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Bob Higgins
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Dear Bob,

I have now reviewed the Ballina Koala Plan that details the outcomes of the koala population viability analysis (PVA) of the proposed Pacific Highway upgrade near Wardell, NSW and I am happy to endorse the contents of that report. Within the constraints of limited data and the time frames within which the report had to be produced, I believe that this report is scientifically sound. The report details estimates of the potential impact of the road upgrade on the koala population in the region and identifies the extent to which habitat restoration may offset these impacts. It then considers other potential management strategies, which could further compensate for the impact of the road upgrade, by reducing mortality on other roads, or by increasing fecundity through measures such as disease management. It also assesses the robustness of the estimates of the impact of the road.

As with all models, the models underlying PVA are only as good as the data used to develop them and the appropriateness of the assumptions made in the model structures. PVA generally requires large amounts of data over many years to reliably parameterise the models that underpin PVA. In particular, reliable estimates of demographic rates and their variability through time are very hard to obtain without large sample sizes and many years of data. However, extensive data of this kind are rarely available (as is the case with this study) and therefore the reliability of absolute estimates of risks of extinction are generally highly unreliable. However, even when absolute estimates of extinction risk are unreliable, it has been demonstrated that *relative* measures of extinction risk or population size predictions will tend to be much more robust. Consequently, using PVA to compare the likely relative outcome of alternative management scenarios is a much more reliable use of PVA than using it to meet targets based on absolute measures of extinction risk. Consequently, this report focuses on comparing predicted outcomes among alternative scenarios (e.g., the impact of the road upgrade is estimated based on the difference between scenarios with the road upgrade and scenarios without the road upgrade) rather than on absolute predictions of extinction risk or population size.

Given considerable uncertainties about the input parameters for the model underpinning the PVA and the appropriate structure of that model, estimates of the impact of the road upgrade are uncertain. These uncertainties translate into a range of plausible outcomes being presented for the impact of the road upgrade, rather than a single value. Based on

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a consideration of a range of values for parameter inputs, the impact of the road upgrade is estimated to have a plausible range between having no effect to having a small affect equal to around a 10% decline in population size relative to the no road case (assuming that fencing will completely prevent mortalities on the road). This impact will be partially offset by proposed habitat restoration activities (with the predicted effect varying with assumptions). In addition, the PVA shows that other mitigation activities, such as fencing on other roads to reduce mortality, or measures to increase fecundity, could compensate for the impact of the road upgrade.

Nonetheless, considerable uncertainties inevitably still exist and I recommend that a robust long-term monitoring strategy be put in place to evaluate the actual impact of the road upgrade and to inform future modelling efforts. What this monitoring strategy should look like will depend ultimately on the monitoring objectives, but the baseline studies that were used to inform the PVA surveys (e.g., Ecosure 2015) could provide an appropriate baseline for future monitoring. The outcomes of this monitoring should then explicitly inform decisions on whether to implement further mitigation activities in the future if necessary.

Yours sincerely,

Associate Professor Jonathan Rhodes