State Government Supported Infrastructure

Koala Conservation Policy 2023:

Guideline for Transport Infrastructure

Using Expert Elicitation to determine conservation outcomes for alternate compensatory actions

June 2023

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Prepared by: Department of Environment and Science

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Introduction

In Queensland, the greatest concentration of koalas is in South East Queensland (SEQ). Koalas in SEQ face a range of threats including habitat loss and fragmentation, impacts from high intensity bushfires, climate change, disease, dog attacks and collisions with vehicles. Threats do not occur in isolation and koalas can be simultaneously affected by multiple threats.

Despite pre-existing koala habitat protection measures, the decline in peri-urban koala populations may have been accelerating over the past 20 years. A 2015 koala population modelling study across SEQ highlighted an 80 per cent decline in population densities along the 'Koala Coast' (Wellington Point to the Logan River) and a 54 per cent decline in the Pine Rivers region between 1996 and 2014.[1]

In February 2020, in response to this decline, the Queensland Government introduced new koala conservation measures to the planning framework. This included amendments to the triggers and assessment outcomes in the Planning Regulation 2017, including new mapping that determines where and to what extent development interfering with koala habitat is assessable or prohibited.

The State Government Supported Infrastructure Koala Conservation Policy (SI Policy) outlines how Queensland public sector entities are to consider koala conservation outcomes in the planning and delivery of Government Supported Infrastructure, which is exempt from the koala planning regulations. It ensures that the planning, design and construction of Government Supported Infrastructure in SEQ is carried out in a way that reduces adverse impacts on koalas and koala habitat and conforms with the Queensland Government's commitment to protect koala habitat in SEQ and halt the decline of koala populations in the wild. Government Supported Infrastructure development must adhere to the requirements of the SI Policy, including the Infrastructure Self-Assessment Criteria.

In 2020, the Queensland Government released the *South East Queensland Koala Conservation Strategy 2020–2025* and committed to review the SI Policy to ensure that Government Supported Infrastructure development is subject to the same requirements for koala conservation as non-government development, and that the SI Policy reflects the new koala habitat mapping and conservation framework.

The SI Policy was amended by Queensland Government in 2023 introducing some flexibility specifically for Transport Infrastructure, where, after all avoidance and mitigation efforts, the development interferes with a Koala Habitat Area (KHA) and requires an offset. The Infrastructure Self-Assessment Criteria in Table 1 and 2 of the SI Policy 2023, allows government supported **transport infrastructure** developments to deliver an alternate compensatory action(s) of a conservation outcome equal to, or greater than, what would otherwise be achieved through offsets under the Offsets Policy.

Specifically, Table 2 of SI Policy 2023 allows for t**ransport infrastructure** to deliver offsets as an alternate compensatory action, where the alternate compensatory action includes the design, prior to the commencement of impacts, of a management plan that:

a. demonstrates that the alternate compensatory action will deliver a conservation outcome equal to, or greater than, would otherwise be achieved through the delivery of a land-based offset; and
b. demonstrates that the alternate compensatory action is based on proven scientific methods and contemporary data; and
c. involves an assessment of the number of koalas at risk from the development;
d. demonstrates how individual koala welfare will be managed, i.e. how will koalas be protected during the development.

[1] Rhodes, J.R., H. Beyer, H. Preece, and C. McAlpine. 2015. South East Queensland Koala Population Modelling Study. Uniquest, Brisbane, Australia.

1. Purpose

The purpose of this guideline is to detail how Expert Elicitation is used to demonstrate that an alternate compensatory action for Transport Infrastructure can achieve a conservation outcome equal to, or greater than, what would otherwise be achieved through the delivery of a land-based environmental offset (offset) under the Queensland Environmental Offsets Policy. This guideline can be used to assist Transport Infrastructure entities involved in delivering Government Supported Infrastructure developments to demonstrate they meet the requirements and outcomes of the Infrastructure Self-Assessment Criteria in the SI Policy 2023 and prepare a Koala Management Plan for the alternative compensatory action.

Expert Elicitation to assess alternative offset options may be time and resource intensive in comparison to providing financial settlement or land-based habitat offsets, however the relative benefits may include improved koala conservation outcomes over shorter timeframes when compared to land-based habitat or financial settlement offsets. Therefore, Expert Elicitation is considered most appropriate for large scale Transport Infrastructure developments that involve long planning phases.

2. Alternative compensatory actions

Environmental offsets usually include restoration activities to increase or maintain the quality of habitat for a species or regional ecosystem. The management and abatement of threats on the offset site, and the site's legal protection through tenure change to prevent its loss in future are also required as part of the offset management plan.

Queensland's environmental offsets framework requires all offsets to be delivered and managed to achieve a conservation outcome that is equivalent to the environmental value being lost at the impact site. For koala habitat offsets in SEQ, and based on expert advice, the Environmental Offsets Policy (Offsets Policy) says that the only appropriate conservation outcome is the rehabilitation, establishment and protection of koala habitat. This is to occur by establishing mature habitat either planting new koala habitat trees or by managing existing juvenile koala habitat trees (i.e. regrowth) until they become mature. Offset sites must be capable of containing koala habitat, threats must be manageable, and sites must be legally secured. No alternate compensatory actions are allowable except under the SI Policy 2023 and only for Transport Infrastructure.

Alternative actions to habitat restoration offsets for Transport Infrastructure that have the potential to achieve significant conservation outcomes for koalas might include:

- Retro fitting existing infrastructure where increasing connectivity and managing other threats could have immediate and significant positive outcomes for koala populations and where these would not otherwise be required.
- Fauna bridges and other connectivity infrastructure that provide safe movement of koalas from one area of habitat to another and where currently, there are few koalas able to access the existing habitat and provide healthy genetic mixing and dispersal habitat for young males.

Alternative actions can occur in concert with habitat restoration offsets. The value of such alternatives would be increased where these are additional actions that would not occur otherwise.

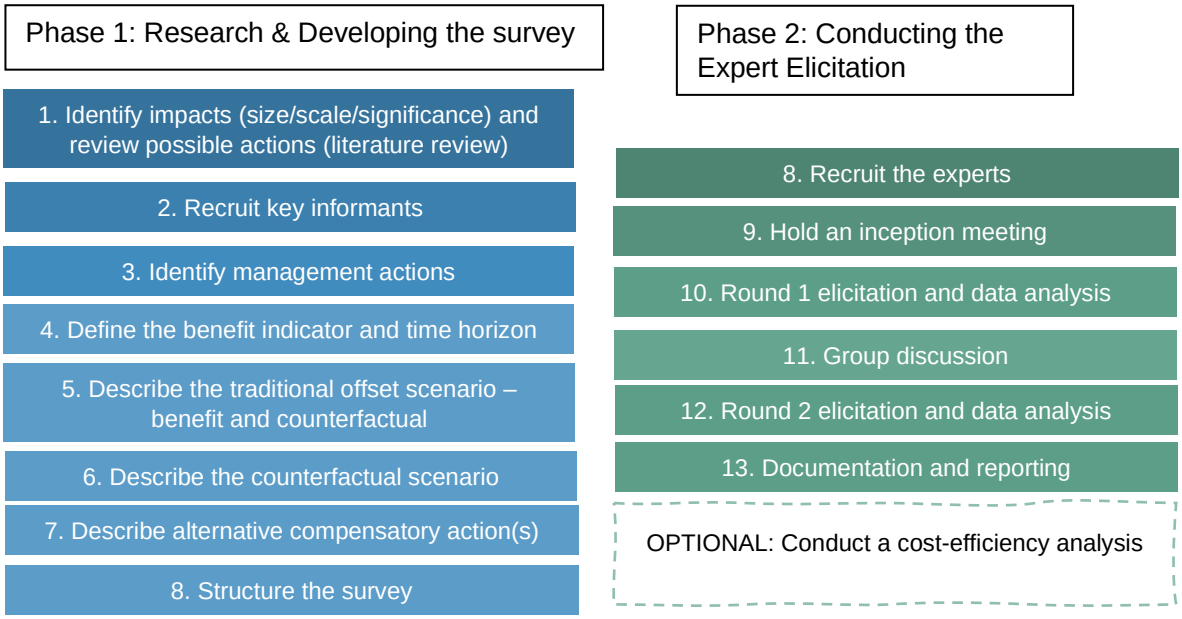
The total residual impact area to be offset is determined after all reasonable avoidance and mitigation has been demonstrated. Offsets (including alternative actions) are to be provided in addition to any mitigation/conservation measures required in a development approval or regulation, and so alternative actions must also be in addition to these and not replace the existing requirements for onsite avoidance and mitigation.

3. Expert Elicitation

An increasingly common technique for obtaining information about the benefits and costs of a range of offset actions in different contexts is the use of structured Expert Elicitation. Expert Elicitation can be used to assess the merits of competing conservation proposals where there is insufficient data or evidence to otherwise make a decision.

There are a number of steps involved in running an Expert Elicitation process which are important to understand when planning commences. An overview of these steps is summarised in **Figure 1** below. Each box corresponds to a step outlined in this guideline, with steps for developing the survey in blue, and steps for conducting the elicitation in green.

Figure 1. Process for using Expert Elicitation to derive the benefits and/or costs of delivering alternate compensatory actions.



When researching and planning for an Expert Elicitation survey and process, it is important to consider the following factors:

1. **Timing and resourcing**

   The duration of an Expert Elicitation process will depend on the financial and human resources available, the level of familiarity with the process, complexity of the project and accessibility of experts to consult with. Depending on the above variables, an elicitation process may take one to three months from start to finish. Due to the resources required, expert elicitation is likely to be beneficial for larger projects, or numerous similar smaller projects.

   A project plan including a purpose and scoping document is recommended.

2. **Project team**

   The project team includes the project manager, facilitator, analyst and key informants:

   Problem owner: public sector entity representative who understands the impacts of the proposed project and alternate compensatory action(s) and assists with the drafting of the survey questions.

Facilitator: manages the interaction amongst experts and oversees the elicitation process. It is beneficial if this person is an independent party and has had prior experience coordinating an elicitation or similar process.

Analyst: handles calibration, elicitation procedures, processing of responses, and analysis of elicited information. This person should be proficient at data analysis in Microsoft Excel and/or R, and if appropriate, may also be the problem owner or the facilitator.

Key informant(s): Persons with significant expertise in koala conservation ecology, who are available to help develop the expert elicitation survey and scenarios prior to engagement with experts. These could be internal or external to the entity.

Note that if the experts are also being asked to consider the economic impact, including costs, of alternate compensatory actions, the project team could also include an additional analyst or key informant with expertise in economic impact analysis.

3. Expert Panel

The number of experts on a panel will vary depending on the complexity and perhaps scale of the offsets required. At a minimum five or six experts should be included. A key informant could also be on the expert panel, but the majority of the panel would ideally be external so as to minimise any biases and conflict of interest in preferring a particular outcome of the process.

4. Developing the Survey

Following the planning phase, the next step in the Expert Elicitation process is to identify what questions are to be put to the experts. This should take the form of a survey which will be developed progressively through the identification, collation and analysis of available data and the formulation of scenarios and counterfactual scenarios in consultation with key informants.

The steps involved are outlined in detail below beginning with a literature review. Generally, the Expert Elicitation surveys would include descriptions of the key elements:

a) the project impacts, quantified using a benefit indicator identified during the development impact assessment (i.e. number of non-juvenile koala habitat trees; or hectares of Koala Habitat Area).

b) the benefit indicator may need to be converted to allow for comparison with the benefits arising from alternative compensatory actions.

c) the site(s) at which alternative compensatory action(s) might be implemented.

d) the proposed alternate compensatory action(s).

e) the benefit or conservation outcome of the proposed alternative compensatory actions(s).

f) a specified time horizon at which the benefit of the action at the site(s) is to be measured.

g) the scenario(s) in which offset actions are implemented at the site(s), for example a scenario where koala road infrastructure, such as a land bridge, is built at the site including the likely number of koala deaths this may avert.

h) the counterfactual scenario in which no actions are implemented at the site(s), for example a where no koala road infrastructure is built at the site including the likely number of koalas killed per year as a result.

i) the benefit or conservation outcome likely from a habitat restoration offset that would otherwise be delivered under the SI Policy 2023. The counterfactual scenario will need to be described and the benefit indicator needs to be the same indicator used for the alternative actions. These may need to be elicited in parallel with the above.

Step 1. Review impacts and possible actions

To inform the development of an Expert Elicitation survey, it is important to first analyse the likely environmental impacts of the proposed project. A valuable source of information for this step is an environmental impact assessment report or similar, which identify the specific impacts to koala populations or habitat requiring offsets and the units to measure the loss.

If the units used to measure the loss are not the same as the benefit indicator unit to be used for the alternative compensatory actions(s) then an elicitation process may be needed to convert the loss into the same units.

Importantly, this step should also involve consulting available literature to identify possible alternative compensatory action(s) that could be used to abate these threats to koala populations, both broadly and at specific individual locations. Also, if the site on which actions are proposed includes the development site then any actions proposed would need to be over and above what would normally be required to avoid and mitigate impacts on koalas at that location as part of the development.

Public sector entities involved in the delivery of Government Supported Infrastructure are encouraged to consult with the Department of Environment and Science (DES) in this phase of the project, to assist with reviewing the project impacts on koalas and identifying options for alternate compensatory action(s).

Step 2. Recruit key informants

Concurrently with the review of project impacts and abatement opportunities, one to two key informants who are known to hold significant expertise in koala ecology, koala populations and threats thereto, road ecology etc. should be identified. Existing networks internal to government can be utilised to find such informants, for example DES or within the Department of Transport and Main Roads may be able to provide key informants or perhaps a list of relevant SEQ koala experts.

The Expert Elicitation survey should be developed in consultation with the key informant(s) prior to recruiting further experts for the elicitation. This is to ensure that the survey questions are logical and relevant, and that the proposed alternate compensatory action(s) being considered are suitable.

Step 3. Identify management actions

During consultation with key informants, the problem owner should refine the list of koala conservation threat and abatement opportunities relating to the project, which may be derived from both environmental impact analysis and the literature review. The objective of this step is to generate, with enough detail, how the proposed alternate compensatory action(s) would be carried out, so that the experts will be able to envisage the likely effectiveness of the action(s) at the particular proposed action site.

Through this process, the list of potential alternate compensatory actions should be refined to those considered most feasible in the context, as well as those most likely to result in a measurable conservation outcome.

It is important to capture detailed information about the method or type of materials used in the action (for example, fence design) and the duration of the action (is it a once-off action, or ongoing, and does it require regular maintenance). Detailed information regarding the proposed action will provide experts with clarity on the benefits that will be derived, and is particularly important if experts are required to estimate and compare the cost and benefits of the action with other actions or traditional habitat offsets.

Discussion with experts during the process may also reveal threats and/or management actions that were not previously identified and may require further consideration.

Step 4. Define benefit indicator and time horizon

To determine the kinds of benefits alternate compensatory actions could deliver for koalas, a suitable ecological indicator of those benefits needs to be identified. The benefit indicator should be something that can be measured at the site level, can easily be monitored using standard survey methods and relates to the viability of koala populations in SEQ.

For the purposes of assessing the relative benefits of alternative compensatory action(s) to offset impacts on koalas in SEQ, a possible benefit indicator is:

Koala abundance - the number of koalas that are likely to be present at a site, or estimated density per hectare; using a suitable repeatable method.

In the survey, experts should be asked about the value of the benefit indicator for koalas at a specific point in the future. This point is called the **time horizon.** Optimally, this is a point in time by which the action will have achieved a conservation outcome. The horizon must balance the need to allow time for the action to take effect, but also disincentivise actions that take a very long time to be effective.

If the units used to measure the loss at the impact site are not the same as the benefit indicator unit to be used for the alternative compensatory action(s) then an elicitation process may be needed to convert the loss into the same units.

Step 5. Describe the restoration offset scenario

In the survey, the first set of information presented to the experts will be a description of the habitat or actions delivered via a restoration offset required under the SI Policy/EO Policy. This provides the base case scenario to compare with the delivery of alternative compensatory action(s). It is important to first understand the benefit a restoration offset is likely to provide to koalas, in order to then demonstrate how alternative actions could deliver an equal or greater benefit.

In addition to presenting the counterfactual scenario, the first section of the survey will also seek to determine the current benefit indicator value (e.g. establish a baseline), and the likely value of benefit indicator at the end of the time horizon. A separate survey may need to elicit the benefit of the restoration offset, including the counterfactual scenario:

a. the project impacts quantified using a benefit indicator during the development impact assessment
b. the conversion of the benefit indicator may be required into one that can be compared with the benefits arising from the alternative action offset. For example, convert the area of habitat to population benefit
c. the site(s) at which habitat restoration offset might be implemented; noting the optimal location of the site(s) is in a Koala Priority Area, as close as possible to the impact site
d. the proposed management action(s)
e. the benefit or conservation outcome of the proposed habitat restoration offset(s) at the site(s) and a specified time horizon (usually 20 years) at which the benefit of the action at the site(s) is to be measured
f. the scenario(s) in which offset actions are implemented at the site(s), for example a scenario where habitat restoration occurs and the benefits that might result
g. the counterfactual scenario in which no actions are implemented at the site(s), for example where no habitat restoration is undertaken at the site(s) and the value of the benefit indicator.

Example survey scenario describing a habitat restoration offset site (counterfactual)

Think of a 16-hectare site south-west SEQ that is located in a mapped Koala Habitat Restoration Area. No koalas or koala activity is present at the site, which is cleared of vegetation and has been extensively used for livestock grazing. The site is adjacent to a new housing estate but is connected to mapped KHA at the back of the estate which contains koalas. The site is not otherwise required to be restored and is category X under the VMA mapping.

Step 6. Describe the counterfactual scenario of the alternative compensatory action

The next step in the survey is to present a description of the alternative compensatory action site(s) and elicit expert opinions about the benefit indicator value of that site if no alternate compensatory action is delivered.

Experts will be asked to estimate what is likely to happen to the value of the benefit indicator at the alternative offset site at the specified time horizon if no changes to the site occur (i.e. no alternate compensatory action is delivered on the site). This is called the counterfactual scenario, sometimes also the 'baseline scenario', 'do nothing' or the 'business as usual scenario'.

Example description of the counterfactual scenario

Think of a 40 hectare site in mapped KHA. In 2018, five koalas were recorded on the site. The site is next to a major road, so impacts from vehicle strikes and dog attacks are a constant threat to koalas at this site. What is likely to happen to the value of the benefit indicator at the alternative offset site at the specified time horizon if no alternate compensatory action is delivered on the site? Would any potential future impacts to the site result in an offset in themselves? Is there an existing requirement to manage the site for these threats?

Step 8. Describe alternate compensatory action(s)

In the survey, the first set of information presented to the experts will be the description of an alternative compensatory action site and the current benefit indicator value of the site (e.g. number of koalas at site).

This requires developing a simple description of one or more alternative compensatory actions that might be delivered, for example koala exclusion fencing or construction of land bridges. Enough context should be required for the experts to envisage the potential impact on the benefit indicator that may result from delivery of the proposed actions.

Often, it is useful to ask about combinations of actions as well as individual actions. This is because some actions may work poorly on their own, but in combination with other management actions, they can be more effective.

The compensatory action description should include key details about the site but avoid providing information that would allow the site to be identified. This is important to maintain focus on general, or average outcomes expected at a typical site, so that it is more likely to be applicable to a larger range of sites.

Information provided in the action description could include the type and quality of habitat at the site and the presence or absence of threatening processes relevant to the species in question.

The description should also clearly state the current value of the benefit indicator at the site, for example the current koala density as a baseline to provide experts with a reference point against which the benefit of the compensatory action scenarios can be measured.

Example survey scenario describing an alternative compensatory action(s):

Think of a 40 hectare site in mapped KHA. In 2018, five koalas were recorded on the site. The site is next to a major road so impacts from vehicles, as well as dog attacks and inappropriate fire regimes are a constant threat to koalas at this site. Records from the last 10 years suggest that 4 koala deaths have occurred from vehicle collision within the area.

A new koala land bridge (30m in length) is proposed to be built across the major road to connect the site with a larger patch of KHA (approximately 120 hectares) located on the other side of the major road. The bridge will be planted with koala habitat and food trees, to facilitate safe koala movement from one habitat patch to another. A fire management plan will be developed and implemented for 10 years.

Accounting for inter-site variation

In many scenarios, there are important differences among habitat types and site characteristics at different locations under consideration. One type of site might be suitable for one type of action, whereas a different site might be more suitable for other actions, depending on the site characteristics and location.

To deal with this complexity in an Expert Elicitation survey, experts should be asked to determine whether different site types and contexts would have large impacts on the effectiveness or suitability of a given action.

Step 9. Structure the survey

Once the tradition offset scenario, counterfactual scenario(s) and alternate compensatory action scenario(s) are clearly described and have been evaluated by the key informant(s), the survey can be drafted. An example survey is included in **Appendix 1** for reference.

The first stage of the survey seeks to define the value of the benefit indicator at the time horizon under a restoration offset scenario in line with the Queensland Environmental Offsets Policy. This step is important to determine if the proposed alternative compensatory action(s) will deliver an equal or greater conservation benefit.

In the second stage of the survey, a description of the sites under consideration for alternative compensatory action(s) is presented, and a question asked about the value of the benefit indicator under the counterfactual or ‘do nothing’ scenario. Importantly, the wording of this question must exclude consideration of any impacts that could trigger offsets themselves, for example by asking respondents to exclude consideration of development impacts that may otherwise occur over the time horizon.

If the benefit indicator is likely to be strongly impacted by stochastic events such as wildfires, it may be appropriate to clarify how experts should consider this. For example, experts might be asked to assume it will be average drought and wildfire year during the set time horizon and if the impact site and the offset site have similar or different drought/fire risk.

The next set of survey questions will ask experts to estimate the value of the benefit indicator under a scenario where alternative compensatory action site(s) are delivered at the site(s) previously described.

For the restoration offset scenario and each alternative compensatory action, experts will need to be asked at least two questions:

1. about the value of the benefit indicator at the time horizon under the counterfactual scenario in which no action occurs at the site, and

2. at least one question about the value of the benefit indicator at the time horizon under the alternate compensatory action(s).

For each survey question about the restoration offset scenario and the alternate compensatory action scenario(s) it is important to clearly describe the suite of actions proposed to be done, with enough detail that the experts can envisage the likely impact on the benefit indicator, which is used to infer the conservation outcome for koalas.

In summary, it is important that an expert elicitation survey:

- elicits quantitative information about the value of the benefit indicator, including any estimates of uncertainty
- provides enough information about the proposed alternate compensatory actions for experts to envisage how it will be delivered
- supplies experts with important contextual considerations such as 'assume the action is delivered to contemporary best-practices'
- provides experts with space to describe a site or context they are familiar with, which can be shared (anonymously) with other experts during the discussion phase
- is free from ambiguity and frames questions in a manner that avoids triggering any bias
- flows logically and is as succinct as possible (survey should not exceed 15 – 20 questions).

5. Conducting the expert elicitation

Step 1. Recruit the experts

Experts for the elicitation process can be based on existing networks and the recommendations of DES. It is essential to recruit experts (ideally more, but at a minimum 5 or 6) who are known to hold significant expertise in koala ecology, koala populations or road ecology etc. Experts may include scientists, managers from research institutes, environmental non-government organisations, government and local government officers, consultants and representatives of species recovery teams.

Evidence shows that groups comprised of diverse participants tend to outperform individual groups of "esteemed" experts. A balance of gender, age, sector, education level and years of experience of experts is desirable.

Step 2. Hold an inception meeting

The inception meeting for the experts is to explain the motivations and expectations of the elicitation process. At the inception meeting, the problem owner should discuss with the experts:

- the elicitation context, including alternate compensatory actions and the counterfactual scenario(s)
- the importance of anonymity and discretion between participants - participants may ask questions or clarify wording but cannot express opinions about the effectiveness of different scenarios to other participants
- that during the elicitation, experts may consult resources and/or publications, personal examples or their own external networks, but not other members of the group.

At the conclusion of the meeting the facilitator should ensure experts are clear about the requirements of the elicitation and their role and establish the timeline and procedures for the elicitation.

Step 3. Round 1 elicitation and data analysis

In the first round of elicitation, the survey should be circulated to the experts, together with instructions. Experts should be allowed 2 to 3 weeks to complete the survey, with additional time allowed for late responses. An alternative approach is to hold a workshop in which the surveys are completed. All responses must remain anonymous to reduce bias among experts.

Once all of the experts Round 1 responses have been provided, the problem owner should review the surveys and:

1. compile and organise the data ensuring anonymity and that units or assumptions are recorded and any irrelevant or incorrect information is noted and/or removed
2. analyse response data using software for statistical computing and graphics by:
    - aggregating expert judgements to calculate the average responses
    - estimating uncertainty by accounting for variation in expert responses
3. present the data using simple graphics and indicate confidence intervals elicited.

For more detailed information on this process including how to consider confidence intervals and adjusting benefit estimations to account for uncertainty, please refer to the paper by Maron et al. 2021[2].

Step 4. Group discussion

The group discussion is an integral part of the elicitation process and should be convened after the results of Round 1 have been reviewed, anonymised and distributed to the experts. The purpose of the group discussion is to ensure that all experts have a shared understanding of the proposed alternate compensatory actions, the impact and action sites and that the experts all interpreted the survey questions in the same way without confusion or inconsistency.

The group discussion phase should include adequate time to go through all results, including discussion of outlier estimates, why they might occur and plausible sources of variation in results. Anonymity must be maintained throughout this discussion unless experts voluntarily identify their own outlying data point for the purposes of discussion.

One common reason for outliers or large variation is different interpretations or assumptions about the action being described. Identifying and discussing these inconsistencies and assumptions through group discussion can result in greater consensus and less variation in a second round of elicitation (if required).

In some cases, some additional information about the benefit indicator, counterfactual scenario conditions, or the alternate compensatory actions being considered might need to be provided.

Throughout the group discussion and in response to any additional information presented, experts should be asked if they would like to reconsider each response or change their round 1 estimates. If yes, the survey should be circulated for a second round of elicitation (round 2).

Step 5. Round 2 elicitation and data analysis (if required)

If a second survey round is considered necessary, the experts should be allowed the option of providing an updated, anonymous, independent response for each question in light of the outcomes of the group discussion. Once all responses from the round 2 elicitation have been collated, the problem owner should repeat data analysis and presentation steps described in Step 3 – round 1 elicitation and data analysis.

Step 6. Documentation and reporting

Once the elicitation process has been completed, the experts' final individual (anonymised) judgements and the group's aggregate estimates should be circulated again to the group for final review. This will help identify any errors. Once experts are satisfied that the results reflect their true beliefs, the data can be used to estimate the benefit indicator values and conservation outcomes of the alternate compensatory actions.

6. Post Expert Elicitation

Summarise the benefits

The aggregated judgements from round 2 (or round 1 if there was no round 2) form the final results of the elicitation process. This generates the best guess mean estimate across the group of experts and summarises inter and intra expert uncertainty about those mean estimates.

Mean estimates should be devised for both the counterfactual scenario and the alternate compensatory action scenario. The difference between these estimates provides the expected benefit expressed in units of the benefit indicator from compensatory actions in the scenario.

It is important to adjust the benefit value for the time lag between the time of an impact and the alternate compensatory action conservation outcome being fully realised, and any uncertainty associated with the delivery of compensatory actions that experts may have indicated.

For example, actions that have highly uncertain conservation outcomes, or benefits based on averting a loss that itself is highly uncertain, might not be acceptable, as robust evidence is required to support alternate compensatory actions. However, uncertainty may be accounted for by penalising the benefit indicator value estimate proportionally (e.g. an outcome about which experts are only 50 per cent certain might be penalised).

For more detailed information on how to estimate uncertainty please refer to Maron et al. 2021[2].

Estimate the costs (optional)

Estimating the costs of alternate compensatory actions is useful for situations where the most cost-effective action is desirable. A cost estimate process can be conducted before, after or alongside the estimation of benefits.

The outcome of cost-effectivity analysis provides a ranking of the relative cost-effectiveness of management actions or offset scenarios, which can provide a guide as to what actions to choose. However, it shouldn't be relied upon for site-specific costs.

The process of evaluating cost-effectivity involves five steps outlined below:

1. Specify detailed tasks within each action	Each alternative compensatory management action should be outlined based on best-practice methods. The expertise of key informers and experts will be helpful to clarify specific tasks involved and best-practice methods. For example, a 'protected habitat' or 'averted loss' offset for koalas would involve establishing a permanent conservation covenant or protected area, ongoing weed management, dog control and fencing. Each of these tasks needs to be costed.
2. Estimate costs of each action	Once management actions are outlined, costs to deliver these actions can be outlined over the specified time horizon (e.g. 20 years), noting that this would be for a longer period if the benefits are to be maintained for the duration of the impact. If uncertainty exists, record the 'best guess' costs where possible, or consider including minimum and maximum costs. In most cases, it is easiest if

	costs are provided in a per hectare format, for scaling to different scenarios quickly. For a template spreadsheet on recording costs, please refer to appendix 2 of the paper by *Maron et. al. 2021*[2].
3. Decide cost data collection methods	There are several methods for recovering cost data, including: • conducting a desktop review of reports and budgets (optimal if time and budget is limited) • individually interviewing experts and request estimates based on past budgets and real protects, or • holding a workshop with multiple experts to develop single estimates for the average, minimum and maximum costs of each action Recording assumptions about costs (for example habitat condition, labor hire and travel costs, spatial considerations or habitat condition) is important as it allows for limitations to be acknowledged, such as over or underestimates. Asking experts for their best approximation and making consistent decisions across each action is therefore recommended.
4. Compile data and verify assumptions	Data derived from multiple sources (e.g. multiple experts) should first be compiled into the summary spreadsheet which records the average or best estimate, minimum and maximum costs per item. Next, data should be 'cleaned' to ensure assumptions cost estimations are consistent and comparable. This step should also screen to avoid double counting (including the same cost in two places), as well as converting costs into an annualized management cost where necessary. The total present value can then be calculated, by incorporating a discount rate (e.g. 5%) so that cost-effectiveness of actions in future can be compared in present day values. It may also be important to consider CPI inflation if utilizing costs from older reports. The total cost of each action can be presented as present value across the time period or average annual cost. Both estimates should consider discounting and the upper and lower cost estimates to account for uncertainty.
5. Estimate cost-effectiveness to inform offsets.	In this final stage, the cost-effectiveness of actions can be determined by dividing total costs by the benefits determined by the Expert Elicitation process. For example, the output of this calculation will be a management cost for conserving an individual koala over the offset time horizon, if the benefit indicator is koala abundance. To assist the problem owner in making a decision about what alternative compensatory action scenarios are likely to achieve the value for money, actions should be ranked by their cost-effectiveness. When making a decision or recommendation about the preferred option, it will be important to ensure that sufficient benefit is achieved to adequately deliver an offset (allowing for uncertainty and time delay).

7. Final steps

The final steps of the Expert Elicitation process involves the problem owner developing a recommendation as to whether the proposed alternate compensatory action(s) will achieve an equal or better conservation outcome, compared to financial settlement or traditional land-based habitat offsets under the Queensland Environmental Offsets Policy.

The problem owner should ensure that the Expert Elicitation process, judgements and outcomes have been properly documented. The recommendation should be documented with reasons, and supported by the findings of the Expert Elicitation in conjunction with any other evidence, such as academic journal articles, ecological assessments etc. recommendation are clearly stated for DES' consideration. As the lead agency for compliance under the SI Policy, DES will provide in principle endorsement of the Koala Management Plan that:

a. demonstrates that the alternate compensatory action will deliver a conservation outcome equal to, or greater than, would otherwise be achieved through the delivery of a land-based offset; and
b. demonstrates that the alternate compensatory action is based on proven scientific methods and contemporary data; and
c. involves an assessment of the number of koalas at risk from the development;
d. demonstrates how individual koala welfare will be managed, i.e. how will koalas be protected during the development of the actions.

8. Definitions

The below terms take their definitions from the SI Policy 2023 and guidelines for estimating the benefits and costs of biodiversity outcomes using expert elicitation Maron etc al.[2]:

Alternate compensatory action is an action, undertaken to offset a significant residual impact, that aligns with the vison of the South East Queensland Koala Conservation Strategy 2020-2025 (or if replaced, the replacing Strategy).

Benefit indicator is a measure of the benefit a management action could deliver for koalas and/or koala habitat. The benefit indicator should be something that can be measured and monitored at a site level and is directly related to the viability of koala populations at the site.

Conservation outcome is achieved by an environmental offset or alternative compensatory action if it is selected, designed and managed to maintain the viability of koala populations in the wild in South East Queensland. A conservation outcome is achieved when there a positive change in the value of the benefit indicator.

Counterfactual scenario is the koala habitat quality or population indicator (benefit indicator) that is expected to occur in the absence of environmental offsets or alternative compensatory actions at a site. Also known as business as usual or do-nothing scenario. Note that impacts at a site that would themselves trigger a requirement for an offset do not form part of the counterfactual scenario, as those impacts would be required to be counterbalanced elsewhere.

Environmental offset is a conservation tool that is designed to counterbalance losses in biodiversity in one place due to development with equivalent benefits to biodiversity elsewhere. In the context of the SI Policy, it is an activity undertaken to counterbalance a significant residual impact of Government Supported Infrastructure on an environmental matter (SEQ koala habitat).

Government Supported Infrastructure is Government infrastructure delivered by a public sector entity, in South East Queensland, that:

a. is funded, wholly or partly, by appropriations from the consolidated fund; or

b. is funded, wholly or partly, by borrowings made by the Government (other than commercial borrowings made by the Queensland Treasury Corporation acting as an agent); or

c. is funded, wholly or partly, by borrowings guaranteed by the Government other than borrowings for commercial investments; or

d. is provided by a person on the basis of conditions agreed to by the Government that are intended to support the commercial viability of the infrastructure.

Interfering with koala habitat has the definition given in Schedule 24 of the Planning Regulation 2017, (at the time of publishing) is described as:

a. removing, cutting down, ringbarking, pushing over, poisoning or destroying in any way, including by burning, flooding or draining, native vegetation in a koala habitat area; but

b. does not include destroying standing vegetation by stock, or lopping a tree.

Koala Habitat Area (KHA) is an area determined under section 7B of the Nature Conservation (Koala) Conservation Plan 2017 and shown on the Koala Conservation Plan Map.

[2] Maron, M., Evans, M.C., Nou, T., Stone, Z.L., Spillias, S., Mayfield, H.J., Walsh, J. 2021. Guidance for estimating the benefits and costs of biodiversity offsets using expert elicitation. NESP Threatened Species Recovery Hub, Brisbane, Australia. Project 5.1 report.

Koala Priority Area (KPA) is an area determined under section 7A of the Nature Conservation (Koala) Conservation Plan 2017 and shown on the Koala Conservation Plan Map.

Public sector entity means:

a. a department or part of a department; or

b. an agency, authority, commission, corporation, instrumentality, office, or other entity, established under an Act for a public or State purpose other than a local government; or

c. a government owned corporation.

South East Queensland (SEQ) means the South East Queensland region under the Planning Regulation 2017.

Transport Infrastructure means:

a. State-controlled road infrastructure; or

b. rail transport infrastructure; or

c. other rail infrastructure; or

d. busway transport infrastructure; or

e. light rail transport infrastructure; or

f. active transport infrastructure; or

g. miscellaneous transport infrastructure.

9. Links to relevant documents

Guidance for estimating the benefits and costs of biodiversity offsets using expert elicitation.

5-1-guidance-for-biodiversity-report_v7.pdf (nespthreatenedspecies.edu.au)

Maron, M., Evans, M.C., Nou, T., Stone, Z.L., Spillias, S., Mayfield, H.J., Walsh, J. 2021. Guidance for estimating the benefits and costs of biodiversity offsets using expert elicitation. NESP Threatened Species Recovery Hub, Brisbane, Australia. Project 5.1 report.

State Government Supported Infrastructure Koala Conservation Policy 2017

https://environment.des.qld.gov.au/__data/assets/pdf_file/0031/88474/comm-infrastructure.pdf

Queensland's Environmental Offsets Policy (in particular Chapter 2A)

Environmental offsets | Environment, land and water | Queensland Government (www.qld.gov.au)

South East Queensland Koala Conservation Strategy 2020 – 2025 - webpages

https://environment.des.qld.gov.au/__data/assets/pdf_file/0016/211732/seq-koala-conservation-strategy-2020-2025.pdf

Koala Sensitive Design Guidelines on DES webpages:

https://environment.des.qld.gov.au/__data/assets/pdf_file/0025/102859/koala-sensitive-design-guideline.pdf

Appendix 1 – example survey

This survey will ask you to estimate how koalas will respond to a range of management scenarios.

Understanding that there are uncertainties around how koalas will respond to management actions, for the sake of this survey, we want you to draw on your experience and knowledge to make a *best estimate* for each question. For the management scenarios we provide, please assume 'best practice' management.

At the end of every question please add any comments you wish to make, which will be shared with the group for discussion before round 2 of the survey.

If you wish, you can use the space below to describe a koala population that you are familiar with here, as a 'base case' for your answers. It may be helpful to include a description of the approximate location, area, size and relevant context.

Scenario 1 – Habitat Offset

Think of a 16-hectare site south-west SEQ that is located in a mapped Koala Habitat Restoration Area. No koalas or koala activity is present at the site, however there is eucalypt-dominant regrowth present. The site was completely cleared approximately 50 years ago and was previously used for livestock grazing. The site is adjacent to a new housing estate but is connected to mapped KHA at the back of the estate. A range of threats to koalas exist in the area, including dog attack, urban development and disease.

We want you to ignore the possibility of any additional human development (mining, infrastructure, large agriculture) that may occur in the site vicinity over the next 10 years. Assume that it will be an average, non-drought year in 10 years.

Question: Realistically, what do you think the lowest plausible number of koalas at the site will be in 10 years? Please exclude any additional impacts from mining, drought, agriculture or development that may occur over the next 10 years in your response.

Question: What do you think the highest plausible number is?

Question: How confident are you that the true value will be between these values (low confidence 1% to high confidence 100%).

Question: What is your best guess?

Now, recall the site described above. Assume the existing site and threats remain in place. In 2018, this land is acquired and awarded legal protection as an environmental offset site. Basic maintenance activities will be conducted including annual weed control activities. The site will be allowed to passively restore over time.

Question: Given the above actions, what is the lowest and highest plausible number of koalas that would be present at the site in 10 years, excluding any additional impacts from mining, drought, agriculture or development that may occur over the next 10 years? What is your best guess?

Scenario 2 – Land bridge + exclusion fencing

Think of a 16-hectare site in a coastal area of SEQ, containing mapped koala habitat. In 2018, four adult koalas (1 male, 3 females) were recorded at the site, in addition to two joeys (sex unknown). The site is located next to a major road (4 lanes, 80km/hr speed limit), and on the other side of which is a larger patch of mapped koala habitat with koala activity present. Impacts from collisions with vehicles and dog attacks are a constant threat to koalas at this site, as they migrate from one patch of habitat to the other. In fact, records show that over the last 10 years, four koala deaths and two injuries were recorded along this stretch of road.

We want you to ignore the possibility of any additional human development (mining, infrastructure, large agriculture) that may occur in the site vicinity over the next 10 years. Assume that it will be an average, non-drought year in 10 years.

Question: How many koalas (lowest and highest plausible number) will be present at the 16ha site in 10 years, excluding any additional impacts from mining, drought, agriculture or development that may occur over the next 10 years?

Recall the site from the previous question and assume the existing site, threats and assumptions remain in place.

In 2018, a new koala land bridge overpass (30m in length) is built across the major road to connect the 16 hectare site with a larger patch of koala habitat (approximately 120 hectares), with known koala activity. To help facilitate movement of koalas between these patches, 400m of koala exclusion fencing is also constructed along the roadside, to reduce the risk of vehicle collision. Koala habitat and food trees have also been planted across the land bridge.

Question: Assuming the koala land bridge is constructed, how many koalas (lowest and highest plausible number) would you expect to be present at the 16 hectare site in 10 years? In your answer, please exclude any additional impacts from mining, drought, agriculture or development that may occur over the next 10 years.

Recall the site from the previous question, and assume the existing 16 hectare site, threats and assumptions remain in place. In 2018, a new koala land bridge overpass is built across the major road to connect the site with a larger patch of KHA (approximately 120 hectares) with evidence of koala activity. Koala habitat and food trees have also been plated across the bridge to facilitate movement of koalas between patches.

At the same time, road signage and road pavement markings are installed to make drivers aware of this koala crossing point. The speed limit is reduced from 80km/hr to 70km/hr. Variable message signs, which are electronic road signs, are temporarily installed during the peak koala breeding season, from August through to October each year.

Question: Assuming the koala land bridge is constructed, how many koalas (lowest and highest plausible number) would you expect to be present at the 16 hectare site in 10 years? In your answer, please exclude any additional impacts from mining, drought, agriculture or development that may occur over the next 10 years.

Scenario 4 - Koala safe crossing infrastructure + awareness campaigns

Recall the 16 hectare site from the previous question and assume the existing site and threats remain in place.

In 2018, two koala rope ladders (30m in length) are built across the major road to connect the 16 hectare site with a larger patch of KHA (approximately 120 hectares) which has evidence of high koala activity. Koala refuge poles are also installed, in addition to the planting of koala habitat and food trees to facilitate movement of koalas toward the crossing. Approximately 400m of koala exclusion fencing is constructed along the roadside, to reduce the risk of vehicle collision and facilitate safe koala movement across the crossing infrastructure.

At the same time, road signage and road pavement markings are installed to make drivers aware of this koala crossing point. The speed limit is reduced from 80km/hr to 70km/hr. Variable message signs, which are electronic road signs, are temporarily installed during the peak koala breeding season, from August through to October each year.

Question: Assuming the koala crossing infrastructure is constructed alongside driver awareness campaigns, how many koalas (lowest and highest plausible number) would you expect to be present at the 16 hectare site in 10 years? In your answer, please exclude any additional impacts from mining, drought, agriculture or development that may occur over the next 10 years.

Scenario 5 – Habitat restoration, monitoring and education

For this question, we would like you to think of a 120-hectare site which is currently degraded cropping land. This site was completely cleared of vegetation 50 years ago but has passively regrown to contain areas of patchy Eucalypt-dominated forest, which contains a population of at least 12 koalas. The site has recently been impacted by fire, and a range of threats including wild dogs attacks, livestock conflicts, disease and reduced gene flow.

We want you to ignore the possibility of any additional human development (mining, infrastructure, large agriculture) that may occur in the 120 hectare site vicinity over the next 10 years. Assume that it will be an average, non-drought year in 10 years.

Question: How many koalas (lowest and highest plausible number) will be present at the 120 hectare site in 10 years, excluding any additional impacts from mining, drought, agriculture or development that may occur over the next 10 years? What I your best guess?

In 2018, a koala habitat restoration program commences at the 120 hectare site, which involves restoration through the active planting of 15,000 koala food and habitat trees and drone seeding across 20 hectares of fire affected habitats to restore plant diversity. The objective of this restoration is to re-create a corridor to facilitate gene flow linkages with other koala populations.

Coupling with this initiative are annual community field days which will be held to showcase best-practice koala management to local landholders. There will also be ongoing engagement with a local university to establish ongoing koala activity baselines, habitat condition assessments and photo point monitoring of the site as regeneration progresses.

Question: Assuming the koala crossing infrastructure is constructed alongside driver awareness campaigns, how many koalas (lowest and highest plausible number) would you expect to be present at the 120 hectare site in 10 years? What is your best guess? In your answer, please exclude any additional impacts from mining, drought, agriculture or development that may occur over the next 10 years.

Scenario 6 – Habitat management and passive restoration

Recall the site from the previous question (120-hectare fire affected property) and assume that the existing site, threats and assumptions remain in place.

In 2018, a koala habitat management program is implemented across the site, which involves restoration of 50-hectares of koala habitat through assisted regeneration (e.g. the strategic removal of lantana and other primary weeds) and mosaic ecological burning to reduce weed load and ground cover over time.

Active control programs for introduced species, such as the removal of foxes and dogs, and the maintenance of fences to protect regenerating areas from cattle grazing will also be implemented throughout the project lifetime.

Please ignore the possibility of any additional human development (mining, infrastructure, large-scale agriculture) requiring approval under the EPBC Act 1999 that may occur in the site vicinity over the next 20 years. Assume also that it will be an average, non-drought year in 10 years.

Question: Assuming above koala habitat management initiatives are introduced, how many koalas (lowest and highest plausible number) would you expect to be present at the 120 hectare site in 10 years? What is your best guess? In your answer, please exclude any additional impacts from mining, drought, agriculture or development that may occur over the next 10 years.