Optimising translocation strategies in the conservation management of reptiles; a case study of an endangered Australian skink *Tiliqua adelaidensis*

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Summary

Translocation is a powerful tool in conservation management. It is relevant for species that have lost a large part of their habitat, or live in a highly fragmented habitat, or have suffered intensive land degradation such as agricultural activities or urban developments. It is also relevant for species that are faced with exotic predators or diseases, and for those with a current distributional range that may become unsuitable with future climate changes. There are a range of terms currently used to describe translocations to augment existing populations, or to introduce individuals to a currently unoccupied site that may be within or outside of the known historical range. Reintroduction, assisted colonisation, reinforcement and ecological replacement are all considered different kinds of translocation performed for different purposes. However, the ultimate goal of each is to increase the chance of survival of a threatened species, with the different approaches appropriate to use in different circumstances. The success of any translocation may be diminished by the high tendency of translocated individuals to disperse from the release site. Many successful translocations have involved releases on islands where a geographical barrier prevents dispersal. For translocations to mainland sites, conservationists have attempted to reduce dispersal with different methods such as soft release strategies (containing the released individuals for a period of time while they adjust to the novel conditions at the release site) or by adding supplementary food. An important component of investigations into translocation success is behavioural changes in the translocated individuals. Behavioural ecology may help conservationists understand how individuals react

to the stress and the novel conditions they experience in the translocation process, and how best to adjust management procedures to minimize the impact of these behavioural changes.

In this project we conducted a series of simulated translocation experiments, within large circular cages, on the endangered Australian skink, the pygmy bluetongue lizard (*Tiliqua adelaidensis*) and recorded individual behaviours under alternative release conditions to understand how change those conditions might modify behaviour and improve translocation outcomes.

The pygmy bluetongue lizard was thought to be extinct until 1992 when it was rediscovered from the stomach of a dead elapid snake, *Pseudonaja textilis,* near Burra in the mid north of South Australia. Pygmy bluetongue lizards use narrow vertical and single entrance burrows that are made by lycosid and mygalomorph spiders. They occupy vacated burrows and use them as refuges from climatic extremes and from predators, and they use the burrow entrances as ambush sites from which they detect passing invertebrate prey. They leave their burrows rarely for catching prey, defecation, finding mates, or for moving to new and better burrows. This species lives in highly fragmented native Australian grasslands, and all of the few populations now known are on privately owned land. Simulation modeling of climate change scenarios has suggested that translocation will be an essential long-term conservation management strategy for this species. Because there is a high tendency for translocated reptiles to disperse from translocation sites, there is a need to document the set of conditions that will minimize this tendency for this species. This information may be helpful for future translocation program for other reptile species too.

I did 10 simulated translocation experiments with pygmy bluetongue lizards. I changed one factor in each experiment. Experiments included adding supplementary food, changing vegetation density, providing higher burrow densities and so on. In each experiment I video-recorded all lizard behaviours during the normal daily activity time. This allowed me to compare lizard behaviour in alternative control and experimental conditions. I investigated how the factor I changed could increase or decrease risk of dispersal and at the same time how other behaviour such as basking, movement and agonistic interaction toward each other changed. A summary of the results is that dispersal was reduced when lizards had higher vegetation, more supplementary food, more burrows available, or burrows more tightly clustered, and when lizards were confined to the release area for a short time period. Dispersal was also reduced if the surrounding area was disturbed, if there were fewer conspecific cues (implying that higher release density may lead to higher dispersal, and if releases took place later in the activity season.

During the experiments I also gathered information about the natural history of this species. I found that the spiders, that are important ecological engineers for pygmy bluetongue lizards by providing burrows for them, are also important enemies of this species because they can kill lizards that try to take over burrow ownership. I also found that the traditional design of artificial burrows that has been accepted by natural populations of pygmy bluetongue lizards and that has been shown to enhance wild population density, leads to more risky behaviour of resident lizards than natural burrows. I have suggested redesign by adding a small chamber at the bottom of the burrows to allow lizards to turn around underground. I found that pygmy bluetongue lizards stay in flooded burrows even when they are underwater up to their necks. I also showed that the lizards accepted alternative natural burrows such as mouse burrows if their entrance diameters are not bigger than spider burrows (about 2 cm). These could be an additional resources of natural burrows in future translocation sites.

Finally I used the data that came from the huge data files (16544 hours of video footage) from the simulated translocation experiments to produce decision tree models and predict how the parameters I investigated can be important in real translocations. I provided two different decision trees; one informing how each of behavioural parameter I studied is likely to be affected by each of the alternative parameter states I investigated, such as vegetation density, supplementary food and soil disturbance. The second model indicated how each of behaviour might be altered by interactions with other behavioural parameters and environmental parameters that I changed. These two model can be used by conservation managers to make decisions under different circumstances for pygmy bluetongue lizards at translocated sites or to predict lizard behaviour in different translocation sites. In a broader context, these models with a few modification could be applied other translocation programs and used to predict translocated species behaviour under different situations.

Briefly, data from this thesis provide new insights into the relationships between behavioural ecology and conservation management with a focus on translocation strategy. The results show how changes in behaviour can be used to predict future translocation success or failure, and how we could manipulate the release conditions for translocated species to alter their behaviour and encourage them to stay at the release sites, thereby increasing the chance of translocation success. This thesis also shows how data from simulated translocation experiments could be useful before actual translocations are attempted. The next stage in developing strategies for the conservation management of the pygmy bluetongue lizard is to see whether the trends from simulated releases in cages are translated into real translocation situations.

Declaration

I certify that this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Mehregan Ebrahimi

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Organisation of Thesis

This thesis contains 11 chapters, based on experiments and observations on translocation and behavioural ecology of the endangered pygmy bluetongue lizard. Chapter 1 is a general introduction that outlines the background and theory of this project and the aims of this research. The general methods of the experiments in simulated translocations are given in the second chapter and results from a series of these experiments are presented from chapter three to chapter eight, in the format of published, under review or submitted manuscripts. Chapter nine includes more published manuscripts that describe some natural history observations derived during the study, that add to our understanding of the biology and conservation management of the pygmy bluetongue lizard. Chapter ten is a conclusion in which I discuss the results of all experiments in this thesis, show how they can improve future translocation attempts in lizards in format of manuscript, and suggest future research on reptile translocations.

Publications arising for this thesis and statement of candidate contribution

This thesis is predominantly composed of papers that have been published, accepted for publication, or have been submitted (or are near to being submitted) for review in peer reviewed journals. I did all of the field work, collection of data, analysis and most of the interpretation. I took advice from my supervisor Prof. C. M. Bull for directions of analysis and for the formatting and presentation of all of the papers. All co-authors have given me permission for this work to be used in my thesis. The paper order reflects the thesis structure rather than chronological order. Below I list the papers and estimate my contribution to each.

Chapter 3

Ebrahimi, M. and Bull, C. M. (2013). Determining the success of varying short-term confinement time during simulated translocations of the endangered pygmy bluetongue lizard (*Tiliqua adelaidensis*). Amphibia-Reptilia 34, 31-39.

ME 80%, CMB 20%

Chapter 4

Ebrahimi, M. and Bull, C. M. (2012). Food supplementation reduces post release dispersal during simulated translocation in the endangered pygmy bluetongue lizard (*Tiliqua adelaidensis*). Endangered Species Research, 18, 169-178.

ME 80%, CMB 20%

Chapter 5

Ebrahimi, M. and Bull, C. M. (2013). Resources and their distribution can influence social behaviour at translocation sites: lessons from a lizard. (Under review).

ME 80%, CMB 20%

Chapter 6

Ebrahimi, M. and Bull, C. M. (2013). Behavioural changes in an endangered grassland lizard resulting from simulated agricultural activities. (Under review).

ME 80%, CMB 20%

Chapter 7

Ebrahimi, M. and Bull, C. M. (2014). Visual conspecific cues will not help in pygmy bluetongue lizard translocations. Applied Animal Behaviour Science, 151, 102-109.

ME 80%, CMB 20%

Chapter 8

Ebrahimi, M. and Bull, C. M. (2013). Effect of time of release on behaviour and movement of translocated lizards. (Under review).

ME 80%, CMB 20%

Chapter 9

Ebrahimi, M., Fenner, A. L. and Bull, C. M (2012). Lizard behaviour suggests a new design for artificial burrows. Wildlife Research, 39, 295-300.

ME 80%, ALF 10%, CMB 10%

Ebrahimi, M. and Bull, C. M. (2012). Lycosid spiders are friends and enemies for the endangered pygmy bluetongue lizard (*Tiliqua adelaidensis*). Transactions of the Royal Society of South Australia, 136 (1): 45-49.

ME 80%, CMB 20%

Ebrahimi, M., Schofield, J. A. and Bull, C. M. (2012). Getting your feet wet. Responses of the endangered pygmy bluetongue lizard (*Tiliqua adelaidensis*) to rain induced burrow flooding. Herpetology Notes, 5, 297-301.

ME 80%, JAS 5%, CMB 15%

Ebrahimi, M., Schofield, J. A. and Bull, C. M. (2012). *Tiliqua adelaidensis* (Pygmy Bluetongue Lizard). Alternative Refuge. Herpetological Review, 43 (4) 652-653.

ME 80%, JAS 5%, CMB 15%

Chapter 10

Ebrahimi, M. Ebrahimie, E. and Bull, C. M. (2013). Minimising the cost of translocation failure by using decision tree models to predict species behavioural response in translocation sites. (Prepared for Conservation Biology)

ME 80%, EE 10% CMB 10%