Science for Saving Species

Research findings factsheet

Project 5.1

Threatened Species Recovery Hub

National **Environmental Science** Programme

Lessons from using expert elicitation where scientific uncertainty is high: the case of the malleefowl

In brief

Expert elicitation is one of the tools used to support and assist conservation decision making. There are several features of expert elicitation which make it useful; as a form of 'collective intelligence', it uses available resources efficiently, and it can reduce bias and improve accuracy of quantitative estimates. In this project, we used expert elicitation to collate information on the benefits and costs of management activities for biodiversity offsetting.

In our first case study, our results were inconsistent with some of the available empirical evidence on efficacy of management actions for the malleefowl. Here, we describe the lessons we learned, and provide recommendations that could help minimise bias when expert elicitation is being used to help assist conservation decision making.

Background

Structured expert elicitation approaches are increasingly used to support conservation decision making. In recent years, expert elicitation protocols have been used as a tool to help inform conservation decision making, including for judgements of wildlife population sizes, life-history parameters, responses of populations to management, and population trajectories of threatened species.

In this project, we developed an approach for eliciting the knowledge of threatened species experts in a structured way, to guide estimates of both the benefits and the costs of alternative biodiversity offset approaches. Biodiversity offsets are required by governments to compensate for "unavoidable development impacts on species or ecosystems by creating an equivalent benefit for the same species or ecosystem elsewhere".

We tested the approach using several case study species that commonly trigger offset requirements, and for which developing appropriate offset proposals is considered challenging. Our findings from one expert elicitation process (for the malleefowl *Leipoa ocellata*) revealed high variation in views of expertise, with some experts noting apparent inconsistencies between the averaged group estimates and some of the available empirical evidence on the efficacy of different management actions for the species. We also provide a summary of the threats, and history of management and research of the malleefowl to provide context to how the current knowledge and expertise has accumulated. We decided to explore this case study to demonstrate lessons learnt from using expert elicitation where scientific uncertainty is high and provide some recommendations for improving the process in the context of biodiversity offsets.

Malleefowl. Image: Ron Knight, CC BY 2.0, Wikimedia Commons

Malleefowl – a declining megapode

The malleefowl (Figure 1) is a shy and solitary bird of semi-arid to arid Australian shrublands and low woodlands. It is the least common of Australia's three megapode species, which are ground-dwelling birds, well-known for the large mounds they build to incubate their eggs.

Malleefowl once occurred extensively across the semi-arid and arid parts of southern Australia. They are now found in scattered locations in New South Wales, Victoria, South Australia and Western Australia, including more mesic agricultural cropping regions.

RIGHT: Figure 1: Malleefowl. Image: Donald Hobern, CC2.0, Flickr

Key threats to malleefowl

The malleefowl is listed as Vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The current Action Plan for Australian Birds states that malleefowl populations are rapidly declining, particularly in South Australia and Western Australia (Benshemesh *et al.* in press). The remaining population of malleefowl is highly fragmented, and small sub-populations are highly susceptible to local extinction.

The main threats to malleefowl include habitat clearing and fragmentation, inappropriate fire regimes, impacts of introduced and native herbivores, predation by foxes and feral cats, and climate change. A major challenge for malleefowl conservation is that the relative contribution of, and interactions between these key threats to malleefowl are poorly known (Bode *et al.* 2017). The current recovery plan (Benshemesh 2007a) states that the most important management actions for malleefowl, in order of priority, are to:

1. reduce permanent habitat loss;
2. reduce grazing pressure from sheep, goats and cattle;
3. reduce fire threats;
4. reduce predation (by foxes and feral cats);
5. reduce isolation of fragmented populations;
6. promote malleefowl-friendly agricultural practices, and
7. reduce mortality on roads.

Research and on-ground management of malleefowl

While the malleefowl has been the focus of a range of studies, conservation management and monitoring efforts (Table 1), there is still scientific uncertainty about the relative contribution of, and interactions between key threats to the species.

The most common management action for malleefowl has been fox baiting, which is carried out patchily across its range (Garnett 2012; Gillam *et al.* 2018). This action is undertaken partly due the findings from studies in the 1990s showing a high predation rate of young (captive reared and/or bred) malleefowl chicks by raptors and foxes (Priddel and Wheeler 1997). This led to a widespread belief in the importance of fox predation to malleefowl population trends (Garnett 2012).

There have been differing results about the efficacy of fox baiting for malleefowl conservation (Benshemesh 2007a; Priddel and Wheeler 1997). Three subsequent studies have examined the effect of fox baiting on malleefowl, and concluded that in most years, there is no net benefit to malleefowl at most sites (Benshemesh 2007b; Benshemesh *et al.* 2020; Walsh et al. 2012). All three studies found no evidence for fox baiting having an effect on malleefowl breeding activity, however it remains unknown if baiting affects breeding success, hatching success or population size. This result is not inconsistent with foxes being an

Research and on-ground management of malleefowl (continued)

important threat to malleefowl – but effective fox control can be challenging to achieve. The efficacy of a fox control program depends on a range of factors including the susceptibility of individual foxes to locate and take baits, the bait's palatability and toxicity, the type of bait used, the pattern, intensity and density of bait distribution (Gentle 2005); it may also be affected by environmental factors, and whether there are integrated management efforts for cats, where they co-exist.

Table 1: Key events and research relating to malleefowl in Australia (note: most research has been undertaken on agricultural land).

Year	Notable actions or publications relating to malleefowl conservation	Reference
1962	First major study on malleefowl conservation completed, highlighted clearing and suggests grazing as threats	Frith 1962
1987	The National Malleefowl Monitoring Program was established, commencing with setting up sites for monitoring malleefowl mounds in Victoria	Benshemesh 2007a
1989	National Malleefowl Recovery Team commenced, comprised representatives from ACT, NSW, SA, Victoria and WA	National Malleefowl Recovery Team 2021
1992	PhD study examined the effects of fire on malleefowl. The research, showed that of 21 newly hatched chicks released, 15 subsequently died: about 1/3 were killed by introduced predators, 1/3 by raptors, and the remaining third by metabolic stress such as starvation.	Benshemesh J 1992
1994	Study on the release of young captive-reared malleefowl in NSW published. The study found that 94% of 31 young malleefowl were killed by predators: 26-39% by raptors and 55-68% by introduced predators, principally foxes.	Priddel and Wheeler 1994
1997, 1999	Experimental study in NSW showed increased survival of captive-reared malleefowl chicks after fox baiting and that survival was proportional to baiting intensity. Fox predation was the primary cause of malleefowl mortality in this study.	Priddel and Wheeler 1997; Priddel and Wheeler 1999
	Malleefowl listed as Vulnerable under the EPBC Act. First iteration of the recovery plan for malleefowl completed.	Department of Agriculture Water and the Environment 2000
2007	Second iteration of the recovery plan for malleefowl completed.	Benshemesh 2007a
2007	Study estimated trends and drivers of malleefowl breeding numbers which quantified national declines and found fox baiting did not increase malleefowl populations. Study found there was a high death rate of captive-bred malleefowl released in long-unburnt mallee, free of exotic herbivores, due to predation by foxes	Benshemesh 2007b Priddel *et al* 2007
2011	Study examined the spatial patterns of contemporary fire regimes in WA. Suggested that a conservative approach to fire management, which considers effects on malleefowl, their habitat and other environmental stressors is applied. Population viability analysis (PVA) for malleefowl suggested that fox baiting at higher densities than currently used in most monitoring sites may reverse malleefowl population declines. The PVA was developed using model parameters estimated from a single malleefowl population, based on multiple assumptions.	Parsons and Gosper 2011 Bode and Brennan 2011

Year	Notable actions or publications relating to malleefowl conservation	Reference
2012	Analysis using national dataset showed large variation in malleefowl responses to fox baiting across sites and years, with no net benefit to malleefowl at most sites. The study notes that the average baiting intensity across malleefowl monitoring sites was well below the recommended fox baiting intensity for wildlife conservation.	Walsh *et al.* 2012
2012	Commentary highlighted the results of the 2012 analysis, noting that strengths of different management actions for malleefowl are likely to vary across space and time.	Garnett 2012
2015	A project between the University of Melbourne and Parks Victoria aimed to clarify effects of predator baiting on malleefowl populations. A power analysis suggested that 20 pairs of sites must be monitored for at least 5 years to detect small to moderate effects of predator management on malleefowl breeding activity.	Threatened Species Recovery Hub 2021a
2015	Project aimed at better understanding the effectiveness of predator control for malleefowl by monitoring breeding and predator activity at Adaptive Management Predator Experiment Project (AMPEP) control-treatment sites was set up across southern Australia by the Threatened Species Recovery Hub and the National Malleefowl Recovery Team.	Threatened Species Recovery Hub 2021a
2018	Expert elicitation process to inform the development of better biodiversity offsets for the malleefowl undertaken by the Threatened Species Recovery Hub. The book 'Recovering Australia's threatened species: a book of hope' is released. The book includes a chapter on the threats to malleefowl, and the uncertainty about the relative contribution of these threats.	Threatened Species Recovery Hub 2021b Gillam *et al.* 2018
2020	Study using the national dataset estimated trends and drivers of malleefowl breeding within a Bayesian hierarchical modelling framework completed. The study involved 127 sites monitored for an average of 14 years and demonstrated national declines. Key findings were that fox baiting did not result in an increase in malleefowl populations and fire is a significant threat for malleefowl. There was considerable variation in the extent, frequency, timing, intensity and bait type over space and time.	Benshemesh *et al.* 2020
2021	Proposal for continuation of the Adaptive Management Predator Experiment Project for malleefowl. The interim results suggest a weak effect of predator control on malleefowl breeding activity. Revised recovery plan in preparation.	Southwell *et al.* 2021a; Southwell *et al.* 2021b

The National Malleefowl Monitoring Program and Adaptive Management Predator Experiment Project

The National Malleefowl Monitoring Program (NMMP) is one of the largest single species monitoring programs in Australia (Benshemesh 2007a). The program is coordinated by the National Malleefowl Recovery Team to ensure that mounds are monitored in the same way across its range (Benshemesh 2007a). Mound activity is used as a surrogate for breeding population size, and signs of predators are also recorded (Benshemesh *et al.* 2018).

An analysis of NMMP data collected from the late 1980s to 2006, comprising over 20,000 mound inspections from 64 sites across Australia had three key findings:

- There was strong evidence that winter rainfall had a positive influence on malleefowl breeding activity;
- There was strong evidence for a positive effect of time since fire on malleefowl breeding; and
- Fox abundance decreased in response to increased baiting effort, but there was little evidence for this benefitting malleefowl (Benshemesh 2007b).

A subsequent study in 2020 with 127 sites and incorporating additional data reached similar conclusions about fox baiting (Benshemesh *et al.* 2020). However, this recent study also indicated that fire appears to have the greatest effect on abundance, probably killing birds directly, potentially removing suitable habitat structure and leaf litter for nesting, reducing food availability and making the birds more prone to predation (Benshemesh *et al.* 2020; Benshemesh *et al.* in press). The chance of breeding activity substantially increased with time since fire (Benshemesh *et al.* 2020).

In order to clarify the relative contribution of different threats, an Adaptive Management Predator Experiment Project (AMPEP) for malleefowl commenced in 2015. This ongoing project aims to better understand the effect of predator control in malleefowl habitat, on both predator activity and malleefowl persistence, through the monitoring program coordinated by the National Malleefowl Recovery Team. The findings will help to identify which of the threats to malleefowl are most important and which actions are most effective.

The interim (2021) results of the Adaptive Management Predator Experiment Project found a weak effect of predator control (fox or cat control) on malleefowl breeding activity; this effect was highly uncertain (Southwell *et al.* 2021a). It has been proposed to continue the project until all sites have been operational for at least five years.

Malleefowl mound. Image: Joe Benshemesh

Case study: using expert elicitation to inform better offsets for the malleefowl

Malleefowl are frequently impacted by proposed development projects. Offsets are required when development proposals (e.g., for mining or agriculture) would impact malleefowl habitat. Guidance on how to deliver effective offsets for malleefowl is needed urgently, and until results from the AMPEP are finalised, structured expert elicitation could help to fill this knowledge gap. In this study, we aimed to elicit expert opinion about the benefits of alternative management actions for the malleefowl. These actions were identified from interviews with two key malleefowl experts from the National Malleefowl Recovery Team (Figure 2).

We used a structured expert elicitation protocol (Hemming *et al.* 2017) involving two rounds of online anonymous surveys with 13 malleefowl experts in early 2018, who collectively had expertise across the species' geographic range. In each survey, experts provided quantitative estimates of the benefits of these management actions at two hypothetical offset sites which had different types of habitats, site conditions and past land management. We asked experts to envisage the outcomes for malleefowl in each hypothetical offset site after 20 years if current management did not change ('do nothing'), and if particular management actions, or combinations of these actions, were implemented. Experts were asked to assume that management actions were implemented using current best practice methods, by experienced and professional staff.

As part of the expert elicitation method, a facilitated discussion (via teleconference) was held in between the two rounds. This phase, which is an essential part of the protocol (Hemming *et al.* 2017), allows for clarification of reasoning and assumptions made for the estimates provided in Round 1.

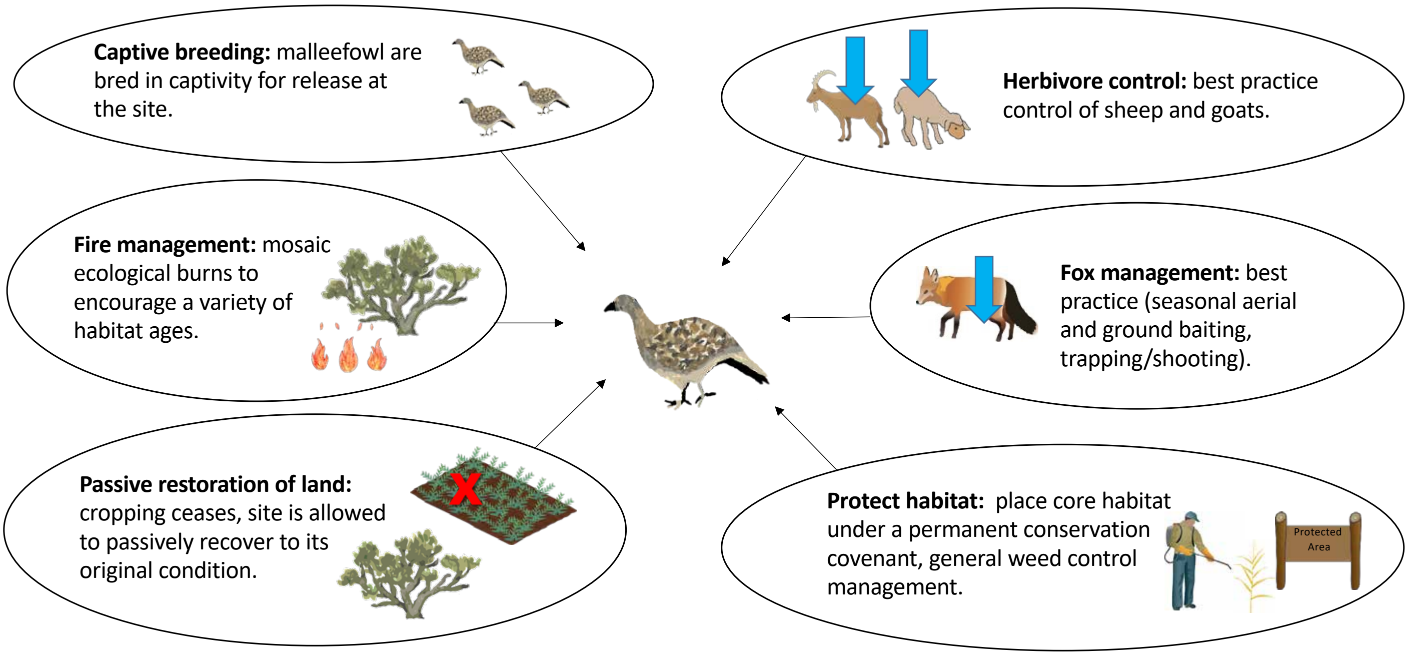

Figure 2: Potential management actions that could benefit malleefowl populations. Experts considered how these actions, alone and in different combinations, would benefit malleefowl at two different hypothetical offset sites.

Results and alignment of expert judgements

Thirteen experts individually estimated the benefits of habitat protection, captive breeding, fox control, herbivore control, fire management and combinations of these actions to malleefowl. These benefits were measured by predicting the number of malleefowl mounds present in the two hypothetical offset sites, relative to a baseline scenario of 'do nothing'. On average, experts believed that the 'do nothing' option would result in a decrease in the number of malleefowl mounds at current habitat sites over the 20-year period, from 5 to 2.7 mounds. While all of the offset actions resulted in some improvement to the 'do nothing' scenario, the uncertainty around these estimated benefits was very high (Figure 3).

Consistent with other expert elicitation processes to inform biodiversity offsets for threatened species, experts thought that combinations of actions (for example, protection of land combined with active and ongoing best practice management of key threats over the 20-year time period) would result in the greatest conservation gains for the malleefowl (Figure 3).

When considering the final results in terms of individual management actions that could be applied, experts on average believed that fox management would have a slightly higher benefit for malleefowl, compared to other individual actions. This is somewhat contrary to recent empirical evidence, as described above. We note that experts may have considered fox baiting as it is generally practiced (typically well below the recommended intensity), rather than as 'best practice' (at recommended intensity) in their assessments of the hypothetical scenarios.

When the variation in responses and low sample size are considered, there is negligible difference between the three individual actions. There was considerable uncertainty associated with the estimated benefit of all actions, except for management at degraded sites, which were believed with reasonable confidence to have very little benefit.

A detailed examination of the raw data (i.e., the estimates provided by individual experts) for fox management helped us understand why the results did not support the most recent scientific evidence. The final 'best guess' individual estimates provided by experts for fox management ranged from two to 20 malleefowl mounds after 20 years of management, at a site that started with 5 mounds.

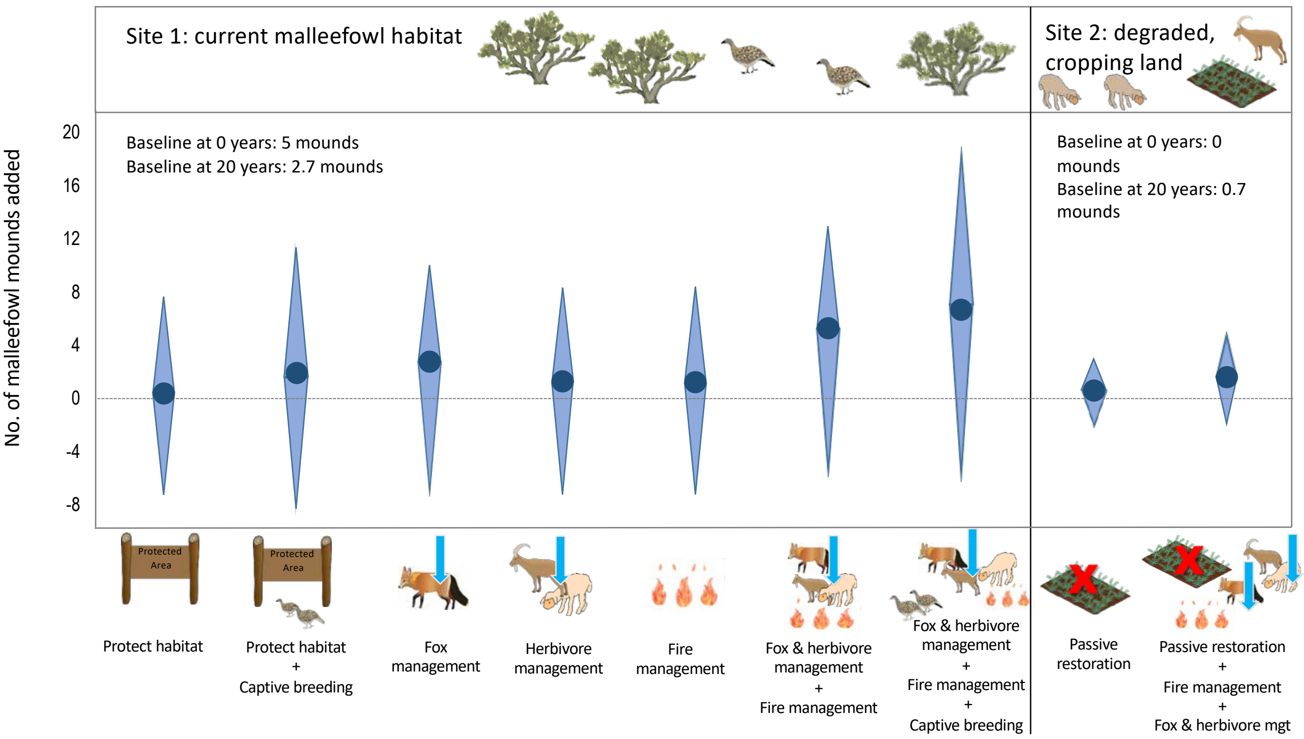

Figure 3: Results of expert elicitation showing the estimated benefit (defined as additional active malleefowl mounds, relative to the 'do nothing' scenario) of different management actions for malleefowl after 20 years. The circle is the aggregated 'best guess' estimate. Diamonds show the 90% confidence intervals around expert estimates.

Five experts thought that the malleefowl mounds would decline over 20 years, three thought that the number of mounds would remain stable, and five experts estimated an overall increase of mounds in response to fox management (Figure 4).

The effectiveness of fox baiting was discussed during the discussion phase between the rounds of scoring, with experts questioning whether the effectiveness declines over time. Three experts commented that fox control could lead to an increase in the number of feral cats, which in turn prey upon malleefowl. The discussion phase led to four experts revising their estimates down in Round 2, one expert revised their estimate up by one mound, while eight experts simply carried over their Round 1 estimates over to Round 2 (Figure 4).

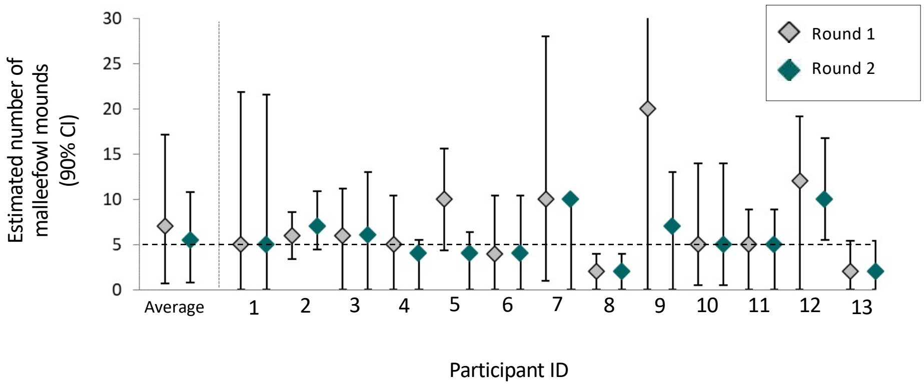

Figure 4: Raw results from Round 1 and 2 of expert elicitation. The diamonds show the experts' estimates of the number of malleefowl mounds after 20 years of best-practice fox management. Lines show upper and lower 90% confidence estimates. The dashed horizontal line represents the initial number of mounds at t=0. The group averages for both rounds are shown at the far left of the graph. There is a high level of inter-expert variability (particularly in Round 1). Several experts in Round 1 estimated increases in the number of mounds (with a high level of uncertainty) following fox management, but a subset of these experts lowered their estimates in Round 2.

Fox control for malleefowl: a commonly applied management action with unclear benefits

When developing a project team and a panel of experts for expert elicitation, it is important to understand the many ways in which biases can affect the accuracy and calibration of expert judgements. One of the common cognitive biases that can affect expert judgements is confirmation bias: the tendency for us to view new information as confirming our pre-existing beliefs (Klayman 1995).

Individuals from the National Malleefowl Recovery Team advised that it is relatively common for land managers involved in fox baiting to believe it is useful in benefitting malleefowl, although the effectiveness of baiting is limited, and the impact of foxes on malleefowl being documented.

Research indicates that in some cases, managers and practitioners are more likely to rely on their own professional experience rather than externally developed management plans, policy documents and decision support tools; scientific papers and unpublished research are used less often to inform decisions (Ausden and Walsh 2020; Cook *et al.* 2010). The belief that fox baiting is beneficial for malleefowl appears to be widely shared, as demonstrated by being the most commonly applied action for malleefowl. An important consideration is that fox baiting can be readily implemented by land managers, compared to other management actions, and is undertaken to reduce threats to multiple native species (Gillam *et al.* 2018).

The results of the Adaptive Management Predator Experiment Project for malleefowl should help clarify the relative effectiveness of different interventions in benefiting the malleefowl. This knowledge will help inform future management of malleefowl populations, and support more targeted and strategic use of conservation management funds for the species, providing it is communicated effectively to and applied by land managers.

Overall, our results for the benefit of management actions for the malleefowl showed there is currently a lack of scientific consensus, along with considerable uncertainty, about the effectiveness of alternative management actions for malleefowl. The considerable disagreement amongst experts on

Fox control for malleefowl: a commonly applied management action with unclear benefits (continued)

the most effective interventions for malleefowl is likely due to a combination of factors, including limited trials of the specific intervention settings that were put to experts, and the likely substantial variation in malleefowl responses amongst different contexts. It did not allow us to propose appropriate offset actions for the malleefowl with confidence. We present this as a case study to examine the potential limitations of expert elicitation as a tool to inform conservation decision making, noting the malleefowl was the first case study species used in the process of developing the expert elicitation approach. Several adjustments were made to the process in subsequent elicitations, described in detail below.

Recommendations for future expert elicitation exercises

Structured protocols for expert elicitation can assist in conservation decision making, but their use does not guarantee accurate estimates. Expert elicitation is commonly used in situations when data are absent or insufficient (Hemming et al. 2017). Where suitable data are available, results should be checked for alignment and consistency, and any inconsistencies carefully reviewed.

The reliability of expert judgement will depend on a range of factors: how many and which experts are selected and participate, how questions are asked, the individual experience of the participating experts, and the information participating experts use to underpin their decisions. Expert judgements can be prone to contextual biases, and without directly comparable empirical data, there is no way to evaluate judgements for their accuracy (Hemming *et al.* 2017).

In the context of using expert elicitation to inform biodiversity offsets for threatened species, it is crucial to remember that actual responses of threatened species are influenced by many factors which are likely to vary across time and space, particularly for species with broad distributions.

We suggest five key ways to minimise bias in expert elicitation for conservation purposes:

- Establish an online library of relevant key research (peer reviewed literature, grey literature) relating to the expert elicitation subject matter, to be shared amongst participating experts prior to the facilitated discussion phase. This will ensure that all participants have the same information available to them when providing estimates of benefits of management actions (Ausden and Walsh 2020; Petrovan *et al.* 2018). For the subsequent expert elicitations we undertook, our project team did collate recent research papers on the focal threatened species, and made these available to participants, prior to the facilitated discussion phase. For these subsequent case studies, the expert judgements were generally consistent with the available empirical evidence and tended to converge on a group 'best guess'.
- All participating experts should be strongly encouraged to participate in the facilitated discussion phase of the expert elicitation process, where sources of variation in results can be explored and discussed.
- For species/ecological communities with a broad distribution, ensure the inclusion of experts from across the range of the species in the process.
- Ensure that project team members have an understanding of the many ways in which biases (including confirmation bias and groupthink) and overconfidence can affect the accuracy of expert judgements (Hemming *et al.* 2017), how these may affect results, and determine an appropriate course of action as required. Project team members should also be mindful of expert elicitation fatigue; lack of concentration and engagement may result in errors in assessments. A third round of elicitation may be required in some circumstances (e.g., if the results in Round 2 were unclear, or if there were errors in the scoring process).
- In some cases, excluding expert estimates that are outliers may be warranted; for example, if an expert who has provided outlying values was unable to attend the facilitated discussion phase of

Recommendations for future expert elicitation exercises (continued)

the expert elicitation, and was unable to provide reasons for the outlying data point.

We also suggest that it is worthwhile to engage members of threatened species recovery teams in the design of expert elicitation processes as they can assist (to a certain extent) in reviewing survey questions, suggesting relevant experts, and sharing the available key research on the target threatened species.

Expert elicitation is not a perfect tool or solution for addressing issues with biodiversity offsets in Australia, particularly for species where the relative contribution of threatening processes is unknown. It is designed to be an improvement on unstructured, single expert estimates of an offset benefit, and can be used to underpin a 'best guess' of how a species may respond to alternative offset actions.

Decision making, including about the design of biodiversity offsets, should be based on the best-available ecological knowledge and full consideration of cumulative impacts (geographically and over time) for the threatened species of interest. Expert elicitation will continue to be an important and useful tool in conservation, but also has limitations that warrant attention and awareness by users. Importantly, it should not be regarded as a one-off process and should be repeated as new significant information becomes available.

For the malleefowl, repeating the expert elicitation process following the release of the final results from the Adaptive Management Predator Experiment Project may be useful to ensure the development of more accurate, evidence-based estimates of management effectiveness.

For land managers and decision makers, a recently released framework, FoxNet, can be used to help predict fox population dynamics, including responses to control and landscape productivity (Hradsky et al. 2019), and as a planning tool for how fox control programs can be structured to gain greater conservation outcomes for threatened species.

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Further Information

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Malleefowl. Image: Western Australia,Butupa, CC2.0, Wikimedia Commons

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