Expert review of “Modelling Trends in *Powelliphanta patrickensis* Snail Populations on Buller Plateaux”

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Proteus
YOUR ECOLOGICAL STATISTICAL EXPERTS

EXECUTIVE SUMMARY

1. I have reviewed the report "Modelling Trends in *Powelliphanta patrickensis* Snail Populations on Buller Plateaux" by Dr Brian Lloyd and have no substantial areas of concerns about the methodology or demographics parameters used. A key assumption in association to the projected response of *P. patrickensis* in predator-free enclosures is that adult survival will increase by 0.2. Whether an increase of this size is attainable in practice is outside my area of expertise.

INTRODUCTION

2. My full name is Darryl Ian MacKenzie. I am the Managing Director and Principal Biometrician at Proteus Research and Consulting Ltd (Proteus).

3. This technical assessment addresses the establishment of predator-proof enclosures for *Powelliphanta patrickensis* proposed for the Buller Plateaux Continuation project, and provides an independent review of the population modelling and resultant projected trajectories of *P. patrickensis* populations aspects of the Project.

Qualifications and experience

4. I have the following qualifications and experience relevant to this assessment:

   (a) Ph.D. (Statistics), University of Otago, 2002.

   (b) Diploma in Applied Statistics, University of Otago, 1998.

   (c) B.Sc (Statistics), University of Otago, 1995.

   (d) Since September 2001 I have been self-employed at Proteus.

   (e) In 2019 and 2020 I held a 0.2 FTE Associate Professor position in the Department of Mathematics and Statistics, University of Otago, a since that time held an Honorary Associate Professor position in the same department (currently in the renewal process).

   (f) I specialise in applying statistical methods to ecological applications, with a particular expertise in species distribution modelling, mark-recapture methods, and distance sampling for estimating animal abundance. During my almost 30-year consulting career I have worked

on a wide range of ecological and environmental applications, all around the world.

(g) I have 80 peer-reviewed publications in scientific journals, taught over 60 short-courses on statistical methods to ecologists and other biological scientists.

(h) I have previously provided the Department of Conservation and Solid Energy with expert design advice on mark-recapture studies for *Powelliphanta augusta* and *Powelliphanta patrickensis* on monitoring plots the Buller Plateaux, and conducted analyses of such data to estimate snail abundance and annual survival probabilities (e.g., MacKenzie 2014; MacKenzie 2020).

Code of conduct

5. I confirm that I have read the Code of Conduct for expert witnesses contained in the Environment Court Practice Note 2023. This assessment has been prepared in compliance with that Code, as if it were evidence being given in Environment Court proceedings. In particular, unless I state otherwise, this assessment is within my area of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

Purpose and scope of assessment

6. The purpose of this assessment is to provide an independent review of and comment on:

(a) Statistical aspects of the population modelling used to project population trajectories for *P. patrickensis* in response to the establishment of predator-proof enclosures on Buller Plateaux.

Assumptions and exclusions in this assessment

7. I have not reviewed the computer code used to implement the population modelling for errors or omissions, although have not identified any results that would suggest the presence of any notable errors or omissions in the code.

THE BULLER PLATEAUX CONTINUATION PROJECT

8. The full description for the Project is provided within the AEE. I do not repeat it in my assessment.

METHODOLOGY

Introduction

9. My approach has been to review reports associated with the population modelling developed in support of proposed offset measures for *P. patrickensis* at the Project site. I have not visited the site.

10. The primary report I reviewed was “Modelling Trends in *Powelliphanta patrickensis* Snail Populations on Buller Plateaux” prepared by Dr Brian Lloyd, and also the following reports cited therein (also by Dr. Lloyd) that contained source information on the demographic studies and analyses that were used to project population trajectories: “Capture-recapture Monitoring *Powelliphanta patrickensis* Snails in Denniston Permanent Protection Area, 2014–2024.”; and “*Powelliphanta patrickensis* Snail Surveys on Buller Plateau: 2012 and 2024.”

11. I reviewed an initial draft version of Dr Lloyd’s report, provided high level feedback that was incorporated into the next iteration of the report, which I then reviewed. This iterative process was completed four times before the final version was received that I review here.

COMMENT ON THE METHODOLOGY USED TO ASSESS POPULATION TRAJECTORIES

12. I have no substantial areas of concern about the population modelling presented by Dr Lloyd in his report, and matters raised below I generally consider, in my expert opinion, to be relatively minor in the context of his overall findings.

13. The general methodologies used by Dr Lloyd for the population modelling are scientifically sound, widely used and appropriate given the objective and available information.

14. Alternative modelling frameworks exist (e.g., individual based models) but the added complexity is unlikely to substantially affect conclusions given the individual-level estimates of demographic parameters are not available.

15. I concur with Dr Lloyd's statement that " …models simplify the complexities of reality and are never entirely correct. However, well-constructed models can assist with decision-making about the real world." Population models are a mathematical construct reflecting a series of assumptions about how part of the world functions, and using parameter input values that have been obtained from real-world data. Even though a simplification of reality, a model can still usefully predict consequences of changes to assumptions or input values provided no critical assumptions are violated.

16. Input demographic parameters have been sourced from relevant, in-situ, demographic studies of *P. patrickensis*.

17. Snail abundance estimates exhibit annual fluctuations, which should be expected and has been observed in other studies of *P. augusta* (MacKenzie 2020) and *P. patrickensis* (MacKenize 2014) in the region. This would indicate that population growth is not constant over time and as some natural annual variation.

18. The finite population growth rate (lambda) used by Dr Lloyd is calculated from the first and last abundance estimates available in his time series, which happen to be the highest and lowest estimates, respectively. This situation should not be unexpected for a declining population, although whether these values are spuriously high or low values is unknowable without the context of a longer timeseries of abundance estimates.

19. I note that the lambda value calculated from the first and last estimates of the timeseries only is equal to the geometric mean of the lambda values determined from successive years during the timeseries, as the abundance estimates for the intervening periods will appear as both a numerator and a denominator in the series of lambda calculations, and so therefore cancel. That is:

$$
\begin{aligned}
Geometric\ mean &= \left(\frac{N_{2015}}{N_{2014}} \times \frac{N_{2016}}{N_{2015}} \times \frac{N_{2017}}{N_{2016}} \times \ldots \times \frac{N_{2022}}{N_{2021}} \times \frac{N_{2023}}{N_{2022}}\right)^{\frac{1}{9}} \\
&= \left(\frac{1}{N_{2014}} \times \frac{N_{2015}}{N_{2015}} \times \frac{N_{2016}}{N_{2016}} \times \ldots \times \frac{N_{2022}}{N_{2022}} \times N_{2023}\right)^{\frac{1}{9}} \\
&= \left(\frac{N_{2023}}{N_{2014}}\right)^{\frac{1}{9}} \\
&= \lambda_{pred}
\end{aligned}
$$

20. Dr Lloyd accounts for uncertainty in the abundance and population growth parameter estimates, and the resulting confidence intervals provide an indication of the range of possible population trajectories, and can be used to infer the projected population trajectory if the true lambda value is much higher or lower than the assumed point estimate of 0.896.

21. As noted by Dr Lloyd in his conclusion, his derived values for survival in the absence of predation are inline with those obtained for other *Powelliphanta* populations over similar timeframes (and therefore the estimated survival probabilities in the presence of predation are lower than those estimated from other populations). He suggests that the predation pressure on the populations in these other times and/or places is therefore lower than that experienced by *P. augusta* on the Stockton and Denniston Plateaux. I do not have any first-hand knowledge of how predation pressures vary in the general region so defer to his judgement on this matter.

22. Using the observed cause of death from recovered snail shells to attribute source-specific mortality rates (i.e., predation vs natural) assumes that the probability of detecting shells of dead snails does not substantially vary by cause of death. That is, the fraction of shells recovered of snails that died of natural causes is very similar to the fraction of shells recovered of snails that were predated. If the detection probability is substantially different by cause of death, the observed cause of death proportions will be biased, leading to biased source-specific mortality rates.

23. Predation mortality rates will be overestimated if the detection probability of predated snail shells is higher than the detection probability of natural-death snail shells, and predation mortality rate will be underestimated if detection probability for predated snail shells is lower. No data was available to assess whether detection probability is reasonably similar by cause of death, and collecting such data would be difficult.

24. Dr Lloyd has carried through, or propagated, uncertainty in demographic parameter input values, which allows an assessment of the level of certainty about any resultant population trajectory, and also provides insight on expected trajectories under different demographic input values.

25. The main driver of the projected population increases in enclosures is an increase in adult snail survival from 0.524 to 0.725 (which also contributes to a higher fecundity value). Irrespective of the specific values for survival, the change in population trajectory will be relative to the uplift in snail

survival as a result of predator-free enclosures. Increases in adult survival that are greater, or lesser, than 0.2 will result in population trajectories that are correspondingly larger or smaller.

SUMMARY

26. I have reviewed the report “Modelling Trends in *Powelliphanta patrickensis* Snail Populations on Buller Plateaux” by Dr Brian Lloyd and have no outstanding substantial areas of concerns about the methodology used.

27. The demographic parameters used in the assessment were obtained from sound analyses of demographic data from in-situ sites. A key assumption in association to the projected response of *P. patrickensis* in predator free enclosures is that adult survival will increase by 0.2.

28. Whether an increase in adult survival of this magnitude is achievable in practice is outside my area of expertise.

REFERENCES

MacKenzie, D. I. (2014). Abundance and Survival Estimation of *Powelliphanta patrickensis*. Retrieved from Proteus Wildlife Research Consultants, Dunedin.

MacKenzie, D. I. (2020). Abundance and survival estimation of *Powelliphanta augusta*: 2009-2020. Retrieved from DOC, Hokitika.

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