Threatened Species Recovery Hub

National Environmental Science Programme

A decision tool for evaluating whether ex-situ management is appropriate for a threatened species

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Summary

The research team for this project delivered the completed PACES (Planning and Assessment for Conservation through Ex Situ management) decision tool in May 2020. This report summarises the work undertaken as part of the extension of TSR hub project 4.1.5 from October 2020 until June 2021. Under this extension I was engaged on a casual basis (approx. 0.25 FTE on average) to conduct further outreach, communication and training with the PACES decision tool, and to conduct or facilitate more case study applications of the tool.

This report describes:

- The outreach and communications activities conducted,
- The three case study applications of the PACES tool that are completed or are currently underway.

Outreach and communication activities

Between October 2020 and February 2021, I gave one short conference presentation and conducted 9 one-hour online information and training workshops with the PACES tool, organised with the assistance of TSRH knowledge broker Rachel Morgain. Workshops were conducted with interested parties from the:

- Federal Department of Agriculture, Water and the Environment,
- IUCN SSC Conservation Planning Specialist Group,
- ACT Department of Environment, Planning and Sustainable Development,
- NSW Department of Environment, Energy and Science,
- NT Department of Environment, Parks, and Water Security,
- Queensland Department of Environment and Science,
- SA Department of Environment and Water,
- Tasmania Department of Primary Industries, Parks, Water and the Environment
- Victoria Department of Environment, Land, Water and Planning, and
- WA Department of Biodiversity, Conservation and Attractions.

Between December 2020 and February 2021, I created two informational videos for the TSR website. One is a short (approx 7 min) min introduction to PACES tool, explaining what the tool is and what it can do. The other is a long-form tutorial (1 hr 15 min) to assist users in applying the tool themselves. These videos are now available on the TSR hub project website: https://www.nespthreatenedspecies.edu.au/projects/a-decision-tool-for-evaluating-whether-ex-situ-management-is-appropriate-for-a-threatened-species.

Case study applications of PACES

The mahogany glider (*Petaurus gracilis*)

The mahogany glider was originally identified as a candidate case study species before the 2019 testing workshops with the Queensland Department of Environment and Science, however the case study was postponed as the departmental representative was not available. It was therefore a priority to apply the completed PACES tool to this species.

The mahogany glider is an arboreal marsupial native to open, wet sclerophyll forest north of Townsville in north Queensland. It is threatened by habitat loss and degradation, habitat fragmentation due to clearing, intensive grazing, mortality from barbed wire fencing, and extreme climatic events such as cyclones and wildfire (Jackson and Diggins, 2020). It is listed as endangered in Queensland and nationally.

I conducted the PACES assessment over two online video call sessions (3-4 hours in length) held in February and April 2021. Before and in-between sessions I gathered the required information from participants via email and phone calls. The 6 participants were from mahogany glider recovery team, the Queensland Department of Environment and Science (Qld DES), the Hidden Vale Wildlife Centre, and Terrain Natural Resource Management (NRM). The completed PACES assessment is included as an Appendix to this report.

The heath mouse (*Pseudomys shortridgei*)

Since conducting the testing workshops with the Western Australian Department of Biodiversity, Conservation and Attractions (DBCA), I have been in regular contact with members of DBCA discussing how PACES could be used to assist decision-making for threatened species. I have been working with Dr Megan Barnes, the in-house decision scientist in DBCA, discussing how to frame decisions within PACES and training her to use PACES as a facilitator.

Megan and I identified the heath mouse as a species where PACES could be a useful decision-making aid. While it was originally found across the heathlands of Australia, the heath mouse is now restricted to two populations, one in Victoria/South Australia, and one in southern WA (DBCA WA Government n.d.). The heath mouse is listed as Vulnerable in WA and as Endangered nationally. A recent survey by DBCA in 2019 detected the heath mouth at two locations in south-west WA, which were the first confirmed records of the species since 2004 (DBCA WA Government, 2020).

We first planned a workshop applying PACES to the health mouse in early May 2021, however, this had to be rescheduled due to participant availability. Megan will now be facilitating the workshop on the 30th June 2021, and I have been assisting her in preparing. As part of this, I have developed an extended version of PACES that can accommodated five alternatives instead of three, including two ex-situ alternatives and two 'in-situ plus' alternatives. Depending on feedback from the workshop, we may make this extended version available on the PACES TSR hub website for public use.

The southern black-throated finch (*Poephila cincta cincta*)

The southern black-throated finch is listed as Endangered in Queensland and nationally. It has disappeared from over 80% of its original range, and habitat loss is ongoing (Reside et al. 2019). A captive breeding program has been suggested as a way to boost population numbers in the wild. I have been working with Dr April Reside to frame how PACES could be used to evaluate the likely benefits of a captive breeding program, against alternative scenarios of conservation (including 'do nothing' and 'extensive on-ground conservation efforts').

We decided to engage a masters student through UQ, Emma Fitzsimmons, to work on the project. Emma's project will run until the end of 2021, and has been timed to potentially make use of a population viability analysis for the Black-throated finch being developed by Kylle Quinn (also April's student). I have been working with Emma to train her in the use of the PACES tool and to scope out how it will be used in her project. Emma has been collating information about the black throated finch, and will soon begin working with the Recovery Team to define different alternatives. Predictions about population size in the wild under different alternatives and scenarios will be informed by expert elicitation, augmented if possible by modelling results from the population viability analysis.

References

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Appendix

Completed PACES case study: the mahogany glider (*Petaurus gracilis*)

Facilitator: Tracy M. Rout, Threatened Species Recovery Hub, National Environmental Science Program, University of Queensland.

Participants: Dalene Adam (Hidden Vale Wildlife Centre), Daryl Dickson (Mahogany Glider Recovery Team), Jacqui Diggins (Terrain Natural Resource Management), Stephen Jackson (Mahogany Glider Recovery Team), Mark Parsons (Queensland Department of Environment and Science), Vere Nicolson (Hidden Vale Wildlife Centre).

Also invited or consulted: Megan Brady (Hidden Vale Wildlife Centre), John Hodgon (Queensland Department of Environment and Science), Conrad Hoskins.

Methods

After an initial information gathering phase, the PACES assessment was conducted over two online video call sessions (3-4 hours in length) held in early 2021. There were 6 participants and a facilitator in the assessment, with representatives from the Mahogany glider recovery team, the Queensland Department of Environment and Science (Qld DES), the Hidden Vale Wildlife Centre, and Terrain Natural Resource Management (NRM).

Participants opted to predict the outcomes of management alternatives in terms of relative population size in 15 years' time as compared to now (i.e., % change). The first session was spent defining the three active management alternatives (in-situ status quo plan, in-situ plus plan, and ex-situ plan) by listing the actions that would be included in each. Full descriptions and costings are provided in the completed PACES workbook.

The in-situ status quo plan was defined as a continuation of current management actions over the next 15 years. These included fire management, weed management, feral cattle and grazing management, revegetation and building glider poles to improve habitat connectivity, and conducting basic monitoring. This alternative was estimated to cost around $9.5 million over the next 15 years, an average cost of $634,650 per year. This cost was split between the Qld DES and Terrain NRM, with DES conducting management within national parks and Terrain NRM conducting management outside of national parks, including monitoring (Figure 1).

By default the PACES tool defines the in-situ plus plan as a plan that costs the same as the ex-situ plan. However, in this case participants opted instead to define the in-situ plus plan as in-situ management in the absence of budgetary constraints. The actions in the plan were mostly the same as the in-situ status quo plan but to be conducted at higher intensity, for example, the area to which fire management was applied in national parks was increased from 70% to 100% of glider habitat. Additional resources were added to build long-term partnerships with stakeholders, for example, adding extra resources for fire management inside national parks to form partnerships with indigenous landholders to conduct fire management. Monitoring was upgraded from basic ad-hoc monitoring to structured estimation of abundance, trends, range size, and key threats. This alternative was estimated to cost around $30.3 million over the 15 years, an average of $2,016,900 per year. Again, this cost was split between the Qld DES and Terrain NRM, with DES conducting management within national parks and Terrain NRM conducting management outside of national parks, and monitoring (Figure 1).

The ex-situ alternative was defined by planning out a program that could be used to supplement the existing wild populations. Actions included pre-capture population surveys, capture and transport, maintenance of the captive population, pre-release habitat improvement, surveys, research, disease screening and predator training, and post-release monitoring. This alternative also included the in-situ status quo actions, as in-situ management is required to maintain wild populations. This alternative was estimated to cost around $12.9 million over the 15 years, an average of $859,790 per year. The cost of the ex-situ component was borne by Hidden Vale Wildlife Centre, with the in-situ component split between the Qld DES and Terrain NRM as for the in-situ status quo alternative.

As a baseline for comparison, a 'do nothing' alternative was included in the analysis, with no associated actions or cost (Figure 1).

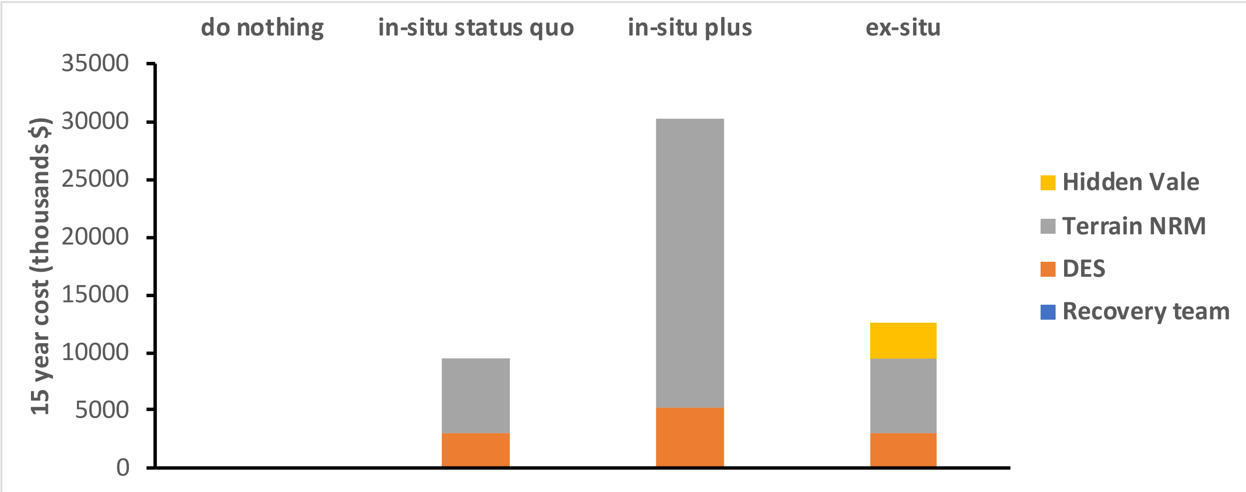

Figure 1: *Estimated cost of each management alternative with organisational contributions*

In the second session a Delphi expert elicitation process was conducted, with participants providing estimates on the likelihood of success of different components of the management alternatives, and the predicted outcomes in terms of relative population size in the wild. As part of the Delphi process, participants provided initial independent estimates, which were then standardised, anonymised, viewed, and discussed. Following discussion participants provided their final estimates, which were standardised and averaged across all participants to obtain mean values for each parameter, and 90% credible intervals for the relative population size predictions (e.g., Figure 2). These averaged estimates were then combined using the decision tree calculations (Figure 3) to give overall predictions of expected relative population size in 15 years under each management alternative.

The PACES tool also includes the capacity to elicit participants subjective trade-offs between the value of the wild population size change, the value of having an insurance population ex-situ (i.e., the value placed on having a successfully breeding ex-situ population independent of the stated plans for supplementation of the wild population), and management costs. Some participants chose to provide their value judgements, and the utility of a sensitivity analysis around trade-offs between wild population increase and the value of an insurance population was discussed.

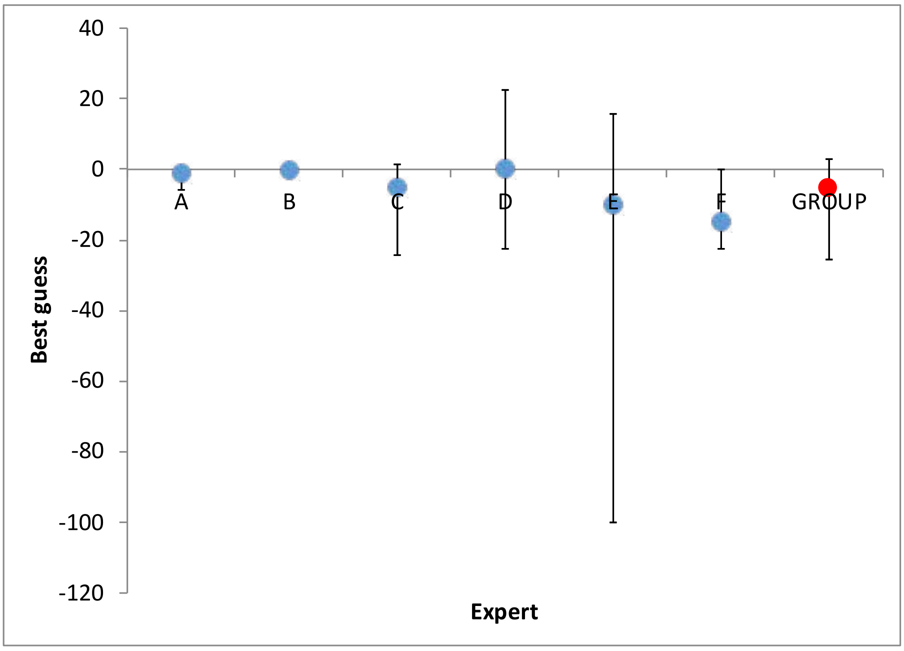

Figure 2: *Anonymised expert estimates of relative population size in the wild in 15 years' time under the baseline 'do nothing' alternative. Blue dots show each expert's best guess estimate, with whiskers showing the standardised 90% credible intervals. The group estimate (red dot and whisker) was found by taking the mean best guess, mean upper limit, and mean lower limit across all expert estimates.*

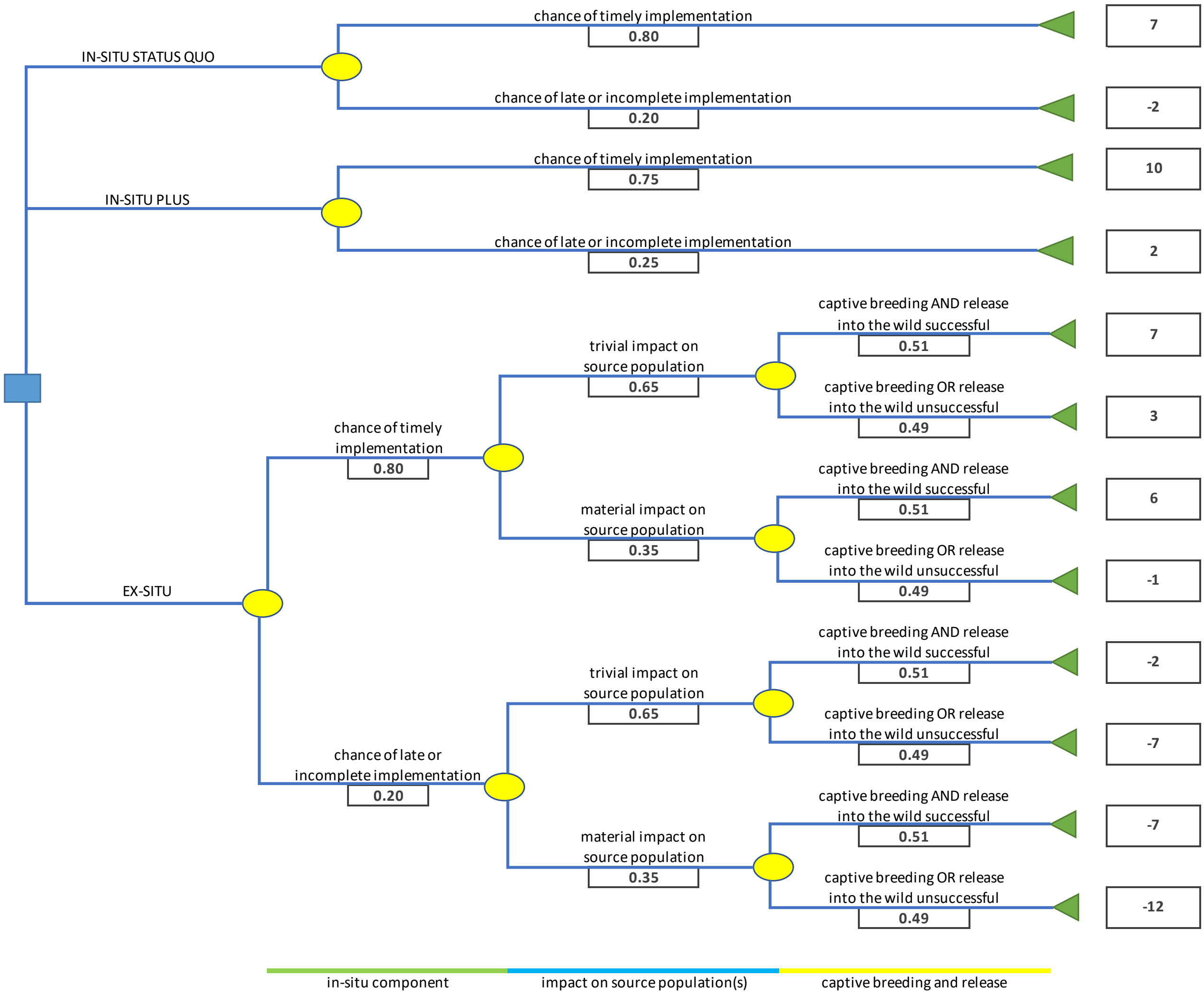

Figure 3: *Partial screenshot of the PACES tool showing the decision tree (also known as an event tree) for the three active management alternatives, with the mean (across experts) best guess estimates for each parameter. The blue square indicates a management decision, i.e., a choice between alternatives, while the yellow circles indicate chance events, with the mean probability of these events in the boxes on each branch. The green triangles are outcomes or payoffs, with the mean relative population size in 15 years (%) shown in the boxes to the right of these triangles.*

Results and discussion

Population predictions

The in-situ plus alternative had the best predicted outcome based on the averaged best guess estimates (a 7.7% increase in population size over the next 15 years), followed by the in-situ status quo alternative (a 5.4% increase), and then the ex-situ alternative (a 2.2% increase) (Figure 4). The do nothing alternative was the only alternative with a predicted population decrease based on the averaged best guess estimates (a 5.2% decrease over the next 15 years). The averaged 90% credible intervals show a sizable level of uncertainty around these predictions, generally negatively skewed to indicate a possibility of population decrease under all management alternatives. The lower bounds of the 90% credible intervals were quite similar across all three active management alternatives, from -17% under the in-situ plus alternative to -14.8% under the ex-situ alternative. The in-situ plus alternative had the highest upper bound by far, of 18.8%.

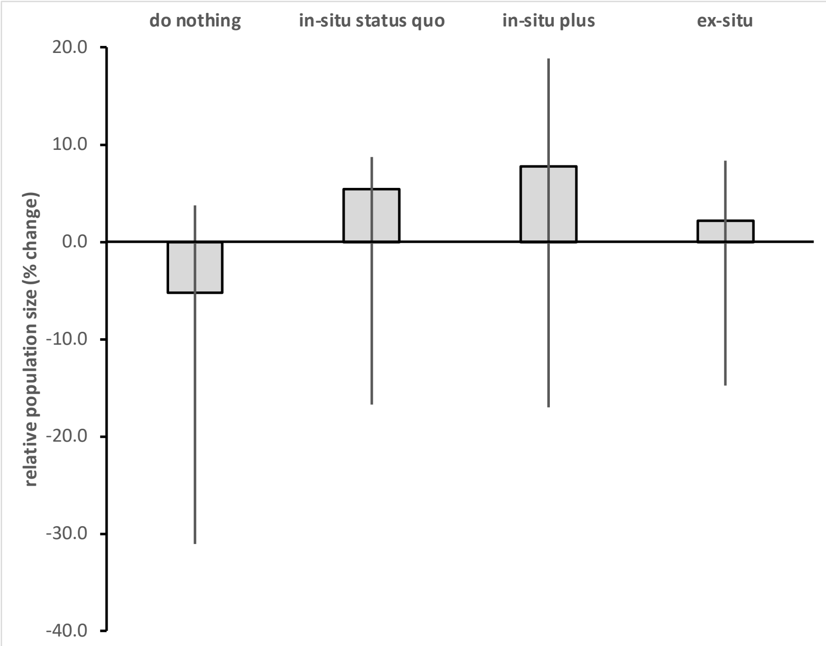

Figure 4: *Expected relative population size in the wild in 15 years' time under the 3 active management alternatives and the baseline 'do nothing' scenario'. Bars show predictions based on averaged best guess estimates, while lines show predictions based on averaged 90% credible intervals.*

Given that the ex-situ alternative includes the in-situ status quo actions, it is interesting to note that the mean predictions for relative population size under ex-situ management are lower than under in-situ status quo management, although the 90% credible intervals are very similar. The chance that sourcing individuals for the ex-situ program could have a material impact on the wild population (i.e., an impact that could threaten its viability) was estimated as 0.35 (Figure 3), which likely underlies this difference.

During the elicitation discussions, several participants expressed the view that population supplementation was unlikely to be effective in increasing the overall population size, because all available mahogany glider habitat is currently occupied. Due to the social patterns of gliders, any individuals added to already occupied habitat would be very unlikely to survive and breed. These concerns were included in the planning process by including pre-release surveys to find unoccupied habitat for release as part of the ex-situ management plan. However, we can still see this view reflected in the averaged best guess estimates. The best predicted population outcome under the ex-situ alternative (i.e., if all chance outcomes are successful) was a 7% population increase – the same as the predicted outcome if the in-situ status quo alternative was implemented successfully (Figure 3). Given that the worst predicted outcome under the ex-situ alternative was a 12% population decrease compared to a 2% decrease if the in-situ status quo alternative was implemented unsuccessfully (Figure 3), it makes sense that the overall population prediction under ex-situ management was lower than the prediction under in-situ status quo management.

Given the habitat limitations described above, several participants were of the view that the most effective way to increase population size would be by expanding the area of available habitat. We can see this view reflected in the results, in that the in-situ plus alternative, which has intensive investment in actions to expand, connect, and increase the quality of habitat, is predicted to results in a higher population size than the other alternatives.

Value judgements

While population predictions are essential information for choosing between alternatives, other information must also be taken into account. The option with the greatest predicted population increase may not necessarily be the best option, if the size of the expected benefit does not justify the price tag for implementation. Also, these population predictions do not take into account any value of an ex-situ population beyond its contribution to population size in the wild, such as its value as an insurance population. Assessing the trade-offs between these three outcomes – population size in the wild, having a successfully breeding insurance population ex-situ, and the cost of management – is a subjective value judgement that will be different for each participant. Knowing whether there is consensus or disagreement among participants as to a preferred alternative is a useful input to decision-making, and can indicate whether mediation or negotiation will be needed to progress to a decision.

The PACES tool includes an elicitation method allowing participants to describe the value of an ex-situ population relative to the wild population, and the extent to which that value depends on the size of the population in the wild, and also to identify a fair price indicating willingness to pay for specified conservation outcomes.

Four out of six participants completed the value judgement elicitation section (Figure 5). Among those four participants, the status quo in-situ alternative was unanimously supported (i.e., within participants' top two preferences) while the 'do nothing' alternative was unanimously opposed (within participants' bottom two preferences). There were then differences as to whether participants had the in-situ plus alternative or the ex-situ alternative in their preferred alternatives. These differences are due to differences in participants' assessment of the value of an ex-situ insurance population relative to changes in the wild population, and also their willingness to pay for conservation outcomes.

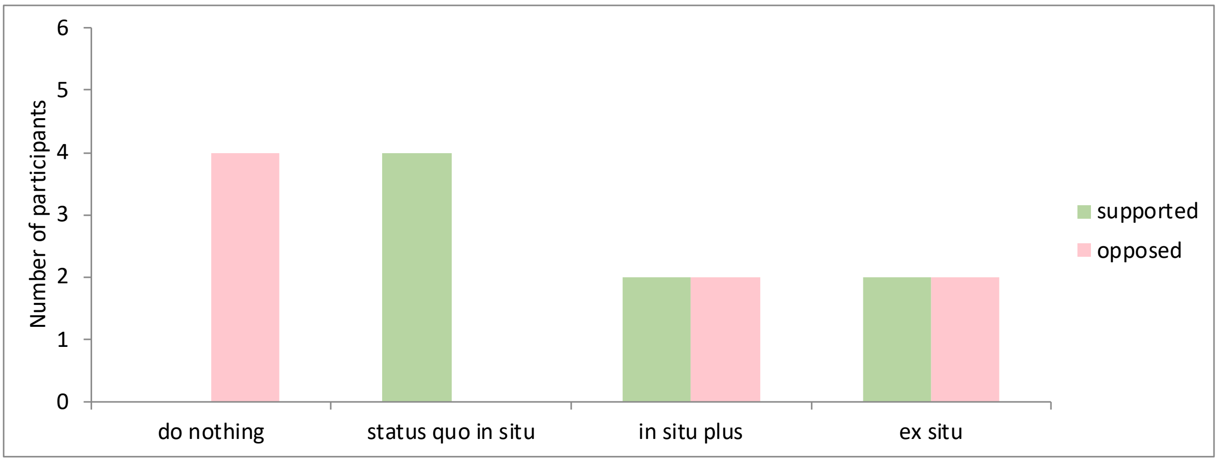

Figure 5: *A summary of participants' value judgements, showing the number of participants supporting and opposing each alternative for the mahogany glider. Value judgements express the relative value a participant assigns to the conservation outcomes (predicted relative population size and the presence of an ex-situ 'insurance' population) versus the cost of the management alternative. Expected value of each alternative is calculated from the best estimate predictions in Figure 4. A participant was characterised as 'supporting' an alternative if it was in their top 2 favoured alternatives (out of 4), and 'opposing' an alternative if it was in their bottom 2.*

The first step of the value judgement elicitation was to elicit participants relative values for wild population status and ex-situ insurance population. Participants were asked to judge four scenarios that are different combinations of the best and worst plausible conservation outcomes. These best and worst outcomes are taken from the 90% credible intervals in population predictions under different alternatives (Figure 4). The worst plausible scenario is the worst outcomes for both wild population status and the insurance population, which for the mahogany glider was a 31% population decline with no insurance population. This scenario is assigned a value of 0 by default. The best plausible scenario is a 19% population increase and an insurance population, which is assigned a value of 100 by default. Participants then decided, on this scale from 0 to 100, how they would assign value to the two intermediate scenarios that are combinations of the best and worst outcomes for population size and insurance population (Figure 6).

	Relative change (%) in population size in the wild	Insurance population	Value
worst	-31	no	**0**
intermediate A	19	no	100
intermediate B	-31	yes	20
best	19	yes	**100**

Figure 6: *Screenshot from the PACES tool showing one participant's value judgements for the intermediate scenarios (cells in orange)*

The second step of the value judgement elicitation draws out values for the different scenarios of combined conservation outcomes and cost. In this step, participants must imagine they are given a chance to change either the conservation outcomes from the worst to the best outcomes, or the cost outcome from the worst to the best outcome. They specified which of these changes they would prefer or value the most, and by how much. All participants ranked the change in conservation outcomes as their first preference, giving it a value of 100 (Figure 7). Each participant gave the second ranked change in cost a different value. For example, one participant gave it a value of 0, meaning they assigned no importance to the cost of alternatives and were comfortably willing to pay the highest cost for conservation outcomes (Figure 7). The participant whose judgements are displayed in Figures 6 and 7 preferred the in-situ status quo and in-situ plus alternatives over the ex-situ and do nothing alternatives.

	WORST	BEST	Rank	Value	Weight
Species status (% change in wild population) Insurance population	-31 no	19 yes	1	100	1.00
Cost ($'000)	30253	0	2	0	0.00

Figure 7: *Screenshot from the PACES tool showing one participant's value judgements for the second step of values elicitation focusing on willingness to pay (cells in orange)*

Given that the in-situ status quo alternative has a relatively good population outcome for a relatively low cost, it makes sense that it will be in most participants supported alternatives, unless their subjective value for an insurance population is high. Similarly, given that the do nothing alternative has the worst conservation outcome by far, it is unlikely that it will be in participants supported alternatives unless they rank the cost objective higher than the conservation outcomes. However, a key point of different between participants was whether they preferred the in-situ plus alternative over the ex-situ alternative or vice versa.

Looking at the best estimate predictions, the in-situ plus alternative is predicted to deliver a better outcome for wild population status than the ex-situ alternative (7.7% increase versus 2.2.% increase). However, this increase comes with a much greater cost ($30 million versus $13 million) and without the benefit of an insurance population. (Note that the ex-situ population has a 0.79 chance of successfully resulting in an insurance population, as given by the estimated ex-situ breeding success.) It therefore makes sense that preference for these two alternatives depends on the value assigned to wild population status versus insurance population status, as well as the willingness to pay for conservation outcomes.

Preference for the in-situ plus alternative over the ex-situ alternative occurs when the value placed on an insurance population is low, and the value placed on the cost of alternatives is also low (Figure 8). When no value is placed on cost (Figure 8a) there is a small state space where the in-situ plus alternative is preferred over ex-situ alternative. This is where the value of a scenario with an insurance population and a wild population decrease is minimal, and also where the value of a scenario with a wild population decrease is almost equivalent to achieving that increase in addition to an insurance population. As the importance placed on cost increases (Figure 8b), the space where the in-situ plus alternative is preferred shrinks. If the cost is valued at 20% or more of the value of conservation outcomes (Figure 8c), then the in-situ plus alternative is no longer preferred over the ex-situ alternative regardless of other values.

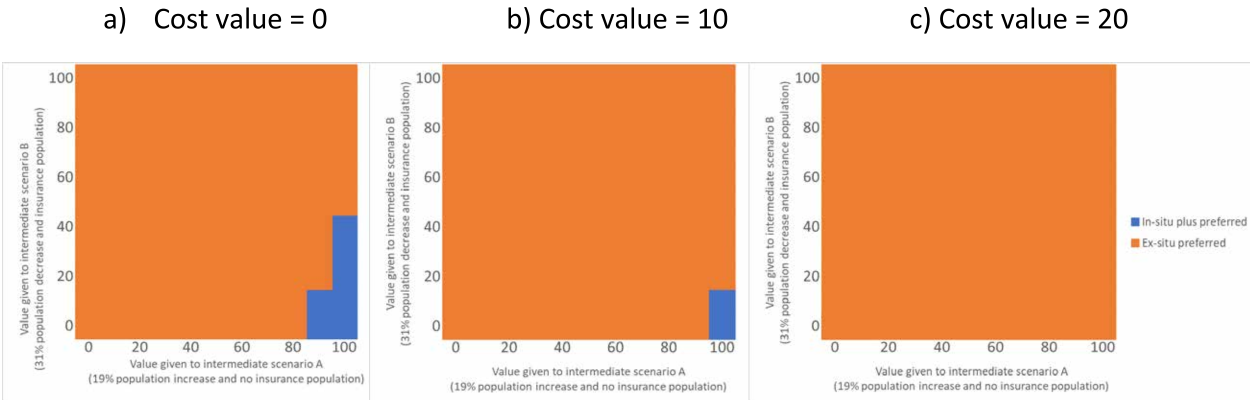

Figure 8: *Sensitivity analysis on the values assigned to intermediate scenarios A and B (see Figure 6) and the cost value (see Figure 7). Only compares preference for in-situ plus and the ex-situ alternative, calculated using best estimate predictions from Figure 4.*

In conclusion, the in-situ plus alternative is predicted to have the best outcomes for the mahogany glider in the wild over the next 15 years. Consideration over whether this alternative should be implemented must include a careful consideration of the value and utility of having an insurance population for this species, and also whether the cost of the in-situ plus alternative is justified by its conservation benefit given the priorities and competing conservation goals of the investing organisations.

Further information:

http://www.nespthreatenedspecies.edu.au

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