Patch genetics

Steve Davidson finds genetic clues for conservation.

When CSIRO geneticist, Dr Andrew Young, sees a patch of native vegetation in an otherwise bare paddock, he ponders the invisible genetic threats to these increasingly rare communities of Australian native plants. The subtle threats arise because strange things happen to the breeding behaviour, genetics and overall fitness of plant populations as the number of individuals dwindles to a few hundred or so.

Young heads a team of scientists in CSIRO Plant Industry with broad interests and expertise straddling conservation biology, ecology and population genetics. The group is examining the viability of plant populations in small and isolated remnants of native vegetation. Fragmented patches are mostly all that remain of these once widespread habitats. In the case of native grasslands, just 0.5% persist after decades of cropping and grazing.

'Our aim in studying the genetics and ecology of fragmentation is to come up with firm advice for conserving and managing these remnants,' Young says.

'Which particular species are most in need and what is the best way to treat them? Which ones will respond to intensive care? Are some populations beyond help? What are the population size thresholds for various plant species to remain viable?'

Rare plants

Young has been interested in the genetic consequences of habitat fragmentation for rare and endangered plants for years.

Inbreeding and reduced gene flow between populations by pollen or seed are two possible consequences that are perhaps most familiar and understandable to non-geneticists, but there are others too. Together they can erode genetic variation and, due to isolation, increase the genetic differences between populations of a plant species.

In the short term, this may reduce the individual 'fitness' of plants and lower the viability of remnant populations, they are more likely to go extinct. Eventually, loss of genetic variation, the raw material of evolution, may limit a species' ability to respond to changes in the environment.

One example is the once widespread, endangered plant, *Swainsona recta* (the small purple pea), which survives only in fragmented grasslands and woodlands along roadsides, railway easements and within reserves.

In 1994 there were 21 populations. By 1997, this had fallen to 17, ranging in size from 1–430 flowering plants.

When Lejla Buza, a research student at the Australian National University, teamed up with Young and colleague Dr Peter Thrall to study the rare pea, they found that genetic variation was indeed reduced in smaller populations, a process known as genetic erosion.

This was mostly due to loss of alleles (the various forms of genes) and increased inbreeding. In the most inbred population, percentage seed germination was also reduced.

On the basis of their genetic findings, the scientists were able to recommend that conservation efforts for the besieged herb should focus on populations consisting of more than 50 breeding plants. These appear to be capable of maintaining high genetic diversity and show no negative signs of inbreeding. Their long-term prospects are better.

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Similarly, investigations of the unusual sub-alpine forb, *Rutidosis leiolepis*, a vulnerable species confined to Kosciuszko National Park and the nearby Monaro Plains, led to recommendations for its conservation.

The plant tends towards vegetative reproduction (natural cloning) at higher altitudes, forming large 'clonal mats' over the ground. In situ conservation of the low-altitude Monaro populations should therefore be a priority in the Species Recovery Plan, because they show the greatest sexual reproduction and the highest genetic variation: they are more dynamic, in an evolutionary sense.

Fruit collection for off-site propagation and conservation, however, is best spread across populations at higher altitudes, where more of the genetic diversity is partitioned among sites. This will give the most broadly representative sampling of the genetic diversity of the species with minimum effort.

Not so rare

Young is also involved in a new project supported by the Native Revegetation Research and Development Program, managed by Land and Water Australia.

In this project, he and Dr Linda Broadhurst are studying genetic threats faced by the dominant plants – trees, shrubs and herbs – in remnant grassland, grassy woodland and heathland communities. Unlike rare plants, these more common ones provide most of the structural habitat complexity that wildlife needs.

With colleagues at the Department of Conservation and Land Management in Perth, and at the Queensland Forestry Research Institute, the scientists are concentrating on six key species: *Acacia dealbata*, *Swainsona sericea*, *Calothamnus quadrifidus, Eucalyptus wandoo, Eucalyptus populnea* and *Eremaea pauciflora*.

These are being studied in three different landscapes: the grasslands and grassy woodlands of south-eastern New South Wales, the kwongan shrublands and heathlands of Western Australia, and the box woodlands of southern Queensland. All have become highly fragmented due to clearing for wheat-sheep farming or grazing.

In each case, a broad range of sites in terms of patch size, degree of isolation, environmental degradation, and species composition is being investigated so that the findings will be widely applicable.

Using DNA profiles and other genetic trickery, the scientists intend to look into such aspects as the degree of genetic diversity in patchy populations, the pedigrees of individual plants, the role of pollinators like birds, insects and wind in gene flow between fragments, hybridisation effects, and the fitness of individuals and populations under different circumstances.

Computer modelling of populations with varying degrees of inbreeding will help to predict thresholds for viability. That is, indicate at what stage inbreeding will cause population collapse.

'Armed with this sort of knowledge, we will be well placed to advise landholders, community groups and governments on appropriate ways to conserve, manage and rehabilitate remnant grasslands and heathlands in ways that will preserve the genetic integrity of the flora,' Young and Broadhurst say.

'Only if the dominant plant populations are viable, will other native plants and animals sharing fragments have a fighting chance of a secure future.'

More about patch genetics

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