Conserving small island populations of endangered New Zealand birds: does genetic rescue improve the cognitive functions of inbred robins?

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Many of New Zealand's endemic birds have passed through severe population bottlenecks because of introduced predators or habitat loss. Even if a population recovers, a bottleneck can lead to the long-term loss of genetic variation and a reduction in the fitness of the post-bottleneck population. One proposed solution to this problem is the use of 'genetic rescue', in which birds from outbred populations are introduced into the bottlenecked population in an effort to restore genetic variation. Unfortunately, for many endangered birds in New Zealand, few non-bottlenecked populations survive to supply the donors needed to rescue bottlenecked populations. In 2017 and 2018, I conducted a study to test how the loss of genetic variation affects the cognitive processes in a small passerine bird, the South Island robin *Petroica australis*, and whether any deleterious effects could be reversed through genetic rescue.

Each spring in 2017 and 2018 I collected audio recordings of the dawn chorus from male robins on Motuara and Allports islands in Queen Charlotte sounds. Both islands were subject to genetic rescue in 2008, and my goal was to determine if song structure in a male's dawn chorus was linked to his cognitive capability, and in turn, to his level of genetic variation. Song in robins is composed of many complex learned features, some of which are likely constrained by genetic or environmental aspects of male quality. This means that birdsong can be an useful indicator of male memory and cognitive ability, as it is expected to be compromised by the loss of genetic variation.

Recording the dawn chorus of robins is not for someone who likes a late start to the day, as I had to be in position with my recording equipment before each male started singing each morning. This meant crawling through the undergrowth in the dark at 5 am or earlier, and not using a torch to avoiding disturb the targeted individual. To make things more difficult male robins often sing duets with neighbouring males, on their territory boundary. This meant that I also had to correctly identify each male that was singing during a duet via his colour bands. In daylight robins are so tame they approach within a few metres and bands are easy to see but at dawn a singing male positions himself at the top of the canopy and at heights approaching 20 m. It was not always so easy to see colour bands at this distance in the dark without a torch and binoculars! In the end I was able to obtain audio recordings for 46 male robins from which I have been able to extract information on repertoire size, syllable diversity and levels of song complexity.

Reduced genetic diversity is thought to affect other key aspects of cognitive ability, and for robins, this may involve their ability to solve problems in extracting food. The second part of my project involved testing the ability of robins to complete a series of complex tasks using experimentally created food caches comprised of mealworms. I used two experiments that measure a set of cognitive processes including attentional control, inhibitory control, and memory. Each test was run in the absence of other birds, so that the focal bird could not learn from others or that other birds could not learn from the tested individual. This presented a problem, as once an individual had been tested it soon learnt that I was associated with food. Unlike the audio recordings, I was now inundated with birds who had participated in the experiment previously! To minimise this problem, my field assistant and myself put ourselves under a self-imposed silence when leaving the camp so that neighbouring birds

would not be alerted to our presence and follow us to the next test bird! Eventually I was able to test the problem solving ability of 32 robins. It soon became clear that some individuals were quite adept at being able to extract mealworm prey from my experimental food caches, while others to be polite, would struggle in a battle of wits with the mealworms!

Whether a robin's level of genetic variation dictates his ability to sing a more elaborate dawn chorus or solve the food cache experiment more quickly is the next step in my project. DNA samples collected from each bird have been sent to a lab in Germany for analysis. The first of these have arrived back and show a wide range of levels of genetic variation among the birds I studied. How these relate to the results of my cognitive tests will become clear as the final DNA analyses are completed by the end of the year.

Robin on Motuara sighting a meal worm.