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NCCARF Travel Grant Summary Report

This year, with thanks to NCCARF, I was able to travel to Victoria to collaborate with my external supervisor Dr. Mike Kearney from the University of Melbourne. My research focuses on the 'where' of managed relocation (previously termed assisted migration); determining how to identify translocation reserves for threatened species under climate change. Traditional modelling approaches (such as climate-envelope models) that could be used to predict the future distributions of species are correlative in nature, and as such have limited applications for threatened species which typically have restricted distributions. Specifically, these models draw statistical correlations between species distribution records and spatial environmental data to make predictions about future distributions. Unfortunately, threatened species can have so few populations that there is insufficient distribution data with which to construct these models. Mechanistic models are independent of species distribution records and so offer a promising alternative to statistical models. Using Australia's rarest reptile, the Western Swamp Tortoise (*Pseudemydura umbrina*) as a model species, I aim to identify the most optimal translocation sites for the species that will remain suitable long term and under multiple climate scenarios (see case study in NCCARF-TB e-bulletin vol. 2, 2009).

The purpose of this collaborative visit was to learn mechanistic modelling techniques and theory that would be relevant to my PhD. In particular, I hoped Dr Kearney would teach me new elements of Niche Mapper™, the mechanistic model I will be using to model the fundamental niche of *P. umbrina* across Australia. It was also hoped that we could commence preliminary modelling using dynamic energy budget theory – a means with which to understand how species utilise energy for maintenance, storage, growth and reproduction. Dynamic energy budget theory will be particularly relevant for studying the dynamics of populations under multiple climate scenarios as it is sensitive to changes in temperature and energy availability – both key elements that are predicted to shift with global climate change.

Major Findings

While the primary purpose of this collaboration was to learn new modelling techniques and approaches, during my visit Dr Kearney and I were able to commence the development of a dynamic energy budget for the western swamp tortoise, and use this to gain a preliminary understanding on the impacts of a drying climate upon the physiology of the species.

Using data collected by Perth Zoo and the Department of Environment and Conservation, we were able to develop a preliminary model of the dynamics of the energy reserves of a western swamp tortoise through the early phases of its life. Energy availability is particularly important for hatchlings of this species, who must accumulate enough energy during the wet season to sustain them through the summer aestivation period when the swamps dry up. From hatching stage, the model output tracked an accumulation of energy within the tortoise's energy reserve during each winter, and predicted the depletion of its energy stores with each summer aestivation. Simultaneously, the model was also able to predict growth (body mass and size) during this time, which is a valuable measure against which I will be able to validate the model. By shortening the normal (historic) hydro-period by 4 weeks to mimic a drying climate, the dynamic energy budget model predicted that a hatchling tortoise would only just survive its first aestivation period. However, we were able to gauge the relative importance of climate factors by manipulating temperature and water availability, and found that, while a shortening of the hydro-period would limit the time available for a tortoise to accumulate energy stores, a simultaneously warmer climate would allow it to grow faster during that time. Further

manipulations of temperature and rainfall inline with future climate predictions (e.g. CSIRO 2007) will assist in predicting hatchling success.

Outcomes of Collaboration

This collaboration gave me crash course in the implementation of dynamic energy budget theory and was invaluable in helping me visualise how the theory could be manifested into a working 'program'. I was able to obtain the models and spreadsheets required for my ongoing research, and in turn this has helped me define what key experiments will be necessary during my PhD for further development and validation of the models. My visit allowed me to put together the "shell" for the modelling and I'm now in a position to develop better estimates of the model parameters through experimental work over the next two years.

The preliminary modelling results generated during our collaboration were presented at the 35th meeting of the Australian Society of Herpetologists (NCCARF acknowledged). The 15 minute presentation, which was principally aimed at those herpetologists involved in conservation planning and management, discussed the impending need for managed relocation and what tools were available for selection of new translocation reserves. Dynamic energy budgets offer a way in which to elaborate upon existing niche modelling through examining energy availability for reproduction and growth, and thus could be used by conservation planners to identify sites that would be most suitable for population establishment under novel climates. The importance of understanding energy fluxes was then demonstrated using the western swamp tortoise dynamic energy budget model generated through our collaboration, where we were able to show the predicted effects of a drying climate upon the survival of young tortoises- key players in population establishment.

The preliminary modelling results were also presented at recent assisted migration workshop run by the NCCARF-TB network in York, Western Australia, and at a community opening of conservation week run by the Conservation Council of Western Australia.

Significance to Adapting and Protecting Australia's Terrestrial Biodiversity

Currently, conservation planners and managers are largely limited to correlative approaches for selecting translocation reserves for threatened species. Correlative approaches can be unreliable when extrapolating to future climates in those species that have restricted distributions. Through collaboration with Dr Kearney I was able to acquire new modeling skills and knowledge that will be directly applied to predicting the future translocation viability of one such threatened species; the critically-endangered western swamp tortoise. The novel application of dynamic energy budget theory to niche modeling represents a step forward in predicting population dynamics for threatened species under uncertain climates. Whilst not only serving to inform conservation planners about optimal translocation sites for the western swamp tortoise, it is also anticipated that the modeling results generated through my PhD will be broadly applicable to other terrestrial Australian species that have an aquatic phase to their life cycle. It is hoped that the approach used will serve as a template for selecting translocation sites for other threatened Australian biodiversity.

Reference

CSIRO, 2007. Climate Change in Australia – Technical Report, Canberra.