north east Hinterland

Table 5: Indicative package of actions assumed for an individual ARK with a $3M budget.

Cost item	Assumptions	Total upfront costs (assumed to be over 3 years)
Direct works and actions		
Integrated package (site specific) – habitat enhancement, weed management, ecological burning, grazing management etc.	500 ha @ $4,586/ha	$2,293,000
Supporting actions		
Project management & delivery	1.25FTE @ $165K/year	$495,000
Planning	20 plans @ $2,500/plan	$50,000
Baseline survey and project level monitoring	20 sites @ $6,000/site	$120,000
Community engagement and education	4 events/year @ $3,500/event	$42,000
OVERALL TOTAL		**$3,000,000**

Table 6: Summary of costing assumptions (refined at Workshop #2)

Direct works and actions	Assumptions	Comments
Revegetation (enhancement planting)	$500/ha to $2,000/ha	Habitat weeding, enhancement planting, protection and management. Includes targeted rehabilitation of die back and drought stressed koala habitat and protection of refugia.
Weed management	$2,500/ha to $3,500/ha	
Sustainable grazing	$4,000 - $5,000/km (NT LLS) $17,000 - $20,000/km (NC LLS)	Additional fencing to exclude stock. It was noted that this activity would be expected to be a minor component of the overall investment
Ecological burning	$3,000 - $6,000/ha	Includes Hot Spot ecological fire management plans and training
Water drinkers	$1,000 per unit	
Agreement mechanisms		
Covenanting	Likely to be of interest to a small % of landholders	$10,000/ha estimated costs (NSW BCT Koala tenders in North Coast) to undertake an integrated package of actions including weed management, grazing exclusion, enhancement planting.
Voluntary management agreements	**Cost of establishment included in landholder management plan**	Non-title voluntary agreements with agreed management actions
Supporting actions	**Assumptions**	**Comments**
Planning - including studies/investigations	$2,500/plan	Landholder management plans to identify targeted actions
Monitoring - survey	$5,000/survey to *7,500/survey (NC LLS)*	Target areas for monitoring of actions
Community engagement/education	$2,000/event to *5,000/event (NC LLS)*	Field days to engage landholders
Project management	Estimated at 1-1.5 FTE per ARK ($150-180K/year)	Includes project management, delivery coordination, MERI etc.

A common feature of project funding is that on-going maintenance funding is not included. If it is not provided then there is increased risk that benefits might not be maintained in the long-term. In the INFFER analysis, the BCR is based on a 20 year time period. To maintain the benefits (V x W estimate

in INFFER) it is assumed that there will be on-going maintenance funding (and on this basis it is assumed that there is no long-term funding risk, i.e. G=1.0). If long term funding is not provided then the W values in INFFER would need to be reduced. Our analysis assumes that following the initial investment of $3M in direct works (over 3 years), there is ongoing annual maintenance costs of $150K (5% of up-front cost). Based on this assumption the estimate of the impact of works (W) was made using the following guidance:

Think about the proposed works and actions for the priority ARKS … What is likely impact of these works, compared with 'business as usual'?

- The project will make a very significant difference, fully addressing all threats[11] to the values (W = 0.4)
- The project will make a significant difference, but will not address all threats completely (W = 0.2)
- The project will make a moderate difference (W = 0.1)
- The project will only make a minor difference (W = 0.05)
- The project will make little difference (W = 0.01)

Each ARK was then assessed (based on the package of works and actions – Table 6) for lag time, technical feasibility, adoption and socio-political risk to generate BCRs for each case. The results are shown in Table 7, noting that these would benefit from further review if additional knowledge and data became available in the future.

A range of factors have an effect on W, noting that for all projects all agreed threats and actions have been addressed but for very large ARKS areas (e.g. Far NE Hinterland) the overall impact of works is likely to be lower (all other things considered).

Comments on key direct works and actions

Revegetation (enhancement planting): This activity addresses the threats of fragmentation and habitat degradation. It involves the strategic enhancement of high and moderate functional habitat on freehold land, rather than 'greenfield' revegetation which incurs very high costs and has a higher risk of technical failure, for example from climate impacts and weed invasion. In this project it is recommended that at the level of an individual ARKS/Hub opportunities for enhancement planting are identified where they augment existing habitat and/or build connectivity between areas of functional habitat.

Weed management: This activity addresses the threat of habitat degradation due to the impact of invasive weeds (e.g. Lantana) on the quality of functional koala habitat. Invasive weed management often requires an integrated approach using chemical and mechanical control, changed grazing management and the use of fire for ecological purposes to reduce the weed load and promote regeneration of koala food trees.

Sustainable grazing: This activity involves deliberate and enduring changes in grazing regime to improve the quality of koala habitat. In some cases overgrazing results in reduced habitat quality and lack of regeneration of key habitat elements such as the preferred eucalypt species required by

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[11] Note that because not all threats are addressed (e.g reduced dog attacks, planning controls etc), no project can attain a W of 0.4.

koalas, whilst in other cases the impact of weed invasion can be limited through strategic grazing to manage undesirable species and to promote natural regeneration.

Ecological burning: Large and intense wildfires that burn into the canopy can kill koalas, either through direct flame contact or inhalation of smoke and ash. Large fires may also fragment the landscape, isolate populations and leave them with little food or shelter. While large, hot, fast-moving fires can endanger people and wildlife, and cause significant damage, less intense patchy fires that are appropriately timed can actually be very beneficial to people, koalas and native habitat. Using fire for hazard reduction ('burning off') or for ecological reasons can minimise the impact of bush fire on koala populations, while also helping to provide a level of protection for human life and property[12].

Within the context of this project it is intended that an integrated package of actions can be deployed as required on a site by site basis in areas of high/moderate functional habitat on freehold land.

It is important to note that detailed mapping is available for each ARKS (see Appendix 6 for maps of the three highest ranked ARKS in this assessment: Belmore River, Coffs-Harbour/North Bellingen and Port Macquarie) as well as finer scale identification of priority locations (Hubs) within each ARK, for which an example is shown for Belmore River in Appendix 5.

Comment on other INFFER risk factors

In addition to the previous comments on V (value), W (impact of works), G (risk that long-term funding is not provided), C (up-front costs) and M (ongoing maintenance costs), the BCR results outlined in Table 7 are affected by other risk factors, namely F (technical feasibility of actions), A (adoption of actions by private landholders) and P (socio-political risk).

Technical feasibility (F): Because the package of actions is the same for each priority area, it follows that the technical feasibility is the same for all areas. The F factor has been set as 0.87, or low risk of failure on the basis that the works and actions are well known and tested but so have some risk of failure (e.g. weed control does not always fully control weeds).

Adoption (A): Landholder adoption will be different in different priority areas and therefore different A factors are important to incorporate. Based particularly on LLS input, as an example adoption for koala habitat protection in Armidale is likely to be very low (A estimated as 0.2) compared with a number of other areas, such as Tweed Ranges and Far north-east Hinterland (both with an A value of 1) where there is apparently a strong history of landholder interest and capacity for adoption of the proposed works at the proposed scale.

Socio-political risk (P): The socio-political risks have been assessed as the same for all areas and as very low risk given the cooperation between DPIE and LLS and the institutional capacity and willingness to deliver the project.

Further explanation of how these factors were assessed is provided in Appendix 1.

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[12] Living with koalas and fire in the Tweed (Tweed City Council and NSW Nature Conservation Council)

Table 7: Results of benefit: cost analysis assessment for priority ARKS

INFFER Benefit: Cost Ratio calculator v21	Description of scenario	Value (V)	Impact of works# (W)	Technical feasibility# (F)	Adoption# (A)	Socio-political risks# (P)	Long-term funding risk (G)	Lag until benefits occur (L)	Up-front cost, total over N years (C $ million)	Maintenance cost (M $ million /year)	Benefit: Cost Ratio	Ranking	Comment
4. Belmore River	All works and actions to address identified threats across the ARK	3.5	0.20	0.87	0.7	0.97	1	10	3.0	0.15	1.10	1	Good opportunity to secure a small ARKS with lots of private land. Council ecologist capacity, potential to link with Hastings Macleay partnership, KPOM in place (Kempsey coastal - approved under SEPP44), good landholder uptake, couple of NPs and state forests. Potential for connectivity. PLAs that include sustainable grazing to encourage natural regeneration.
9. Coffs Harbour - North Bellingen		7	0.05	0.87	0.7	0.97	1	10	3.0	0.15	0.55	2	Lower threats, good habitat value. Lots of NP and State Forest. Work to be done around Lowanna-Ulong on private land (very small section of the ARKS). Low confidence on the KLM that could improve with survey. Potential to improve connectivity with surrounding reserves and forests.
35. Port Macquarie		3	0.10	0.87	0.7	0.97	1	10	3.0	0.15	0.47	3	May be ranked lower once current status is better understood. Major koala population affected by fires. Needs post-fire survey at existing SAT sites. And detailed assessment before understanding what management action is required. May benefit from a pilot study to see what the post-fire recovery rate looks like. How long does the regrowth take before it can support koalas? Koalas were released into Limeburners NP about 12 weeks after fire - enough epicormic growth to provide feed.
1. Armidale		2.5	0.20	0.87	0.2	0.97	1	10	3.0	0.15	0.23	7	Lower value area, but potential for greater impact. Emerging population in the Northern Tablelands. Adoption assessed as very difficult – at best 100 ha might be able to be secured due to lack of interest/capacity from commercially oriented landholders. Challenging to take action because of drought. Need to better understand the population to inform management actions
43. Wilson River		4.5	0.07	0.87	0.5	0.97	1	10	3.0	0.15	0.35	5	Medium-size
48. Tweed Ranges		1.2	0.15	0.87	1	0.97	1	10	3.0	0.15	0.41	4	Small area, few koalas
13. Far north-east Hinterland		10	0.01	0.87	1	0.97	1	10	3.0	0.15	0.23	8	Very large area. Some areas within this very large ARKS are priorities. West of Byron, between Lismore and Wardell; Blue Knob to Terania Creek; Federal to Rosebank, (including Bangalow Koalas group with good momentum); Sustainable grazing could be promoted under covenant.
39. Southern Clarence		1.8	0.07	0.87	0.3	0.97	1	10	3.0	0.15	0.09	12	Low density of koalas, little functional habitat
10. Comboyne		6	0.01	0.87	0.5	0.97	1	10	3.0	0.15	0.07	13	Very large area
30. North Macleay - Nambucca		5.5	0.01	0.87	0.7	0.97	1	10	3.0	0.15	0.09	11	Very large area. Valla area north to Bongil Bongil - a small area of the ARKS. Nambucca Shire Council. Mapped core habitat in council's study.
18. Inverell		3.5	0.2	0.87	0.2	0.97	1	10	3.0	0.15	0.32	6	
31. Nowendoc		2	0.15	0.87	0.3	0.97	1	10	3.0	0.15	0.20	9	
Tenterfield		2	0.15	0.87	0.3	0.97	1	10	3.0	0.15	0.20	9	

Note: INFFER BCR parameter, B (adverse adoption) has been omitted on the basis that we don't believe this factor will be relevant to the analysis.

Discussion of NSW results

Table 8 shows the benefit: cost ratios in ranked order of the 13 priority ARKS in NSW.

The results indicate that Belmore River is the highest priority with a BCR of 1.10, suggesting that benefits exceed costs by approximately 10%. This is followed by Coffs Harbour – North Bellingen (BCR 0.55), Port Macquarie (BCR 0.47) and Tweed Ranges (BCR (0.41). The least cost-effective ARKS based on BCRs are Comboyne (BCR 0.07) and North Macleay-Nambucca and Southern Clarence, both with BCRs of 0.09. In these three cases the costs of investment are estimated to be in the order of ten times the predicted benefits and are therefore unlikely to be cost-effective.

Table 8: Cost-effectiveness ranking of priority ARKS

Ranking	ARKS No: Name	ARKS area in ha (% high/moderate functional habitat)	BCR
1	4. Belmore River	48,027 (68%)	1.10
2	9. Coffs Harbour - North Bellingen	190,531 (64%)	0.55
3	35. Port Macquarie	25,140 (51%)	0.47
4	48. Tweed Ranges	32,043 (36%)	0.41
5	43. Wilson River	112,432 (65%)	0.35
6	18. Inverell	35,407 (5%)	0.32
7	1. Armidale	70,509 (17%)	0.23
8	13. Far north-east Hinterland	339,862 (40%)	0.23
9	31.Nowendoc	42,505 (69%)	0.20
9	Tenterfield		0.20
11	30. North Macleay - Nambucca	242,233 (57%)	0.09
12	39. Southern Clarence	63,164 (25%)	0.09
13	10. Comboyne	220,554 (64%)	0.07

It is acknowledged that there is large uncertainty associated with a number of the BCR parameters. In particular, given the contestability of defining the value of koalas, (V, value) and also W (impact of works), a sensitivity analysis was undertaken for the priority ARKS using the following assumptions:

- ARKS significance (V) was adjusted to +/- 50% of the estimated value, and
- Impact of works (W) was adjusted to +/-50% of estimated value, and
- Other parameters (L, F, A, P, C and M) were unadjusted from the estimated value

The results of the sensitivity analysis are shown in Table 9, along with recommendations for investment. These results suggest that under an optimistic scenario (V and W adjusted up by 50%) that three of the ARKS; Belmore River, Coffs-Harbour-North Bellingen and Port Macquarie are cost-effective investments (BCR>1), with a fourth ARKS (Tweed Ranges) being close to cost-effective with a BCR of 0.91.

Table 9: Cost-effectiveness under sensitivity analysis

Ranking	ARKS No: Name	BCR (unadjusted)	BCR (V and W adjusted +50%)	BCR (V and W adjusted -50%)	Recommendation/comment
1	4. Belmore River	1.10	2.48	0.28	Immediate investment in direct works and actions in

2	9. Coffs Harbour - North Bellingen	0.55	1.24	0.14	conjunction with baseline assessment/survey.
3	35. Port Macquarie	0.47	1.06	0.12	
4	48. Tweed Ranges	0.41	0.91	0.10	Undertake baseline assessment to refine BCR estimates prior to investment of Australian Government funds
5	43. Wilson River	0.35	0.80	0.09	
6	18. Inverell	0.32	0.71	0.08	
7	1. Armidale	0.23	0.51	0.06	
8	13. Far north-east Hinterland	0.23	0.51	0.06	
9	31.Nowendoc	0.20	0.46	0.05	
9	Tenterfield	0.20	0.46	0.05	
11	30. North Macleay - Nambucca	0.09	0.19	0.02	Not recommended for investment at this time in this project based on our analysis.
12	39. Southern Clarence	0.09	0.19	0.02	
13	10. Comboyne	0.07	0.15	0.02	

Furthermore, the assessment and subsequent raking has been undertaken using the best available data, knowledge and information that were made available. In the case of some ARKS it should be acknowledged that their low ranking may be, at least in part, due to significant knowledge gaps. For example koala observation records as a factor in driving prioritisation may risk biasing the results towards more populated areas. Koala populations in the Northern Tablelands are generally sparse and occur in low densities, they are unique in that they are adapted to open woodlands and the extant populations remain significant and important to protect (pers.comm. Northern Tablelands LLS).

Predicted implementation outcomes from priority investment

Table 10 has been developed to provide a summary of the scale of outputs (area of direct works and actions) that could be achieved under two investment scenarios for each ARKS, firstly with an investment of $3M in each priority area (as outlined previously). A subsequent analysis was undertaken with an assumed investment of $1M in each priority area; undertaken for two reasons:

- In recognition of the potential preference to invest in more than one priority area
- To show the effect that reduced funding has in terms of impact (% effect on habitat improvement)

Table 10: On-ground outputs in priority ARKS with large ($3M) and small ($1M) budget.

ARKS	ARKS area in ha (% high and moderate functional habitat)	Area of private land – approximate (ha)	Area of high and moderate functional habitat (ha)	Quantity of works and actions ($3M investment)	% effect on high and moderate functional habitat	Quantity of works and actions ($1M investment)	% effect on high and moderate functional habitat
4. Belmore River	48,027 (68%)	35,000 ha	32,658 ha	500 ha	1.53%	167 ha	0.51%
9. Coffs Harbour -	190,531 (64%)	95.000 ha	121,939 ha	500 ha	0.41%	167 ha	0.14%

North Bellingen							
35. Port Macquarie	25,140 (51%)	15,000 ha	12,821 ha	500 ha	3.89%	167 ha	1.30%

Integration and complementarity with other mechanisms and initiatives

During the analysis it became apparent that there is already significant work occurring across NSW and within the project area, involving direct works and actions to secure koala habitat and populations, as well as supporting activities including research, monitoring and community capacity building.

The NSW Koala Strategy identifies a suite of mechanisms and initiatives (some of which are already underway) that are guiding and supporting government, NGOs and landholders to achieve the aims of the strategy. Appendix 6 provides an overview along with some brief commentary on how they might be best integrated with recommendations in this analysis.

Recommendations for NSW

The results of this report have identified many more priority koala project areas (ARKS) and on ground activities than can be funded by the $3M election commitment. The list of priority project areas and on ground actions provides an opportunity for other investors and potential partners to invest in projects to protect Koalas in northern NSW.

In terms of allocating the $3 M project funding, options include:

1. Investment in the Belmore River ARKS is most cost-effective based on the evidence provided. If there are no additional considerations and based on the information provided, investing in this ARK provides the best investment to achieve impact in terms of moderate to high functioning habitat.
2. If there is preference to invest in more than one ARK area, then Belmore River, Coffs Harbour - North Bellingen and Port Macquarie are the top three priority regions.
3. Baseline assessment to refine habitat areas within ARKS of Tweed River, Wilson River, Inverell, Armidale, Far north East Hinterland, Nowendoc and Tenterfield is recommended. Investment in targeted areas within these regions might be possible as information is refined. For additional Australian Government investment to be contemplated based on cost-effectiveness, decisions would need to be weighed up against higher ranked areas. The ARKS of Tweed River, Wilson River and Inverell appear most promising as second tier investments.
4. Based on the evidence, investment is not supported in the ARKS areas of North Macleay – Nambucca, Southern Clarence or Comboyne.
5. Further guidance on the approximate split of funding between on-ground actions and baseline assessment is needed.

In conclusion, the analysis highlights that targeted investment in an integrated package of works and actions on private land is warranted and this should be done within an adaptive management framework that allows for future investment into new areas (lower priority ARKS) if this is supported by improved information and understanding.

Queensland

The recently released Draft SEQ Koala Conservation Strategy 2019-2024 identifies broad scale prioritisation of areas for koala conservation in south-east Queensland (Figure 4). While this is a useful starting point it has a number of limitations for the INFFER analysis:

- The priority areas are very large in scale and it will be infeasible (with current budgets) to invest cost-effectively across all priority areas.
- There is no indication of how finer scale targeting of actions might be undertaken with respect to the different threats/management action combinations that would be appropriate in different locations.
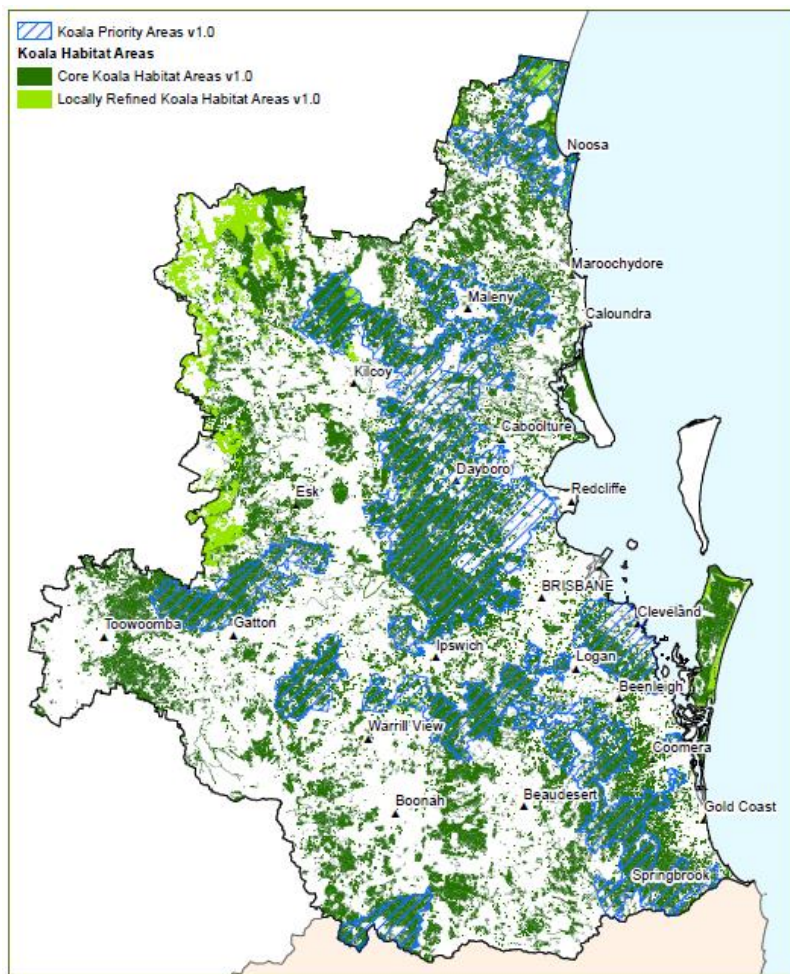
Figure 4: Priority areas for koala conservation (as identified in SEQ Koala Conservation Strategy)

With this in mind we sought advice from the Queensland Department of Environment and Science to identify specific finer-scale target areas that would be appropriate for Australian Government investment, to guide the INFFER analysis. This information was used in collaboration with Healthy Land and Water to identify an agreed set of priority areas.

Results of QDES and HLW prioritisation

A collaborative approach was undertaken, involving staff from QDES and Healthy Land and Water, to identify potential priority areas for investment, within the context of the funding available for this project. The approach resulted in the identification of 21 priority areas across south-east Queensland. These areas are shown in Figure 5 and described in Table 11. The methodology applied to the identification of the priority areas is described in Appendix 8.

Figure 1: Location of priority areas to be considered for Australian Government investment to protect koala habitat in south east Queensland.

Table 11: SEQ Priority areas characteristics

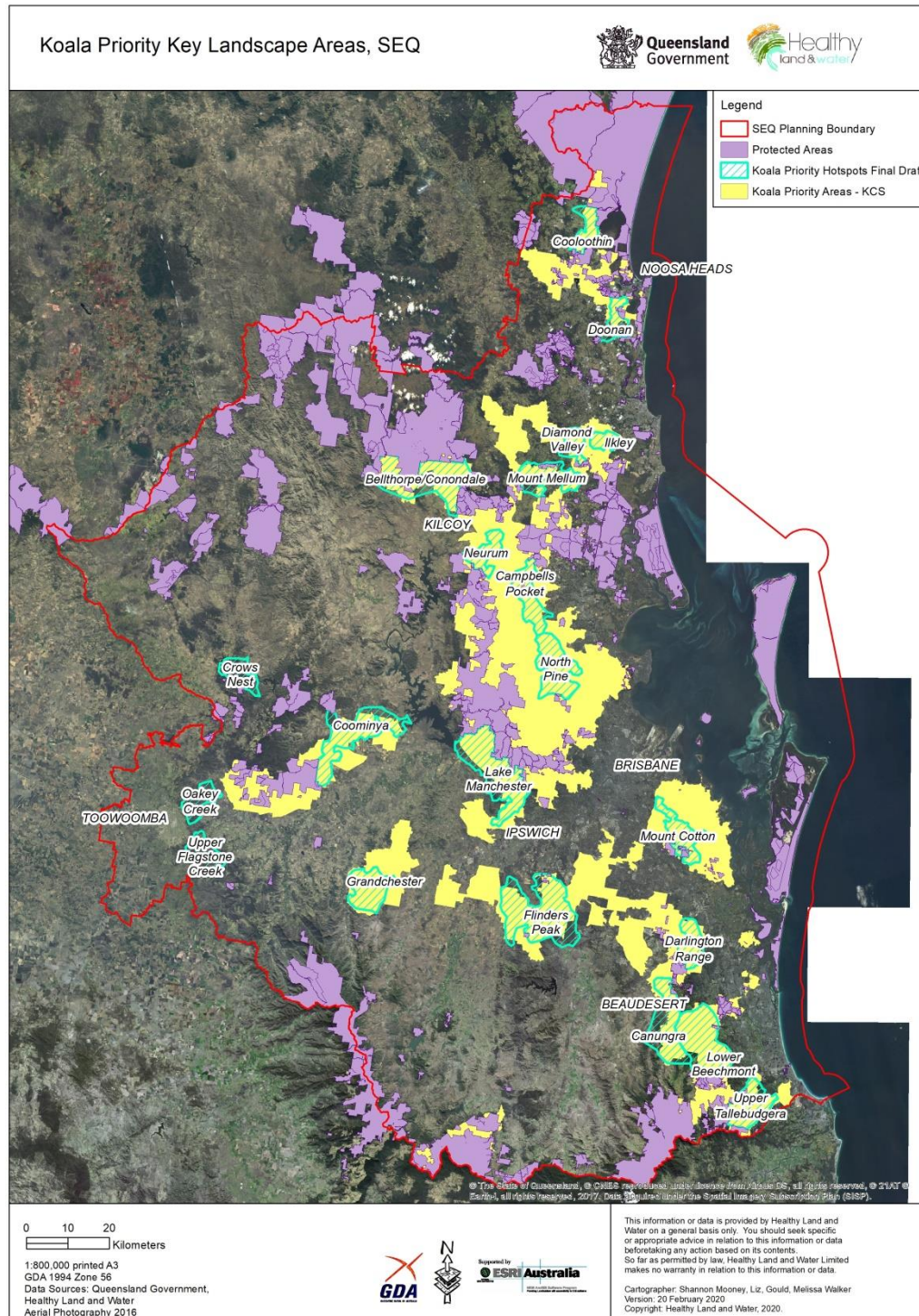| Priority Area Number	Priority area name	Total area (ha)	Freehold land (ha)	% freehold	Area of preferred habitat[13] (ha)	Preferred habitat as % of total area	Average freehold property size (ha)
1	Upper Tallebudgera	7865	6632	84%	4909	61.0	10
2	Lower Beechmont	14398	13497	94%	8349	56.5	16
3	Darlington Range	5652	5333	94%	3031	53.2	12
4	Flinders Peak	23366	21048	90%	8029	53.9	48
5	Grandchester	8082	7750	96%	1729	21.9	30
6	Upper Flagstone Creek	5478	5222	95%	2531	45.7	20
7	Oakey Creek	4300	3911	91%	2188	49.5	25
8	Coominya	13811	13606	99%	4767	24.3	41
9	Lake Manchester	17395	16680	96%	6189	35.3	32
10	Mount Cotton	6584	6257	95%	4468	67.3	6
11	North Pine	10746	10406	97%	4689	43.8	24
12	Campbells Pocket	7205	6638	92%	2995	40.9	16
13	Neurum	4665	4235	91%	589	12.2	27
14	Mount Mellum	7981	7244	91%	2416	29.6	17
15	Diamond Valley	3584	3378	94%	1495	41.0	7
16	Ilkley	2562	2414	94%	1275	50.0	7
17	Doonan	3968	3669	92%	1250	30.8	13
18	Cooloothin	4418	4249	96%	1449	32.2	14
19	Crow's Nest	4284	4226	99%	TBA	TBA	47
20	Belthorpe/Conondale	17744	15284	86%	2002	11.1	52
21	Canungra	11062	10650	96%	3313	28.2	12

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[13] See Appendix 8 for description of what constitutes preferred habitat.

Given the budget for the project it was agreed that not all priority areas could be funded, and that further prioritisation was required to identify the relative cost-effectiveness of investment in each of the 21 priority areas.

Ranking of the 21 priority areas was undertaken using a tailored version of the INFFER BCR calculator. Firstly each area was assigned an INFFER V score relative to Flinders Peak which was assigned a maximum score of 10 because it was considered to have the highest overall significance.

As for the NSW analysis a notional constrained budget of $3M per area was used. The $3M figure also enabled a high but feasible amount of works (500 ha of habitat protection over 3 years to be achieved). The BCR parameter values were then assigned based on the amount of activity occurring in each priority area). The indicative package of actions for each area was used, based on the same costing assumptions (Tables 5 and 6) that were applied in the NSW analysis[14].

The parameter estimates were discussed at a meeting held on 20th February 2020 at Healthy Land and Water involving Liz Gould and Shannon Mooney (HLW), Stephen Howell (QDES/Queensland Herbarium - Manager of Biodiversity Assessment Team) and facilitated by Geoff Park (Natural Decisions). While an attempt was made to assign all parameter values at this meeting the participants agreed that with respect to V (area significance) and W (impact of works) that they lacked the required knowledge and expertise to do this with confidence and that additional advice would be sought from QDES staff. Meeting participants did however provide estimates of the remaining BCR parameters.

Subsequently Geoff Park liaised with two QDES koala experts, Gavin Hammermeister and Chris Evenson (Program Coordinator, Wildlife and Threatened Species Operations), to independently elicit V and W estimates for the 21 priority areas. These results were averaged and then combined with the remaining parameters estimates to generate BCRs for the 21 priority areas. It is important to note that the estimates will be subject to review by HLW and QDES before finalising the report.

The results of the prioritisation are shown in Table 12.

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[14] Costing assumptions to be reviewed by QDES and HLW.

Table 12: Summary of parameter estimates for the 21 SEQ priority areas

Priority Area No.	Priority area name	Description of scenario	Value (V)	Impact of works# (W)	Technical feasibility# (F)	Adoption# (A)	Socio-political risks# (P)	Long-term funding risk (G)	Lag until benefits occur (L)	Up-front cost, total over N years (C $ million)	Maintenance cost (M $ million /year)	Benefit: Cost Ratio	Ranking	Comment
1	Upper Tallebudgera		7.5	0.13	0.70	0.8	0.97	1	10	3.0	0.15	1.36	11	Coastal (higher, more predictable rainfall; higher weed growth, but higher regen. capacity), upper catchment (wetter forest), mostly small (<10ha) acreage
2	Lower Beechmont		8	0.15	0.70	0.8	0.97	1	10	3.0	0.15	1.74	8	Coastal (higher, more predictable rainfall; higher weed growth, but higher regen. capacity), upper catchment (wetter forest), small to medium acreage.
3	Darlington Range		6	0.08	0.70	0.8	0.97	1	10	3.0	0.15	0.65	18	Coastal (higher, more predictable rainfall; higher weed growth, but higher regen. capacity), upper catchment (wetter forest), small to medium acreage.
4	Flinders Peak		10	0.30	0.65	0.8	0.97	1	10	3.0	0.15	4.03	1	Non-coastal, dry forest ranges; focal area for three local governments, increasing edge effects / threats from adjacent urban community; opportunity to recreate alluvial habitats and link to hills; large average property size.
5	Grandchester	All works and actions to address identified threats across the priority area	8	0.20	0.65	0.8	0.97	1	10	3.0	0.15	2.15	3	Non-coastal extension off Main Range; dry country; mix of rural grazing and peri-urban; some current capacity / opportunity through Little Liverpool Range initiative; larger property sizes.
6	Upper Flagstone Creek		6	0.15	0.70	0.8	0.97	1	10	3.0	0.15	1.30	12	Non-coastal ; wetter forests in gullies; mostly grazing and some lifestyle; good capacity / opportunity through Lockyer Uplands Catchments Inc; range of medium to large property sizes.
7	Oakey Creek		6	0.15	0.65	0.6	0.97	1	10	3.0	0.15	0.91	17	Non-coastal; wetter forests in gullies; mostly grazing and some lifestyle; limited engagement by HLW; range of medium to large property sizes.
8	Coominya		8	0.25	0.65	0.6	0.97	1	10	3.0	0.15	2.02	5	Non-coastal connection between Wivenhoe and Helidon; dry country but mostly flat land / alluvial rather than hillslopes; mostly rural landholders / primary production; past HLW engagement through riparian weeds project; larger property sizes.
9	Lake Manchester		8.5	0.25	0.65	0.6	0.97	1	10	3.0	0.15	2.14	4	Non-coastal; dry country; mix of rural grazing and peri-urban; some current capacity / opportunity; significant SEQ Water and Council reserves; limited past engagement with private landholders by HLW; larger property sizes.
10	Mount Cotton		6.5	0.06	0.70	0.75	0.97	1	10	3.0	0.15	0.49	20	Coastal (higher, more predictable rainfall; higher weed growth, but higher regen. capacity), upper catchment , mostly small (<10ha) acreage.
11	North Pine		7.5	0.25	0.70	0.75	0.97	1	10	3.0	0.15	2.55	2	Coastal (higher, more predictable rainfall; higher weed growth, but higher regen. capacity), upper catchment (wetter forest); peri-urban / rural residential landholders, mix of small to large properties
12	Campbell's Pocket		7.5	0.20	0.70	0.6	0.97	1	10	3.0	0.15	1.63	9	Coastal (higher, more predictable rainfall; higher weed growth, but higher regen. capacity), upper

														catchment (wetter forest), mostly small to medium acreage
13	Neurum		6.5	0.15	0.70	0.7	0.97	1	10	3.0	0.15	1.24	13	Coastal (higher, more predictable rainfall; higher weed growth, but higher regen. capacity), upper catchment (wetter forest); mostly grazing properties and some lifestyle; mix medium to larger properties
14	Mount Mellum		7	0.20	0.70	0.75	0.97	1	10	3.0	0.15	1.90	6	Coastal (higher, more predictable rainfall; higher weed growth, but higher regen. capacity), upper catchment (wetter forest); primary production/ peri-urbane; medium properties sizes; current activity by Hinterland Bush Links.
15	Diamond Valley		6.5	0.20	0.70	0.75	0.97	1	10	3.0	0.15	1.77	7	Coastal (higher, more predictable rainfall; higher weed growth, but higher regen. capacity), upper catchment (wetter forest), mostly small (<10ha) acreage; strong private landholder engagement current activity by Hinterland Bush Links.
16	Ilkley		6.5	0.20	0.70	0.6	0.97	1	10	3.0	0.15	1.41	10	Coastal (higher, more predictable rainfall; higher weed growth, but higher regen. capacity), upper catchment (wetter forest), mostly small (<10ha) acreage; current activity by Hinterland Bush Links.
17	Doonan		5.5	0.08	0.70	0.7	0.97	1	10	3.0	0.15	0.52	19	Coastal (higher, more predictable rainfall; higher weed growth, but higher regen. capacity), upper catchment (wetter forest), small to medium acreage; current activity by Hinterland Bush Links.
18	Cooloothin		4.5	0.06	0.70	0.75	0.97	1	10	3.0	0.15	0.34	21	Coastal (higher, more predictable rainfall; higher weed growth, but higher regen. capacity), upper catchment (wetter forest), small to medium acreage; current activity by Hinterland Bush Links.
19	Crow's Nest		6.5	0.15	0.65	0.65	0.97	1	10	3.0	0.15	1.07	16	Non-coastal, but escarpment ranges (higher, more predictable rainfall; higher weed growth, but higher regen. capacity), upper catchment (wetter forest), large average property size.
20	Belthorpe/Conondale		6.5	0.15	0.65	0.75	0.97	1	10	3.0	0.15	1.23	14	Non-coastal, but wetter forests and extension lower slopes and flat country (higher, more predictable rainfall; higher weed growth, but higher regen. capacity), opportunity to build on past HLW extension (fire planning) and current activity by Hinterland Bush Links; large average property size
21	Canungra		7	0.15	0.65	0.65	0.97	1	10	3.0	0.15	1.15	15	Coastal (higher, more predictable rainfall; higher weed growth, but higher regen. capacity), upper catchment (wetter forest), small to medium acreage

Discussion of Queensland results

Table 13 shows the benefit: cost ratios in ranked order of the 21 priority areas in SEQ.

The results indicate that Flinders Peak is the highest priority with a BCR of 4.03, suggesting that benefits exceed costs by approximately four times. This is followed by North Pine (BCR 2.55), Grandchester (BCR 2.15) and Lake Manchester (BCR 2.14). The least cost-effective areas based on BCRs are Cooloothin (BCR 0.34), Mount Cotton (BCR 0.49) and Doonan (BCR 0.52). In these three cases the costs of investment are estimated to be in the order of two to three times the predicted benefits and are therefore unlikely to be cost-effective.

Table 13: Cost-effectiveness ranking of priority areas

Ranking	Priority area No and Name	Area in ha	Area of preferred habitat in ha	BCR
1	4. Flinders Peak	14,900	8,029	4.03
2	11. North Pine	10,715	4,689	2.55
3	5. Grandchester	7,894	1,729	2.15
4	9. Lake Manchester	17,517	6,189	2.14
5	8. Coominya	19,641	4,767	2.02
6	14. Mount Mellum	8,162	2,416	1.90
7	15. Diamond Valley	3,647	1,495	1.77
8	2. Lower Beechmont	14,788	8,349	1.74
9	12. Campbell's Pocket	7,327	2,995	1.63
10	16. Ilkley	2,552	1,275	1.41
11	1. Upper Tallebudgera	8,052	4,909	1.36
12	6. Upper Flagstone Creek	5,534	2,531	1.30
13	13. Neurum	4,825	589	1.24
14	20. Belthorpe/Conondale	18,049	2,002	1.23
15	21. Canungra	11,742	3,313	1.15
16	19. Crow's Nest	4,284	TBA	1.07
17	7. Oakey Creek	4,421	2,188	0.91
18	3. Darlington Range	5,692	3,031	0.65
19	17. Doonan	4,058	1,250	0.52
20	10. Mount Cotton	6,635	4,468	0.49
21	18. Cooloothin	4,505	1,449	0.34

Predicted implementation outcomes from priority investment

Table 14 has been developed to provide a summary of the scale of outputs (area of direct works and actions) that could be achieved under two investment scenarios for each ARKS, firstly with an investment of $3M in each priority area (as outlined previously). A subsequent analysis was undertaken with an assumed investment of $1M in each priority area; undertaken for two reasons:

- In recognition of the potential preference to invest in more than one priority area
- To show the effect that reduced funding has in terms of impact (% effect on habitat improvement)

Note that only the top four priority areas have been considered in Table 14. As for NSW it is not possible to fund every area with the available budget. Another very important note is that NSW and

Qld BCR figures cannot be compared because different prioritisation approaches were used and even though INFFER was used in both cases, the Queensland W values are generally much higher than the NSW values (which is likely to be related in part to the smaller areas within each priority are in Queensland.

Table 14: On-ground outputs in priority areas with large ($3M) and small ($1M) budget.

Priority area No and name	Area in ha (% preferred habitat)	Area of private land – approximate (ha)	Area of preferred habitat (ha)	Quantity of works and actions ($3M investment)	% effect on preferred habitat	Quantity of works and actions ($1M investment)	% effect on preferred habitat
4. Flinders Peak	14,900	TBC	8,029	500 ha	6.2%	167 ha	2.1%
11. North Pine	10,715	10,406	4,689	500 ha	10.7%	167 ha	3.6%
5. Grandchester	7,894	7,750	1,729	500 ha	28.9%	167 ha	9.6%
9. Lake Manchester	17,517	16,680	6,189	500 ha	8.0%	167 ha	2.7%

Integration and complementarity with other mechanisms and initiatives

As was the case in NSW, during the Queensland analysis it became apparent that there is already significant work occurring across the south-east and within the project area, involving direct works and actions to secure koala habitat and populations, as well as supporting activities including research, monitoring and community capacity building. Further documentation will be summarised in the Final Report

Recommendations for Queensland

The results of this report have identified many more priority koala project areas and on ground activities than can be funded by the $3M election commitment. The list of priority project areas and on ground actions provides an opportunity for other investors and potential partners to invest in projects to protect Koalas in south east Queensland.

In terms of allocating the $3 M project funding, options include:

1. Investment in the Flinders Peak priority area is the most cost-effective based on the evidence provided. If there are no additional considerations then investing in this area provides the soundest investment to achieve impact in terms overall effect on preferred habitat.
2. If there is preference to invest in more than one priority area, then North Pine, Grandchester and Lake Manchester are the next three priority regions.
3. In compiling the assessment it became apparent that there are a range of existing and proposed initiatives for koala conservation across SEQ. This includes actions proposed in the draft Queensland Koala Strategy, local government programs as well as investment in on ground works through Queensland Trust for Nature. Discussions are encouraged between the various stakeholders to identify how the proposed Australian Government investment can be used to be complementary to these programs and projects.
4. Baseline assessment to refine knowledge and information is required across all habitat areas.

5. Based on the evidence, Australian Government investment is not supported in many of the other areas. The lowest priorities include Crow's Nest, Oakey Creek, Darlington Range, Doonan, Mount Cotton and Cooloothin and the extent to which investment in areas ranked abouve these and below the top four will depend on many factors.

6. Further guidance on the approximate split of funding between on-ground actions and baseline assessment is needed.

In conclusion, the analysis highlights that targeted investment in an integrated package of works and actions on private land is warranted this should be done within an adaptive management framework that allows for future investment into new areas if this is supported by improved information and understanding.

Comparison between NSW and Queensland priorities

Table 15 provides a comparison between NSW and Queensland priority areas, showing the relative extent of each area, the V and W parameter estimates and BCRs. It was for these BCR factors that the most significant variation in estimates was observed, rather than for other BCR factors (L, F, A and P) which tended to be similar on an area/state basis.

As described above the priority area BCRs for Queensland are, on average, higher than for NSW. The following observations are made:

- First and most importantly, results between NSW and Queensland cannot be directly compared because the prioritisation approaches were different and the INFFER parameter results in particular were assessed by different groups in each state. For example BCR 4.03 in Queensland for Flinders Peak does not indicate a better investment than in NSW Belmore River (BCR 1.10).

- The area of priority ARKS (NSW) is significantly higher than for Queensland priority areas. For example the highest priority NSW ARKS (Belmore River) is 35,000 ha and has a V score of 3.5 compared with the highest priority Queensland area (Flinders Peak) is 14,000 ha with a V score of 10. This suggests that the Queensland V scores are somewhat 'inflated' compared to NSW.

- In a similar vein the impact of works (W) estimates tended to, on average, to be lower in NSW than Queensland. Given the differences in the size of priority areas this suggests that the W scores in each state are more directly comparable than for the V estimates. It is also worth noting that the % effect on habitat (high and moderate functional habitat in NSW – Table 10 and preferred habitat in Queensland – Table 14) is relatively much higher in Queensland priority area than in NSW ARKS, further supporting the relationship between the effect of works and the extent of priority habitat.

- If the Australian Government requires an overall ranking then standardising all parameter values, but in particular V and W will need to be undertaken.

Priority ARKS or area	Total area (ha)	V (significance)	W (impact of works)	BCR
NSW				
4. Belmore River	35,000	3.5	0.20	1.10
9. Coffs Harbour - North Bellingen	95.000	7	0.05	0.55
35. Port Macquarie	15,000	3	0.10	0.47
Queensland				
4. Flinders Peak	14,900	10	0.30	4.03
11. North Pine	10,715	7.5	0.25	2.55
5. Grandchester	7,894	8	0.20	2.15
9. Lake Manchester	17,517	8.5	0.25	2.14

Approach and challenges with prioritisation

Not surprisingly there are different views when attempting to identify priority areas and also in identifying the appropriate mix of actions within a priority area.

As a means of reconciling and accommodating different views on priorities we used the following steps to arrive at the preliminary results for each state.

Table 15: Steps undertaken to prioritise areas for koala habitat protection investment.

Step	Comment	Who
1. Clarification of state level priority areas	Consideration of state level strategies and identification of broad-scale priority areas	Desktop review of strategy document by Natural Decisions
2. Identification of finer scale geographic priorities and 'first cut' of actions and costs	Consideration of AG funding requirements and quantum, local knowledge and current context (e.g. bushfire impacts)	State level experts (DPIE NSW and QDES)
3. Review of findings at Step 2	A number of adjusted/alternative priority areas were identified as well as different mixes of actions/costs	Regional NRM groups to provide input if feasible
4. Discuss results at Workshop #2	Use findings to confirm scope of alternative scenarios to assess for benefits and costs with INFFER	Project group

Conclusions

The most cost-effective investment to protect koala habitat has been assessed to be in the Belmore River ARK in NSW and the Flinders Peak area in south-east Queensland. This will achieve the greatest impact in protecting functional areas of koala habitat. However, if the Australian Government prefers to invest in more than one area, then investment in Coffs Harbour - North Bellingen and Port Macquarie in NSW and North Pine, Grantchester and Lake Manchester in south east Queensland could be contemplated. INFFER provided a useful and structured way to make transparent decisions about investing available funding.

APPENDIX 1: Overview of INFFER

INFFER is a framework (based on benefit: cost analysis principles) for developing and prioritising projects to address environmental issues such as reduced water quality, biodiversity conservation, environmental pests and land degradation. It is designed to help environmental managers achieve the most valuable environmental outcomes with the available resources.

INFFER is an integrated framework which incorporates the important factors (including asset value) needed to make environmental decisions based on benefits and costs. It has been used extensively in Australia on terrestrial, aquatic and marine assets at large and small scales. Importantly INFFER can also be used as a defensible basis in prioritising between assets of different types, and to assess the cost-effectiveness of different options/scenarios for protection of specific assets within the context of limited environmental budgets. INFFER has been used extensively across Australia and overseas for investment analysis and to develop business cases for funding into protecting assets as diverse as rivers, threatened species and communities, woodland birds, Ramsar sites and the Great Barrier Reef.

For further information on INFFER see www.inffer.com.au

The INFFER Process

INFFER is a participatory and collaborative process, involving technical and scientific specialists, policy makers, NRM Managers and people with local knowledge and experience. This process draws together readily available information, from a desktop review of publications and reports, and consultation with the community and with relevant experts.

The stakeholder workshops (4-5 hours duration) will have a clearly structured agenda and be supported by the provision of pre-reading materials for participants.

Workshop #1 (November 21st 2019) is designed to draw together information that is essential to the INFFER analysis. This includes information on: asset significance, threats, project goal, works and actions, time lags, effectiveness of works, risk factors (practice change, technical feasibility, socio-politics, long-term funding), spin-offs, quality of information and key information gaps. At this workshop we will identify a preliminary set of scenarios (maximum 6) to be assessed in terms of their relative benefits and costs[15].

Following the workshop the INFFER assessment will be undertaken by integrating information collected at the workshop and from relevant background documents. Key information areas and gaps will be addressed through consultation (phone/email) with relevant experts. The draft INFFER assessment, including preliminary scenario results will be made available for circulation to key stakeholders in advance of Workshop #2.

Workshop #2 (February 5th 2020) was designed to present and discuss the preliminary results of the analysis. This will include:

- Testing the key assumptions that have been used to underpin the analysis.
- Identify which scenarios appear to be most promising for project implementation.
- Confirm any remaining knowledge gaps and strategies that will be required to address them.

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[15] Typically these scenarios will be compared with a 'kitchen sink' option that involves all actions at all sites and will have the highest cost.

- Ensuring the project delivery mechanisms are consistent with the Public: Private Benefits Framework.

Following Workshop #2 the final INFFER Report will be developed and provided to the Australian Government for review and feedback, including from relevant stakeholders, prior to final revisions being made.
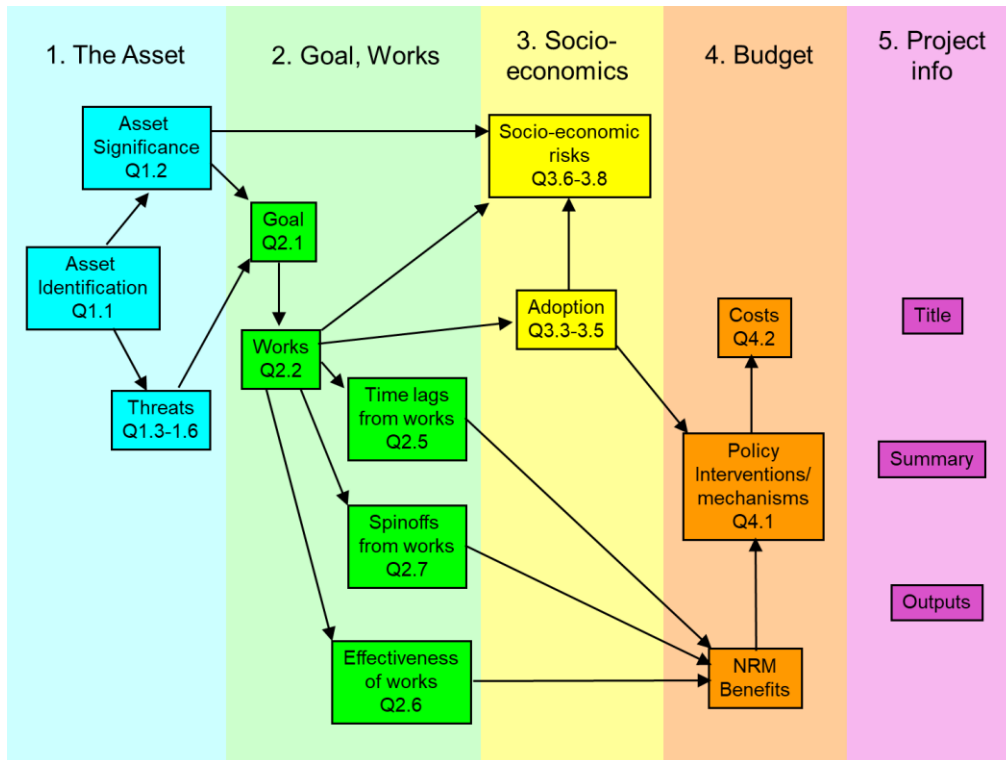
Figure A1: INFFER Logic and information requirements

A key output of the INFFER analysis will be calculation of a Benefit:Cost Ratio (BCR) for each scenario assessed. Initially this was calculated for the 'kitchen sink' option and then for an agreed range of alternative scenarios. The equation for the BCR is shown below.

$$\text{BCR} = \frac{V \; x \; W \; x \; A \; x \; B \; x \; F \; x \; G \; x \; DF \; x \; 20}{C + PV \; (M + E) x \; G}$$

The variables that feed into calculation of the Benefit: Cost Ratio (Pannell, 2012) are mostly specified as proportions, and are included in the Index multiplicatively. They are described below in Table 1.

Table A1: Overview of INFFER information requirements used to estimate Benefit: Cost ratios of scenarios.

Parameter value	Description	Comment
V	Value of the asset	The ecological, economic and social value of the asset using the INFFER Asset scoring system (See Background Paper for further details).
W	Impact of works	The overall impact (effectiveness) of works expressed as a proportional change in asset value, with and without projects works and actions.
F	Technical feasibility risk	The probability that the benefits aren't realised due to technical factors.
A	Likelihood of adoption	The probability that works and actions on private land and/or relevant to behavioural change by private citizens will be adopted.
B	Likelihood of adverse adoption	The probability that actions will be undertaken by landholders and/or private citizens (over and above current practice) that lead to environmental damage.
P	Socio-political risk	The probability that the benefits aren't realised due to administrative, institutional or political factors.
G	Long-term funding risk	The probability that long-term funding required for ongoing maintenance actions is not made available.
DFB	Discount factor function for benefits, which depends on L	A 5% discount rate has been used.
L	Lag until benefits occur (years)	The minimum length of time (in years) for the majority of benefits to be realised.
C	Short-term cost of project	The initial up-front costs required for project implementation
PV	Present value function	Applied to both maintenance and compliance costs.
M	Maintenance costs	Annual cost of maintaining outcomes from the project in the longer term.
E	Compliance costs	Cost to private citizens, if the project involves enforcement of regulations.

Assessment of selected INFFER Risk factors

Technical Feasibility (F)

Think about the proposed works and actions … What is the likelihood the impact of works (W) you have predicted wont be realised due to technical issues?

- 0-10% Very low risk of project failure due to poor technical feasibility. (F = 0.9)
- 10-20% Low risk (F = 0.8)
- 20-40% (F = 0.7)
- 40-60% (F = 0.5)
- 60-100% High risk of long-term project failure due to poor technical feasibility. (F = 0.2), Or custom value for probability of technical failure: %

Adoption (A)

Think about the proposed works and actions that need to be undertaken by landholders and/or private citizens... What is the likelihood (% uptake) that these actions will be adopted to achieve the impact of works (W) predicted?

Socio-political risk

Estimate the risk that the project will fail to achieve its goal(s) due to one or more of the following factors: Non-cooperation by other organisations responsible for natural resource management, social, administrative or political constraints.

- 0-5% Very low risk of project failure for either of the specified reasons.(P = 0.97)
- 6-25% (P = 0.85)
- 26-50% (P = 0.62)
- 51-75% (P = 0.37)
- 76-100% Very high risk of long-term project failure for either of the specified reasons. (P = 0.12), or enter custom value if required

APPENDIX 2: Assessment of BCR factors (from Workshop #1)

Table A2.1: Summary of key information and ratings related to BCR factors captured at Workshop #1

Works and actions	Extent to which the works and actions will deal with the threat - effectiveness (H,M,L)[16]	Time lag (years)	Who is responsible for implementation?	Technical feasibility (VH,H,M,L, VL)	Is ongoing maintenance likely to be required? (Yes/No)	What is the likely adoption by private landholders/citizens (if applicable)?[17] (H,S,N,SN,HN)	Socio-political risks (H,M,L)	Which threats does this action address?	Comment (e.g. regional differences etc.)
Covenanting	High	1	Private landholders	N/A	No	SN-HN	L	Direct habitat loss/clearing Fragmentation	Who is responsible for covenanting?
Voluntary management agreements	Medium	1	Private landholders	N/A	Yes	N	L	Direct habitat loss/clearing Fragmentation	Project could influence acquisitions priorities and potentially fund acquisitions)
Land acquisition	High	1	Public land manager	N/A	Yes	HN	L-H	Direct habitat loss/clearing Fragmentation	Time lag may be longer if process is complex. Is acquisition always voluntary?
Revegetation	High	10-15	Private landholders/public land managers	H	Yes	N-SN	L	Fragmentation	Effectiveness is dependent on scale and on-going management
Natural regeneration	Medium-High	10	As above	M-H	Yes	N-SN	L	Fragmentation Degradation of existing habitat	
Weed management	Medium-High	5-10	As above	M-H	Yes	N-SN	L	Degradation of existing habitat	On-going maintenance required
Sustainable grazing	Medium	5-10	Private landholders	M	Yes	N-SN	L	Degradation of existing habitat	
Ecological burning	Medium-High	1-5	Private landholders/public land managers	M	Yes	N-SN	L-H	Degradation of existing habitat Wildfire	Small scale in NSW cf. Qld
Cultural burning	Medium-High	1-5	As above	M	Yes	N-SN	L-H	Degradation of existing habitat Wildfire	Small scale in NSW cf. Qld
Firebreaks	High	1	As above	H	Yes	N	L-H	Degradation of existing habitat Wildfire	Targeted to high value sites/refugia
Restoration (shelter and habitat trees) and protection of priority refugia	Medium-High	5-10	As above	M-H	Yes	N-SN	L-H	Drought/Heat Stress	Can be linked to firebreaks, cultural and ecological burning

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[16] This relates to the level of benefits expected to be generated by the specified works. It requires knowledge of the cause-and-effect relationships between actions and outcomes. What is the likely reduction in overall damage to the asset over the next 20 years resulting from the proposed works and actions (the works and actions that were outlined above? "Damage" means loss of overall asset value. Damage is measured relative to the benchmark asset condition. Discussion on this question will be a key focus of Workshop #1.

[17] Without financial incentives/payments – level of financial assistance required to promote adoption will need to be specified when costing this action.

APPENDIX 3: Summary of key prioritisation attributes of NSW ARKS

Table A3.1: NSW ARKS characterisation

| ARK Name | Total area (ha)[18] | Resilience class | Threats | | | Security | Priority | 2019 Fire impact |
			Habitat Fragmentation Risk	Wildfire Risk	Heat Stress/Climate change Risk			
NORTH COAST								
Banyabba	141,774 (43%)	MODERATE	High	Moderate	High/High	LOW	NO	>50%
Tweed Ranges	32,043 (36%)	MODERATE	Moderate	Low	Moderate/Moderate	MODERATE	YES	Nil
Far north-east Hinterland	339,862 (40%)	MODERATE	Moderate	Moderate	Moderate/Moderate	MODERATE	YES	<10%
Far north-east	20,827 (28%)	LOW	Moderate	Low	Moderate/Low	MODERATE	NO	Nil
Broadwater	13,913 (46%)	MODERATE	Low	Low	Low/Low	MODERATE	NO	Nil
Woodenbong	175,702(61%)	MODERATE	Moderate	High	High/Moderate	MODERATE	NO	<10%
Mt Pikapene	93,196 (39%)	MODERATE	High	High	High/High	MODERATE	NO	25-50%
North Grafton	59,755 (29%)	LOW	High	Moderate	High/High	MODERATE	NO	Nil
Southern Clarence	63,164 (25%)	LOW	High	High	High/High	MODERATE	YES	10-25%
Gibraltar Range	9,206 (100%)	HIGH	Low	Moderate	Moderate/Moderate	HIGH	NO	10-25%
Clouds Creek	115,417 (92%)	HIGH	Moderate	Moderate	Low/Moderate	MODERATE	NO	>50%
Coffs Harbour - North Bellingen	190,531 (64%)	MODERATE	High	Moderate	Moderate/Moderate	MODERATE	YES	10-25%
North Macleay - Nambucca	242,233 (57%)	MODERATE	High	Moderate	Moderate/Moderate	MODERATE	YES	10-25%
Belmore River	48,02768%	MODERATE	Moderate	Moderate	Low/Moderate	LOW	YES	Nil
Wilson River	112,43265%	MODERATE	High	Moderate	Moderate/Moderate	MODERATE	YES	25-50%
Port Macquarie	25,14051%	MODERATE	High	Moderate	Low/Low	MODERATE	YES	25-50%
Comboyne	220,55464%	MODERATE	High	Moderate	Moderate/Moderate	MODERATE	YES	25-50%
Crowdy Bay	17,49470%	HIGH	Moderate	Moderate	Moderate/Low	HIGH	NO	>50%
NORTHERN TABLELANDS								
Nowendoc	*42,505 (69%)*	*MODERATE*	*Moderate*	*High*	*Moderate/Low*	*MODERATE*	*YES – NT LLS*	*<10%*
Armidale	70,509 (17%)	LOW	High	Moderate	Low/Low	LOW	YES	Nil
Inverell	*35,407 (5%)*	*LOW*	*Moderate*	*Moderate*	*Very High/Moderate*	*LOW*	*YES – NT LLS*	*Nil*
Severn River NR	12,102 (89%)	HIGH	Moderate	Very High	High/Moderate	HIGH	NO	Nil
Kwiambal NP	5,703 (47%)	MODERATE	Low	Very High	Very High/Very High	MODERATE	NO	Nil
Girard – Ewingar	34,110 (84%)	HIGH	Moderate	High	Moderate/Low	MODERATE	NO	Nil

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[18] Figure in brackets is the % of the area that is estimated to have high or moderate functional habitat

APPENDIX 4: Initial ARKS prioritisation

The results are shown in Table A4.1 with the following comments and observations:

- The mix and quantity of works and actions for each priority area is based on what is believed will be required to make a significant difference to the major threats that were agreed as requiring actions through this project[19].
- The preliminary costs were estimated by DPIE using a series of assumptions (these were subsequently modified and adjusted at Workshop #2). It is important to note that the most significant cost related to covenanting ($10,000/ha) where the aim was to secure permanent on-title agreements in conjunction with agreed management actions (habitat enhancement, weed management, ecological burning and grazing management) where a stewardship payment was provided. This approach (and estimated payment levels required to secure participation) is based on previous experience with the delivery of conservation tenders through the NSW Biodiversity Conservation Trust. Note that the initial cost estimates for works and actions were subject to scrutiny at Workshop #2 and adjusted (See Table 5).
- There are significant differences between the ARKS in land tenure; these are captured in the comments column of Table A4.1.

The estimated budgets for the ARKS range from ~ $1.5M (Port Macquarie) to ~$29M (Coffs Harbour-Bellingen and North Macleay-Nambucca). Clearly these figures are well beyond the available funding, highlighting the need to undertake further prioritisation of both interventions and areas.

Table A4.1: Priority ARKS – Works, actions and costs

ARKS	Direct works and actions	Up-front costs ($ over 3 years)	Maintenance cost ($/year)	Supporting actions	Up-front costs ($ over 3 years)	Maintenance cost ($/year)	Total up-front costs $ over 3 years Direct + supporting (total)	Total maintenance cost ($/year)	Comments (provided by Mike Roache/John Turbill)
4. Belmore River	Covenanting (500 ha) Ecological burning (500 ha) Revegetation (500 ha) Voluntary management agreements (1500 ha) Sustainable grazing (100 km)	$5,000,000 $250,000 $250,000 $150,000 $100,000	Nil Nil $50,000 Nil Nil	Planning - (20) Monitoring – survey (10) Community engagement/education (4)	$50,000 $50,000 $8,000	Nil Nil Nil	$5,750,000 + 108,000 **($5,858,000)**	$50,000	~13,000 ha is National Park or State Forest with ~ 35,000 ha private, ~20-30% of which is cleared. ~20,000ha habitat on private land. Aim to better protect and conserve at least an additional ~10% of this, or about 2,000 ha in priority locations.
9. Coffs Harbour - North Bellingen	Covenanting (2500 ha) Ecological burning (2500 ha) Revegetation (2500 ha) Voluntary management agreements (7500 ha) Sustainable grazing (500 km)	$25,000,000 $1,250,000 $1,250,000 $750,000 $500,000	Nil Nil $250,000 Nil Nil	Planning - (100) Monitoring – survey (50) Community engagement/education (20)	$250,000 $250,000 $40,000	Nil Nil Nil	$28,750,000 + 540,000 **($29,290,000)**	$250,000	~190,000 ha ARKS. ~20% burned in 2019 fires ~50% NP or State Forest ~95,000 ha private land ~95,000ha habitat on private land. Aim to better protect and conserve at least an additional ~10% of this, or about 10,000 ha in priority locations.
35. Port Macquarie	Covenanting (100 ha) Ecological burning (300 ha) Revegetation (500 ha) Voluntary management agreements (500 ha) Sustainable grazing (25km)	$1,000,000 $150,000 $250,000 $50,000 $25,000	Nil Nil $50,000 Nil Nil	Planning - (5) Monitoring – survey (10) Community engagement/education (10)	$12,500 $50,000 $20,000	Nil Nil Nil	$1,475,000 + 82,500 **($1,557,500)**	Nil	~35-40% NP or State Forest, ~ 15,000 ha is private or urbanised. Most hubs are mapped in urban and peri-urban areas, and Camden Haven. Urgent action is to establish how many koalas left post-fire and help them persist and breed. Hubs on private land now likely to have a higher significance as a source population for the ARKS. Urgent requirement for vehicle strike mitigation and dog attack mitigation.
1. Armidale	Covenanting (200 ha) Sustainable grazing (100 ha) Restoration (shelter and habitat trees) and protection of priority refugia (1000 ha) Voluntary management agreements (500 ha) Voluntary management agreements (50 water drinkers)	$2,000,000 $100,000 $2,500,000 $50,000 $50,000	Nil Nil Nil Nil Nil	Planning - (20) Monitoring – survey (10) Community engagement/education (4)	$50,000 $50,000 $8,000	Nil Nil Nil	$4,700,000 + 108,000 **($4,808,000)**	Nil	The areas targeted surrounding and north of Armidale have an emerging koala population which requires management and targeted actions to secure viability. SOS projects in the area have provided valuable radio tracking data on koala habitat usage and habitat distribution and linkages. Proposed actions would tie in with Armidale Regional council's proposal to commence a Koala Management Strategy. Habitat restoration will rely on the drought breaking.
43. Wilson River	Covenanting (500 ha) Ecological burning (1000 ha) Revegetation (1000 ha) Voluntary management agreements (1500 ha) Sustainable grazing (100 km)	$5,000,000 $500,000 $500,000 $150,000 $100,000	Nil Nil $100,000 Nil Nil	Planning - investigations (10) Monitoring – survey (8) Community engagement/education (5)	$25,000 $40,000 $10,000	Nil Nil Nil	$6,250,000 + 75,000 **($6,325,000)**	$100,000	~112,000 ha ARKS. ~40% NP and State Forest ~60,000 ha on private land. Highly fragmented. ~50-60% cleared. Might only focus conservation on ~20,000ha. Aim to better protect and conserve at least an additional ~10% of this, or about 2,000 ha in priority locations.

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[19] Dog attack and vehicle strike are not included as agreed at Workshop #1.

ARKS	Actions	Cost	Cost	Actions	Cost	Cost	Up-front cost	Maintenance	Description
48. Tweed Ranges	Covenanting (250 ha) Ecological burning (500 ha) Revegetation (500 ha) Voluntary management agreements (750 ha) Sustainable grazing (50 km)	$2,500,000 $250,000 $250,000 $75,000 $50,000	Nil Nil $50,000 Nil Nil	Planning - (5) Monitoring – survey (4) Community engagement/education (2)	$12,500 $20,000 $4,000	Nil Nil Nil	$3,125,000 + $36,500 ($3,161,500)	$50,000	~32,000 ha ARKS. ~30% NP and State Forest ~20,000 ha on private land. Highly fragmented. ~50-60% cleared. Might only focus conservation on ~10,000ha. Aim to better protect and conserve at least an additional ~10% of this, or about 1,000 ha in priority locations.
13. Far north-east Hinterland	Covenanting (800 ha) Weed management (1500 ha) Revegetation (1000 ha) Voluntary management agreements (3000 ha) Sustainable grazing (100 km)	$8,000,000 $3,750,000 $500,000 $300,000 $200,000	Nil Nil $100,000 Nil Nil	Planning - (40) Monitoring – survey (20) Community engagement/education (8)	$100,000 $100,000 $16,000	Nil Nil Nil	$12,750,000 + $216,000 ($12,966,000)	100,000	SE Lismore to Wardell Focus area: known moderate to high density population estimated to be >2000 koalas, includes a number of mapped koala Hubs. Community capacity estimated moderate. Proposed actions likely to have moderate to high outcomes. West Byron: known moderate density and widespread population, includes a number of mapped pop hubs, landholder capacity likely moderate, weed issues mostly Camphor Laurel / lantana. Proposed actions likely to have moderate to high outcomes.
39. Southern Clarence	Covenanting (250 ha) Ecological burning (500 ha) Revegetation (500 ha) Voluntary management agreements (750 ha) Sustainable grazing (50km)	$2,500,000 $250,000 $250,000 $75,000 $50,000	Nil Nil $50,000 Nil Nil	Planning - (10) Monitoring – survey (6) Community engagement/education (4)	$25,000 $30,000 $8,000	Nil Nil Nil	$3,125,000 + $63,000 ($3,188,000)	$50,000	~63,000 ha ARKS. Main koala population is west of Grafton on small rural residential blocks - Waterview Heights area ~90 % private land, highly fragmented. Low fertility landscape. Low density population. Might only focus conservation on ~10,000ha in the Waterview Heights areas. Aim to better protect and conserve at least an additional ~10% of this, or about 1,000 ha in priority locations.
10. Comboyne	Covenanting (1000 ha) Ecological burning (2000 ha) Revegetation (2000 ha) Voluntary management agreements (3000 ha) Sustainable grazing (200 km)	$10,000,000 $1,000,000 $1,000,000 $300,000 $200,000	Nil Nil $200,000 Nil Nil	Planning - (20) Monitoring – survey (15) Community engagement/education (10)	$50,000 $75,000 $20,000	Nil Nil Nil	$12,500,000 + $145,000 ($12,645,000)	$200,000	~220,000 ha ARKS ~50% NP and State Forest ~100,000 ha on private land. Highly fragmented. ~50-60% cleared. Might only focus conservation on ~40,000ha. Aim to better protect and conserve at least an additional ~10% of this, or about 4,000 ha in priority locations.
30. North Macleay - Nambucca	Covenanting (2500 ha) Ecological burning (2500 ha) Revegetation (2500 ha) Voluntary management agreements (7500 ha) Sustainable grazing (500 km)	$25,000,000 $1,250,000 $1,250,000 $750,000 $500,000	Nil Nil $250,000 Nil Nil	Planning - including studies/investigations (100) Monitoring – survey (50) Community engagement/education (20)	$250,000 $250,000 $40,000	Nil Nil Nil	$28,750,000 + $540,000 ($29,290,000)	$250,000	~240,000 ha ARKS ~15% NP or State Forest ~200,000 ha private land ~ half of this cleared ~100,000ha habitat on private land. Aim to better protect and conserve at least an additional ~10% of this, or about 10,000 ha in priority locations.

Note 1: Planning involves Landholder Management Plans to identify targeted actions **Note 2:** Maintenance costs we believe will need greater consideration.

Table A4.2: Preliminary BCR results based on ideal mix and quantity of actions for initial 10 priority ARKS identified by NSW DPIE

INFFER Benefit: Cost Ratio calculator v21	Description of scenario	Value (V)	Impact of works# (W)	Technical feasibility# (F)	Adoption# (A)	Adverse adoption# (B)	Socio-political risks# (P)	Long-term funding risk (G)	Lag until benefits occur (L)	Up-front cost, total over N years (C $ million)	Maintenance cost (M $ million /year)	Benefit: Cost Ratio	Ranking
4. Belmore River		3.5	0.4	1	1	1	1	1	10	5.858	0.05	2.9	4
9. Coffs Harbour - North Bellingen		7	0.4	1	1	1	1	1	10	29.290	0.25	1.2	9
35. Port Macquarie		3	0.4	1	1	1	1	1	10	1.557	0	10.4	1
1. Armidale		2.5	0.4	1	1	1	1	1	10	4.808	0	2.8	5
43. Wilson River	All works and actions to address identified threats across the ARK	4.5	0.4	1	1	1	1	1	10	6.325	0.1	3.2	3
48. Tweed Ranges		1.2	0.4	1	1	1	1	1	10	3.161	0.05	1.7	8
13. Far north-east Hinterland		10	0.4	1	1	1	1	1	10	12.966	0.1	3.8	2
39. Southern Clarence		1.8	0.4	1	1	1	1	1	10	3.188	0.05	2.6	6
10. Comboyne		6	0.4	1	1	1	1	1	10	12.645	0.2	2.1	7

| 30. North Macleay - Nambucca | | 5.5 | 0.4 | 1 | 1 | 1 | 1 | 1 | 10 | 29.290 | 0.25 | 0.9 | 10 |

Appendix 5: Summary of current mechanisms and initiatives aimed at Koala conservation in NSW (From NSW Koala Strategy)

Mechanism/Initiative	Description	Comment
Creating new reserves for koalas	The NSW Government has committed $20 million to purchase land with prime koala habitat that can be permanently reserved as national parks. Over 4000 hectares of native forest with koala habitat will be transferred to the national parks estate including on the Mid North Coast. This land will be actively managed to ensure prime habitat is conserved, key habitat corridors are linked and to provide safe homes for koalas being returned to the wild.	These areas (and existing reserves) within the priority areas identified in this report may serve as useful starting point for targeting of works and actions with private landholders.
Koala habitat will also be protected on other types of public land, for example on crown land and travelling stock reserves.	Agencies will work together to develop a process for assessing the koala habitat values on government land. This will help inform if the land should be permanently reserved or have protections in place.	Check status of this work in relation to the priority ARKS
The NSW Biodiversity Conservation Trust will invest funds to help interested landholders protect and manage koala habitat on their land through targeted koala habitat tenders.	NSW BCT working with eligible landholders to maximise their options for diversifying income while protecting koala habitat on their land – for example, through annual management payments or grants.	The NSW BCT has conducted tenders in the Lismore-Ballina and Port Macquarie areas. As a result 255 ha have been secured in conservation agreements across 10 sites.
The NSW Government will partner and work with local communities who already have information, knowledge and a network of people on the ground working to protect koala populations.	Local workshops that bring together community groups, local councils, landholders, government agencies, Local Aboriginal Land Councils and koala experts to identify and agree on local actions for key koala populations across the State.	Identify opportunities to conduct workshops in priority ARKS.
NSW Saving our Species investment to secure the koala in the wild.	Local actions funded by the Government and undertaken in partnership with local communities and businesses will target threats specific to the local koala population.	Coordinate implementation of investment through this with project with NSW SOS projects in priority ARKSD.
Establish a koala and wildlife hospital network	Partnerships with fauna rehabilitators, koala experts and local communities to identify needs.	Establish how existing and proposed wildlife rescue network and facilities can support actions in priority ARKS.
Targeted research and Knowledge building	Research to better understand the impacts of diseases such as chlamydia on koala populations and to identify the best ways to reduce the impact. Development by OEH of a state-wide information base about	Understand the extent to which diseases such as Chlamydia are a risk to koalas in identified priority ARKS. ARKS information/data has been a crucial input to this INFFER analysis.

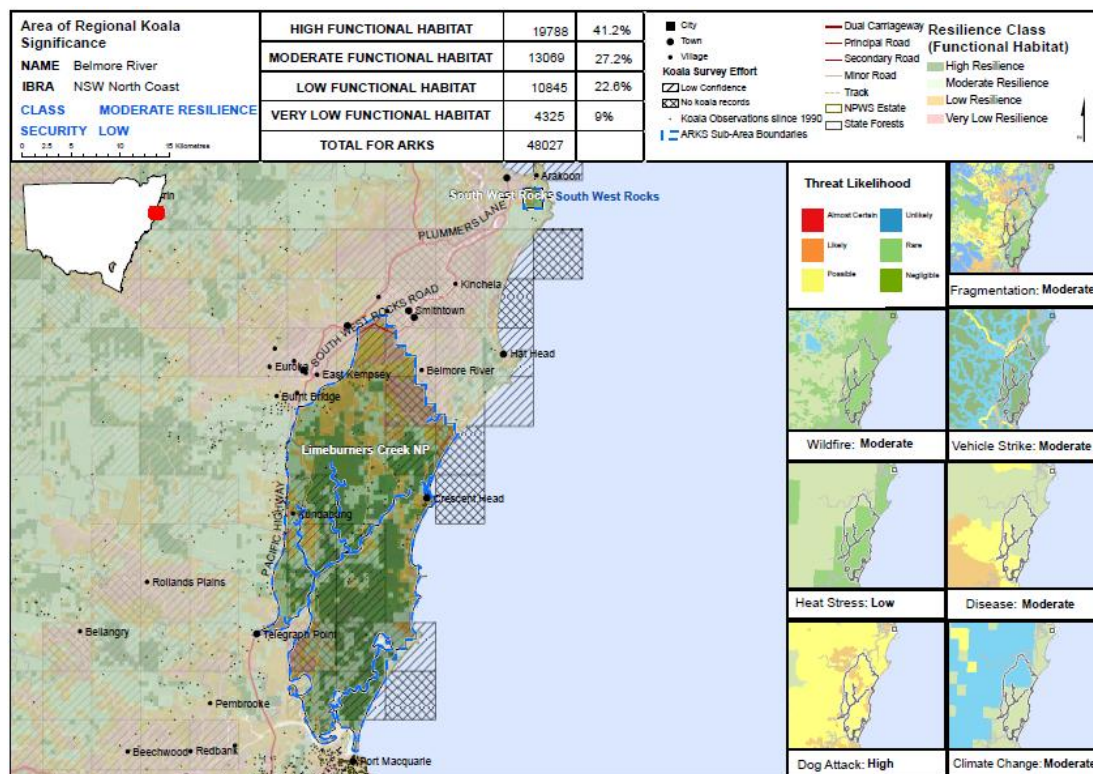|	koala habitat and koala population distribution in New South Wales.	
Fix vehicle strike hotspots	Committed $3.3 million in funding to fix priority hotspots where koalas are struck by cars across New South Wales.	Investigate extent of overlap with priority ARKS for potential collateral benefits.
Monitoring	The Office of Environment and Heritage is developing a state-wide monitoring program in partnership with other agencies to monitor koala populations and their habitat, and measure the effect of the actions in the Strategy.	Ensure there is a coherent link between Australian Government MERI requirements and NSW monitoring protocols and methodologies.

Appendix 6: High priority ARKS Maps

Area of Regional Koala Significance				City / Town / Village		
NAME Belmore River	HIGH FUNCTIONAL HABITAT	19788	41.2%			
IBRA NSW North Coast	MODERATE FUNCTIONAL HABITAT	13069	27.2%			
CLASS MODERATE RESILIENCE	LOW FUNCTIONAL HABITAT	10845	22.6%			
SECURITY LOW	VERY LOW FUNCTIONAL HABITAT	4325	9%			
	TOTAL FOR ARKS	48027				

Threat Likelihood: Fragmentation: Moderate; Wildfire: Moderate; Vehicle Strike: Moderate; Heat Stress: Low; Disease: Moderate; Dog Attack: High; Climate Change: Moderate

Figure 2: Belmore River

Area of Regional Koala Significance				City / Town / Village		
NAME Coffs Harbour - North Bellingen	HIGH FUNCTIONAL HABITAT	42337	22.2%			
IBRA NSW North Coast	MODERATE FUNCTIONAL HABITAT	78755	41.3%			
CLASS MODERATE RESILIENCE	LOW FUNCTIONAL HABITAT	57633	30.2%			
SECURITY MODERATE	VERY LOW FUNCTIONAL HABITAT	11806	6.2%			
	TOTAL FOR ARKS	190531				

Threat Likelihood: Fragmentation: High; Wildfire: Moderate; Vehicle Strike: Moderate; Heat Stress: Moderate; Disease: Moderate; Dog Attack: High; Climate Change: Moderate
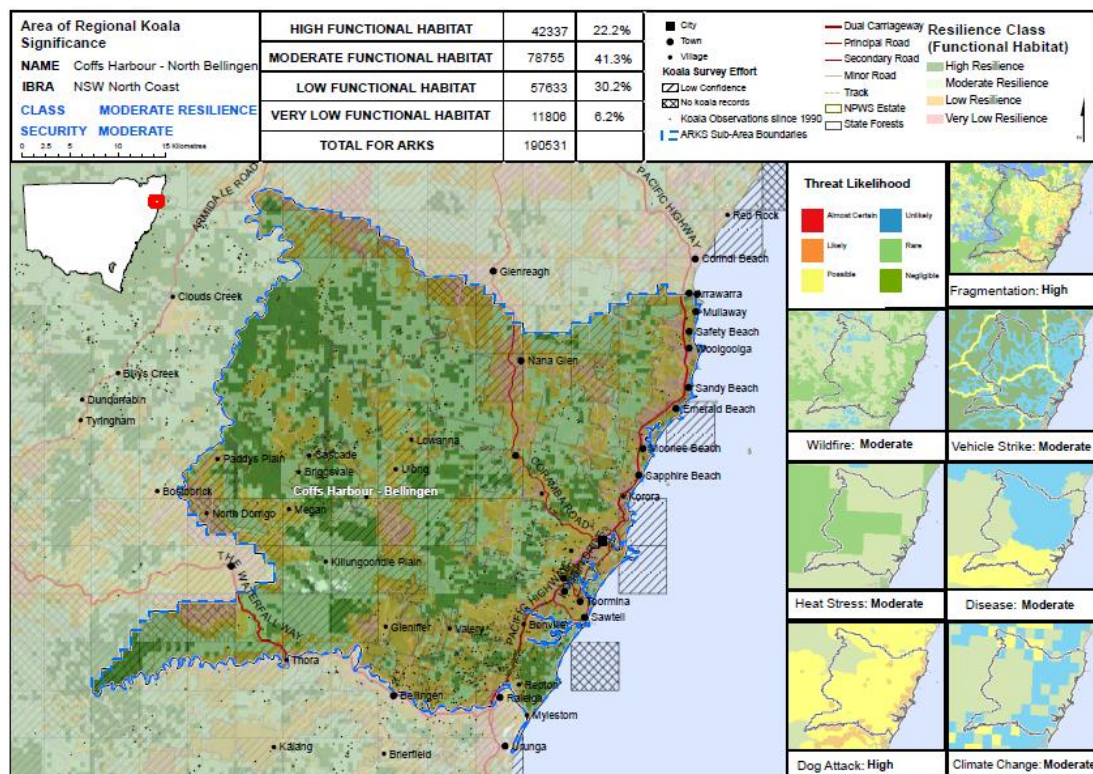
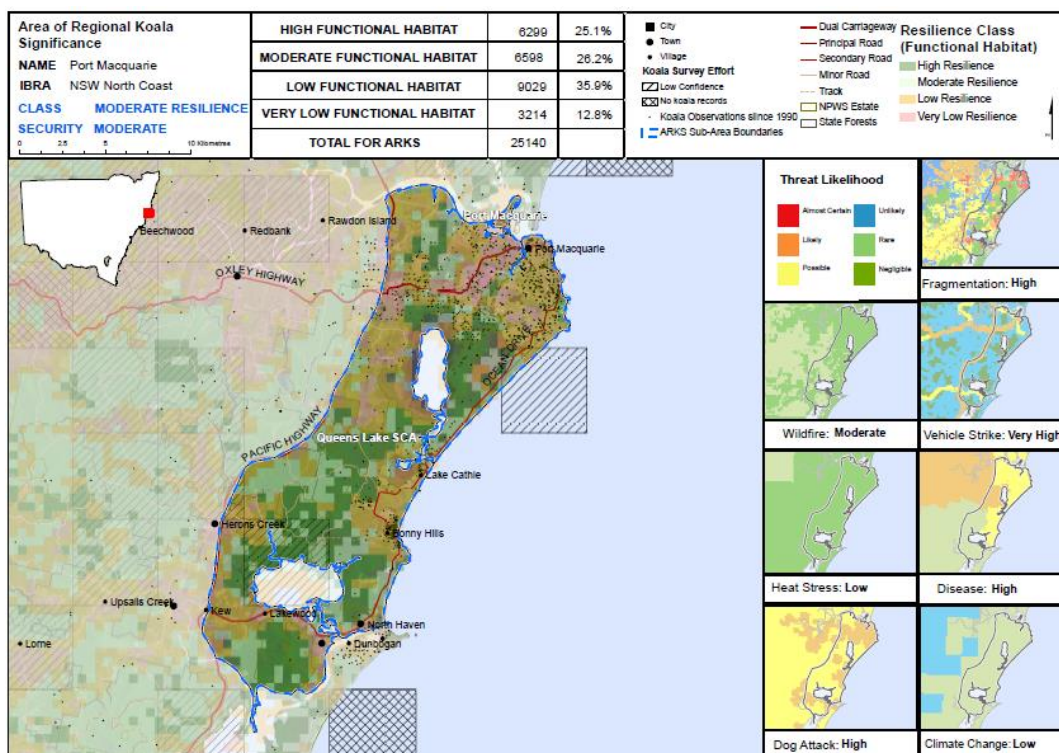**Figure 3: Coffs Harbour-North Bellingen**

Figure 4: Port Macquarie

Figure 5: Belmore River ARKS with Hubs identified (red polygons)

Appendix 7: Results of ranking all 25 ARKS within both LLS regions – please note that this requires validation by DPIE and LLS

ARK Name	Value	W Value	Time lags (yrs)	Discount Factor	F Value	A Value	P Value	Total up-front cost (over 4 years)	Annual maintenance after 5 years	PV (Maintenance cost after 4 years)	BCR	Priority	Comments
Belmore River	3.5	0.20	10	0.61	0.87	0.7	0.97	$ 3,000,000	$150,000	$1,605,000	1.10	1	Good opportunity to secure a small ARKS with lots of private land
Coffs Harbour - North Bellingen	7	0.05	10	0.61	0.87	0.7	0.97	$ 3,000,000	$150,000	$1,605,000	0.55	2	Lower threats, good habitat value
Port Macquarie	3	0.10	10	0.61	0.87	0.7	0.97	$ 3,000,000	$150,000	$1,605,000	0.47	3	Will be lower once current status is included
Armidale	2.5	0.20	10	0.61	0.87	0.2	0.97	$ 3,000,000	$150,000	$1,605,000	0.23	7	Lower value area, potential for greater impact
Wilson River	4.5	0.07	10	0.61	0.87	0.5	0.97	$ 3,000,000	$150,000	$1,605,000	0.35	5	Medium-size
Tweed Ranges	1.2	0.15	10	0.61	0.87	1	0.97	$ 3,000,000	$150,000	$1,605,000	0.41	4	Small area, few koalas
Far north-east Hinterland	10	0.01	10	0.61	0.87	1	0.97	$ 3,000,000	$150,000	$1,605,000	0.23	8	Very large area
Southern Clarence	1.8	0.07	10	0.61	0.87	0.3	0.97	$ 3,000,000	$150,000	$1,605,000	0.09	12	Low density of koalas, little functional habitat
Comboyne	6	0.01	10	0.61	0.87	0.5	0.97	$ 3,000,000	$150,000	$1,605,000	0.07	13	Very large area
North Macleay - Nambucca	5.5	0.01	10	0.61	0.87	0.7	0.97	$ 3,000,000	$150,000	$1,605,000	0.09	11	Very large area
Inverell	3.5	0.2	10	0.61	0.87	0.2	0.97	$ 3,000,000	$150,000	$1,605,000	0.32	6	
Nowendoc	2	0.15	10	0.61	0.87	0.3	0.97	$ 3,000,000	$150,000	$1,605,000	0.20	9	
Tenterfield	2	0.15	10	0.61	0.87	0.3	0.97	$ 3,000,000	$150,000	$1,605,000	0.20	9	
LOWER PRIORITY ARKS													
Banyabba	2	0.07	10	0.61	0.87	0.5	0.97	$ 3,000,000	$150,000	$1,605,000	0.16		The local area around southern Ashby retains important koala hubs. Most of this ARKS was burned in recent fires (73%).
Far north-east	1.5	0.1	10	0.61	0.87	1	0.97	$ 3,000,000	$150,000	$1,605,000	0.34		Low resilience, high risk from development pressure and population growth and associated impacts on koalas. Better to focus on west of the highway in this region.
Broadwater	1	0.1	10	0.61	0.87	0.4	0.97	$ 3,000,000	$150,000	$1,605,000	0.09		Low resilience, high risk from development pressure and population growth and associated impacts on koalas. Better to focus on west of the highway in this region. Some fire impacts.
Woodenbong	3	0.05	10	0.61	0.87	0.7	0.97	$ 3,000,000	$150,000	$1,605,000	0.24		Possible. Poor knowledge of koalas, capacity, and potential for private land engagement.
Mt Pikapene	1	0.15	10	0.61	0.87	0.3	0.97	$ 3,000,000	$150,000	$1,605,000	0.10		Heavily cleared private land – knowledge gap on koalas, capacity and potential for private land engagement. 40% fire impact.
North Grafton	1	0.1	10	0.61	0.87	0.5	0.97	$ 3,000,000	$150,000	$1,605,000	0.11		Little known – possibly an emerging population. Unknown local capacity and potential for private land engagement. Fire impacts
Gibraltar Range	0.3	0.2	10	0.61	0.87		0.97	$ 3,000,000	$150,000	$1,605,000	0.00		Tiny area, half burnt. Mostly national park.
Clouds Creek	5	0.07	10	0.61	0.87	0.6	0.97	$ 3,000,000	$150,000	$1,605,000	0.47		Mostly state forest and national park – 86% burnt.
Crowdy Bay	1	0.15	10	0.61	0.87	0.5	0.97	$ 3,000,000	$150,000	$1,605,000	0.17		Heavy fire impacts. Mostly National Park.
Girard – Ewingar	0.5	0.2	10	0.61	0.87	0.3	0.97	$ 3,000,000	$150,000	$1,605,000	0.07		Tiny area. Mostly State Forest
Severn River NR	0.3	0.2	10	0.61	0.87		0.97	$ 3,000,000	$150,000	$1,605,000	0.00		Tiny area. Largely reserved.
Kwiambal NP	0.1	0.2	10	0.61	0.87		0.97	$ 3,000,000	$150,000	$1,605,000	0.00		Tiny area. Largely reserved.
Girard – Ewingar			10	0.61	0.87		0.97	$ 3,000,000	$150,000	$1,605,000	0.00		Repeat

Appendix 8: Decision Support for SEQ Koala Habitat Restoration Methodology

This document describes the GIS methodology that was co-developed by HLW (Liz Gould and Shannon Mooney) and QDES (Steven Howell, Catherine George) to assist in the identification of koala priority areas in SEQ.

Initial property filter:
- SEQ Planning Area (Catchment and Council Boundaries), DCDB 2019 = 1,977,881 features
- Removed "TENURE" = ' ' (includes road type parcels, unlinked parcel or inter), i.e., 269,007 features = 1,708,874 features
- Selected "Area_ha" ≥1 = 121,611 features

Scores then applied to properties:

1. **Size of Patch (Score 1-10, Weighting x 1)**
   - Tract Size / Tract Analysis (SEQ NRM Plan NC2 Target)
   - Remnant, 14,744 features
   - Field "Tract_CAT"

Size Class (ha)	Score
Less than 1 (only Brisbane City Council)	
1 – 20	1
20 – 50	2
50 – 100	3
100 – 200	4
200 – 500	5
500 – 1,000	6
1,000 – 5,000	7
5,000 – 10,000	8
10,000 – 20,000	9
Greater than 20,000	10

Data Check, 95% of remnant tracts intersect lots ≥1 ha
Note: Doesn't include non-remnant woody vegetation

2. **Connectivity, Remnant and Protected Area (Score 1-7, Weighting x 2)**
   - Spot vegetation framework – 25 ha neighbourhood analysis
   - Field "CON7x2_CAT"
   - Field "Conn10_CAT" (QTFN)

Vegetation zones (ha)	Score
0 - 2.6	1
2.61 – 6.16	2
6.161 – 10.14	3
10.141 – 14.35	4
14.351 – 18.63	5
18.631 – 22.67	6
22.671 - 25	7

Note: Remnant Vegetation also available.

3. **Ecological Corridors (Score 1-4, Weighting x 2)**
   - Biodiversity Planning Assessment version 4.1 (Q.DES)

- Corridor Buffers South East Queensland
  - Regional
  - State
- Corridor Vegetation South East Queensland
  - State
  - Regional
- Field "COR4x2_CAT"

Corridor Type	Score
Corridor vegetation – Regional	1
Corridor vegetation – State	2
Within Corridor Buffer – Regional (non-remnant)	3
Within Corridor Buffer – State (non-remnant)	4

4. **KPA-R (Score 5, 10, 15 or 20, Weighting x 1)**

A. Within South East Queensland Regional Plan 2017 "Shaping SEQ" (DILGP 2017) boundary:
- Koala Habitat Restoration Areas (KHRA) v 1.0, Field "KHRAx2_CAT"
- Koala Priority Areas (KPA) v 1.0, Field "KPA_CAT"
- Koala Habitat Areas (KHA) v1.0 - Remnant and Regrowth Core Habitat
- Locally Refined Koala Habitat Areas (LRKHA) v1.0
- Field "KHALC_CAT"

B. Within SEQ Management Unit but outside Shaping SEQ boundary:
- HLW Koala habitat remnant

Koala Habitat	Score
Koala Habitat Restoration Areas (KHRA) v 1.0*	10
AND	
Koala Habitat Areas (KHA) v1.0 OR Locally Refined Koala Habitat Areas (LRKHA) v1.0 OR HLW Koala habitat remnant*	5
AND	
AND Koala Priority Areas (KPA) v 1.0*	5

*This score not applied to properties outside Shaping SEQ boundary

5. **Alluvial (Score of 4, Weighting x 1)**
- Presence or absence of Alluvial Floodplains, based on SEQ Detailed Geology
- "DOMINANT_R" IN ('ALLUVIUM', 'COLLUVIUM', 'MISCELLANEOUS UNCONSOLIDATED SEDIMENTS', 'SAND')
- 3,556 features
- Field "ALLUV_CAT"

Summarise Scores (Map Algebra)
Field Calculator, Field "DES_Final"
[TRACT_CAT] + [CON7x2_CAT] + [COR4x2_CAT] + [KHRAx2_CAT] + [KPA_CAT] + [KHALC_CAT] + [ALLUV_CAT]

Files:
Koala_Priority_DCDB_19022020_RPB (Regional Plan Boundary)
116,362 features (intersect)

Koala_Priority_DCDB_19022020_RPBclip.shp
116,047 features

Filters / Adjustments
Removed Islands as for advice from DES
115,883 features

The following islands were excluded from the koala habitat mapping (DES advice):

Island	Exclude	Notes
BRIBIE ISLAND	No	
COOCHIEMUDLO ISLAND	Yes	
GARDEN (TINDAPPAH) ISLAND	Yes	
MACLEAY ISLAND	Yes	
MORETON ISLAND (GNOORGANBIN)	Yes	
NORTH STRADBROKE ISLAND	No	
PEEL ISLAND (TURKROOAR)	Yes	
RUSSELL ISLAND	Yes	
Small island near Sandstone Point, Ningi	No	This island has a very small amount of koala habitat due to accuracy at different scales between the RE mapping and the islands. To remove the sliver would require the area to be cut out of the HSM, whilst removal of the other islands can be done via select by location. Therefore decision was made (Steven Howell) not to remove HSM from this island.
SOUTH STRADBROKE ISLAND	No	
STINGAREE ISLAND	Yes	

Summary of Scores / Values
10 classes natural breaks
- 5, 11, 17, 22, 28, 33, 38, 43, 48, 56

10 classes quantile breaks
- 8, 15, 20, 25, 29, 33, 37, 41, 46, 56

Identification of Key Koala Landscape Areas
Neighbourhood analysis applied to total values
Parameters:
- Focal Sum
- Circle 20 cells
- 25 m grids

Summarise output:

- 10 classes, quantile split
- Top 2 classes (highest 2 classes – highest 20% of values)
- 440 areas, 116 above 100 ha

Apply filters and identify Key Koala Landscape Areas
- Overlay Protected Areas / Estates
- Consolidate highest valued parcel locations
- Upper Brisbane River (Toowoomba Regional Council) gap area, outside SEQ Regional Plan area. Additional area identified based on local koala habitat mapping and aligned to criteria scores
- 21 Key Koala Landscape Areas identified