Linking Landscapes Symposium
Bendigo, May 2017
Biolinksalliance.org.au

Symposium Presentation No. 2

Climate proofing – genetic diversity, species diversity and evolutionary processes

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Summarised by Peter Mitchell

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The first part of this talk introduces some general messages about adaptation to climate change. There are many examples of changes that are already happening in response to climate change. In the Australian Alps, grasses are disappearing, forbs are increasing and shrubs are taking over. In the Nardoo Hills north of Wedderburn, Victoria, trees are dying.

We can use evolutionary adaptation to make significant gains in dealing with climate change. There is genetic resilience in the system. But this requires connectiveness between populations. High genetic diversity means that species are more likely to survive, both in the laboratory and in the natural environment. Tawny Owls in Europe occur in two forms; brown forms have become more common than grey forms in response to the need for camouflage in a changing environment but the total population has remained stable. Alpine grasses in Australia show massive adaptation along elevation gradients related to their genetic composition; this adaptation requires gene flow to maintain diversity, and wind pollination allows a high gene flow of the different adapted forms between mountain tops.

Under climate change, environments are becoming more stressful. But human activities are adding to these stresses, for example as farming practices change. Together these drivers are leading to reduced genetic variation. An extreme example is the Mountain Pygmy Possum on Mt Buller. Destruction of habitat for ski runs has been reversed with reconstruction of boulder fields. But the genetic variability in the small remaining population was low and the population continued to decline. Natural gene flow from other populations was impossible, but the decline in genetic diversity and population size were dramatically reversed by translocation of possums from Mt Hotham.

Grey Box (*E. macrocarpa*) is widely distributed but the species shows strong genetic adaptation along temperature gradients. So which trees should we use in revegetation? In Tasmania, Cider Gum (*E. gunnii)* trials over 35 years initially showed that local provenance performed slightly better than a non-local provenance from a warmer environment, but the local provenance (adapted to the local conditions) declined dramatically as climate changed. So which varieties or provenances should we use?

Th conclusions from these studies are that genetic diversity matters, and that we can use modern technologies to identify adaptations within species. Local provenances may not survive climate change so connectivity is critical to allow natural processes to provide genetic diversity between populations. However many species are less mobile or have long generation times so gene flow may be too slow to provide the genetic diversity needed for climate adaptation. Translocation may provide a solution.

Rebecca Jordan

We are working on ways to manage genetic variation to address the challenge of climate change using climate-future plots. Forestry in Canada have developed many plots in many different environments containing many different provenances to work out which provenances work best and where and how we can move genetic variance across the landscape using active connectivity. At the recent VicNature2050 workshop, a big focus was about how we can move genetic material around now to help us into the future (vicnature2050.org/).

Climate -future plots have two aims. First is to create climate-resilient habitat. Knowing that we have uncertainty in our future, we need to think about using the important genetic differences to build in pre-adaption to climate variation by actively connecting our landscapes where natural gene flow may be too slow – de-risking our restoration work by building in the variation so species can respond. The second aim is to use the information from plots to inform future management in the face of the uncertain future.

So we are no longer thinking about preserving historical or even current habitat, but are looking at a new dynamic habitat that has built-in flexibility to respond to change. This flexibility is based on genetic variation, something that is well recognised in Victoria's Biodiversity 2037 Strategy. It involves introducing both new genetic variants across the landscape and introduction of new species to fill ecological niches, aiming to preserve the broader habitat and its ecological functions.

An example of climate-future plots is being developed by Project Goanna to link and connect Grey-Box Woodlands in northern Victoria. This project is looking to develop a series of plots in different environments or across environmental gradients. The plots would contain both local and non-local provenances of Grey Box. Plots would also contain co-occurring species of trees (Yellow Box, etc) and introduce new species such as related species from the warmer climate of northern NSW that may be better adapted or may facilitate adaptation by hybridising with Grey Box. A similar process of selection would apply to shrubs and other smaller species. An essential part of this work would be recording and monitoring to determine which provenances work best and where to source seed for future restoration projects.

The VicNature 2050 workshops also had two recommendations: to use the wealth of knowledge across the conservation sector in collaborations to pull ideas and experiences together, and to learn by doing so we can continuously adapt our work to the uncertainties of climate change.