NCCARF PhD Travel Grant Report

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The PhD. travel grant was used for travel expenses to Auckland to collaborate with Dr. George Perry (University of Auckland). Dr. Perry and I collaborated on the construction of spatially-explicit dispersal models that highlight the importance of dispersal (particularly long distance dispersal) as a means for species to colonise suitable new habitat under the threat of climate change. Whilst in Auckland I opportunistically attended an ecological systems modelling course run by Dr. Perry and Dr. David O'Sullivan (University of Auckland). I also presented a seminar to the School of Environmental Science there on the impact of disperser loss on the demographics of key large-seeded species in the Jarrah (*Eucalyptus marginata*) forests of southwestern Australia, and the importance of dispersers as a mechanism for resilience (via range expansion) under climate change.

Major findings

A major finding of my collaboration has been highlighting the importance of individual species ecology, traits and life histories on their susceptibility to climate change and resilience to its impacts. Dr. Perry has significantly helped in placing this research into a broader climate change context through the use of dispersal modelling approaches.

Information on the ecology of large-seeded species in the Jarrah forests of southwestern Australia has been built into spatially-explicit agent-based models to predict their potential to colonise new habitat in the face of climate change. Our agent-based modelling reveals that in conjunction with the ecology of individual species, dispersal potential is a key component of range shift success. Our models reveal that dispersal, in particular long distance dispersal, is crucial to meaningful range expansion. Modelling will reveal required levels of long distance dispersal (including both distance and rates) to facilitate range shifts.

Major outcomes

A major outcome of the collaboration is the establishment of an ongoing working relationship with Dr. Perry. We are currently finalising the draft of a manuscript on the spatial ecology of large-seeded species in the Jarrah forests of southwestern Australia. This paper is being

presented at the Southern Connections Congress held at the University of Otago early in 2013.

A manuscript has also been drafted on the impact of season of burn on the reproductive biology and population persistence of *P. drouynianus*. This paper is also being presented at the Southern Connections Congress.

A third manuscript is planned that describes an agent-based model for examining the impact of dispersal loss, habitat fragmentation, fire, climate change (and the interactive effects) on populations of species in the Jarrah forests.

A further outcome of this collaboration is that Dr. Perry and Dr. O'Sullivan have been invited to Murdoch University in 2013 to continue further collaborations and to deliver an ecological systems modelling course.

Significance to adapting and protecting Australia's terrestrial biodiversity

The major purpose of this collaboration was to obtain and incorporate individual species information into robust models that can predict the potential for range expansion under climate change and other threatening processes (e.g. altered fire regimes, increasing fragmentation, disperser loss and decline etc). Our manuscripts on the importance of spatial ecology, species-level demography and linked models provide a framework for predicting the resilience of key species to climate change. Our models are being written so that they are available to a wide audience; researchers and conservation authorities alike. As such, they are inclusive (and reproducible) tools for disentangling the impacts of climate change on individual species and provide an opportunity to identify resilience pathways.

Future research suggestions

Future research conducted on climate change adaptation needs to consider the following elements:

- With range shifts a key component of plant climate change adaptation strategies, increasingly sophisticated methods are needed to better describe and understand the range shift potential (via dispersal) of individual species. Individual and agent-based models (ABMs) will be a key part of this range expansion assessment/prediction process.

- A standardised approach to model construction and publication needs to be followed (see Grimm *et al*., 2006; Grimm *et al*., 2010) so that these tools can be used by all researchers, not simply those that constructed them.
- ABMs provide a mechanism to assess range shifts and climate change impacts at local, regional and landscape-level scales. There is a general absence in the literature of multi-scale climate change range shift assessment.
- Improved knowledge on the ecology and reproductive biology of individual species is implicitly important to assess their risk in response to climate change and associated threats (altered fire regimes, severe weather events).

Acknowledgments

I would like to sincerely thank NCCARF for the funding to undertake this collaborative travel. This collaboration has been essential in the drafting of three manuscripts and two conference papers. This collaboration has also provided me with the knowledge and modelling skills (that are developing each day) to better understand how the impacts of climate change on the flora of Western Australia may be mitigated. This collaboration has also served to guide me in the direction and focus of my PhD and beyond.