ANN-KATHRIN SCHLESSELMANN AND BECKY CAMERON

A Delicate Balance: Conservation Genetics of Black Fronted Terns

"When we try to pick out anything by itself, we find it hitched to everything else in the universe."
John Muir 1911. (My First Summer in the Sierra. Boston: Houghton Mifflin)

Figure 1. Black fronted tern on the Clutha.

Black-fronted terns or tarapirohe are as unique to New Zealand as the more famous counterparts like kiwi or kea.[1] Their breeding plumage is a beautiful black cap contrasted by the slate grey body and bright orange bill and feet. In spring time, they come to the braided rivers of the South Island to form breeding colonies on the bare gravel bars. They are amazing flyers, hovering over ripples in the river looking for fish and then briefly dipping into the water to catch it and present it to their mate as part of their courtship ritual[2]. The remainder of the year they live a bit more of a hidden life on the coast of all three main islands. Unfortunately, they are in decline and currently classified as Endangered.[3] [4] Their breeding habitat in the braided rivers is under threat due to water abstraction and invasive weeds.[5] [6] In addition, black-fronted terns generally have low breeding success due to introduced and increasing number of native avian predators.[7] [8] [9]

SCIENTIST: ANN-KATHRIN SCHLESSELMANN

My path to researching the conservation genetics of black-fronted terns was not necessarily a straight forward one. I stayed clear of anything related to genetics in my undergrad years as it felt very specialised, involved a lot of jargon, and I was more driven by answering 'big' ecosystem questions, such as the effects of landcover change and large-scale forest restoration. In some ways I have strayed away from that by now working primarily with bird species and genetics being a major component of my PhD project. However, I am certainly still driven by taking up challenges and addressing 'big' questions that translate into conservation management. In the case of black-fronted terns, it is key to understand how breeding colonies relate to each other and at what scale and location management projects should be planned to be able to reverse that decline. Genetics may allow us to do that in a fast and easy way.

Figure 2. Taking blood.

From October 2014 until January 2015, I embarked, with research assistant Jamie Cooper, on a mad road trip of the South Island, living out of my car and visiting well over 40 rivers on the lookout for tern colonies. In the process, we covered over 14,000 km in those three months. We were catching black-fronted terns and taking small blood samples which are required to extract DNA. Compared to traditional methods of marking and following individuals extensively, getting DNA was not only faster, but also more practical. As terns are spending most of their time in the air, their legs are very short and it is almost impossible to attach multiple colour bands on those legs, let alone re-sight them. Catching black-fronted terns is no easy feat though, due to they're being acrobatic flyers, living in an open environment and

not easily attracted into a single spot. Using an electronic drop-trap, a number 8 wire bent into the right "tent" shape, and bird netting, it is possible to catch adults in the 24-day-window when they are incubating. Chicks need to be about ten days old to take samples, however from about twenty days of age they are also able to fly and are impossible to catch. Many black-fronted tern colonies start up, but unfortunately are never successful due to predation, disturbance or floods. Often a colony can be discovered, but have disappeared by the next visit only four days later. In addititon we could only catch birds in fine weather with not too much wind to ensure that no adults or chicks were exposed to excessive stress. This gives overall very little opportunity to catch birds in each colony. We were very lucky with the breeding season and with a bit of help in the Mackenzie Basin, Canterbury and Marlborough plus a lot of determination. We managed to get blood samples of 589 birds in thirty-one colonies.

Back in the lab, I developed some of my own genetic markers specifically for black-fronted terns. This was a trial-and-error process to assess the best conditions for the bit of DNA, or that genetic region that I was interested in, to be amplified and for me to be able to detect and analyse it. The many samples also meant a lot more processing than anticipated. Currently, I have used seventeen so-called microsatellite markers, that are highly variable. These markers are not within genes or have no function, which allows them to vary through mutations without having deleterious effects on the individual. I have also been using two markers that target areas of the mitochondrial DNA. This is DNA that is only maternally inherited and can give additional insights if there are differences between the sexes, for example if females are not dispersing, but males are.

At the same time as I was trialling different markers and processing samples, the opportunity arose to study the black-fronted tern population in the Lower Waitaki River in more detail and test if providing higher quality habitat would allow them to increase their breeding success. Currently, successful ways are being sought to manage environmental conditions, such as predators and weed

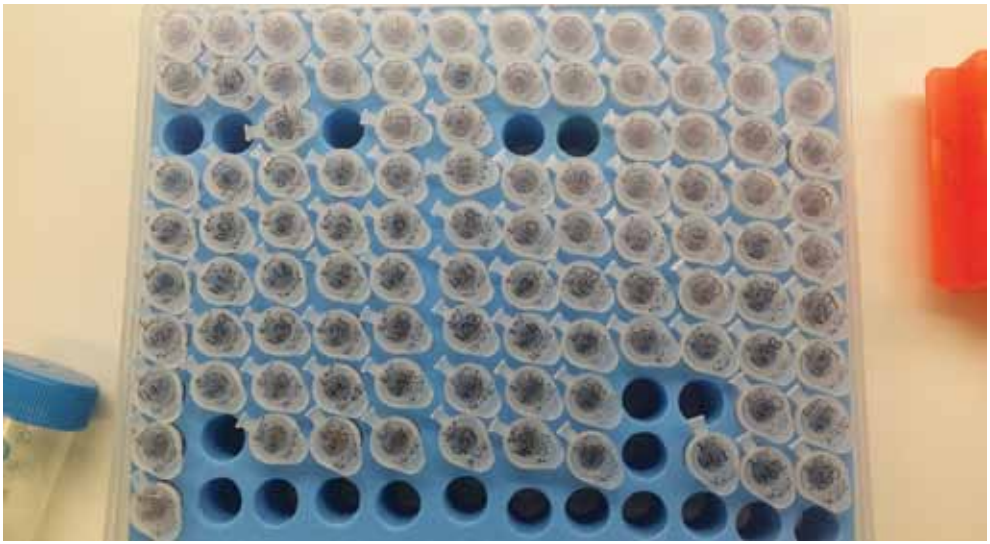

Figure 3. DNA samples for analysis.

cover, in the highly dynamic braided rivers that the black-fronted terns depend upon.[10] Successful management options are the logical next step after the conservation genetic study, which answers the questions around connectivity between the breeding colonies and their level of genetic diversity, and directs where and at what scale management should happen.

This meant, that during the spring months in the last two years, I spent all my time in the river monitoring different tern breeding colonies and determining the outcomes of nests and reasons for failure. Remote cameras were a huge aid in this and did not only give unique, private insights of parents sheltering chicks and partners delivering food to each other, but also revealed when and how life was not going that well for terns. In the Lower Waitaki River, the much larger black-backed gulls started targeting black-fronted tern colonies during the breeding season and taking eggs often in a matter of seconds. Black-backed gulls are native to New Zealand and like in many other parts of the world have profited from open rubbish tips and the land conversion to agriculture, which has allowed them to increase in numbers. The balance has tipped here. Although it is probably only a part of the puzzle and other aspects are also important for black-fronted tern persistence, it exemplifies the major challenges to conservation management of how to restore that balance, if possible.

Preliminary results of my genetic research indicate that breeding colonies are well connected, which is great news for the terns. Genetics is of increasing importance in many different aspects of conservation biology as it hugely aids our understanding of otherwise unseen processes. Like many other people, I found genetics daunting and hard to engage with when I first started out as a researcher. Often the direct translation into management was missing for me, however I was able to discover during my postgraduate studies how important it actually is to take genetics into account from the onset of management rather than as an afterthought.

ARTIST: BECKY CAMERON

I'd known Ann-Kathrin and heard something about her PhD study before we formally started on this collaboration, but was interested to learn more about her research and understand how the field and lab elements linked up. Her overall focus was on conservation ecology, with the genetic research used as a tool within that. I wanted to produce an artwork that reflected the wider concerns of her project as well as showing something of the genetic component.

As part of her study, Ann-Kathrin used motion-triggered cameras to monitor activity at the tern nesting sites. The resulting time-lapse films were grainy and sometimes blurred by raindrops or the dazzle of sunlight, giving an ethereal beauty to the glimpses of riverbed habitat and the movements of the birds.

They brought to life the dynamic environment the terns inhabit, with water levels and weather changing rapidly. This dynamism is a key element of the terns' lives and genetic makeup and was something that I wanted to incorporate into my artwork.

The balance of this delicate and complex web is being altered though, and tern numbers are in decline. Water levels are dropping due to irrigation and hydroelectric power generation, altering the patterns of channels and islands, and making it easier for weeds and introduced predators to invade. I was surprised to learn that in this case it is not the introduced rats or stoats that are the

Figure 4. Still from time-lapse film.

main predator, but rather the black-backed gull that are themselves native birds. It was upsetting to watch one such gull caught on camera swallowing down eggs and chicks and wiping out a whole colony of terns. Changes in land use alongside the rivers have benefitted avian predators such as the black-backed gull, and their numbers have increased as those of the black-fronted tern have fallen.

I felt that I had the key ingredients for my project: the dynamic nature of the terns and their environment; the altered balance of that environment; and the protagonists of black-fronted tern and black-backed gull. To tie in with these themes I played with ideas for balancing and moving constructions, doodling designs that pivoted or rotated, before deciding that a mobile fitted best with ideas of dynamism, connectivity and balance. I researched the work of Alexander Calder and Bruno Munari, and techniques for joining and balancing mobiles. I experimented with ways of making birds, cutting and folding different weights of paper and aluminium shim till I came up with a template that was adaptable and was simple enough to make multiples of. I chose heavy weight tracing paper for the terns as it is robust but light and holds a crease well, and black building paper for the weightier gull.

At this point I faced the challenges of finding an appropriate rather than arbitrary structure for the mobile, and of finding a way to link the evolving work more closely to the genetic component of Ann-Kathrin's project. The broader conservation ecology aspect of her research was easier for me to understand and visualize than the genetic component, where details of methodology and results

Figure 5. Close up of finished mobile.

Figure 6. Mobile installed in Art and Genetics exhibition.

seemed quite abstract. During the project, she was trying out different ways of representing the data produced, using scatter and bar graphs. When she showed me preliminary findings of a tree diagram depicting the relationships between colonies similar to a family tree, I was struck by its resemblance to a diagram for a mobile and I decided that that could serve as a structural link between our work. I realised it wasn't going to be possible to build a mobile to exactly mimic the outline of the tern tree diagram as it would not balance without making the components i.e. the terns very different weights. I did however make the mobile with twenty-one terns to represent the twenty-one samples from different colonies shown on that diagram.

In creating a hanging mobile in response to Ann-Kathrin's research, I wanted to reflect the interconnectivity, and also the fragility and vulnerability of the birds. In the work presented here, a flock of fragile paper terns hang in an uneasy and shifting balance with a single black-backed gull. The terns are arranged to reflect the shape of the genetic family tree that Ann-Kathrin's research is revealing, and move in the slight breeze created as viewers pass by, showing their vulnerability to human actions.

The Art and Genetic project was a challenge and an opportunity to gain a new perspective and a different way of engaging with a conservation issue. The use of jargon in genetics makes it often hard to communicate, however only with more communication comes understanding. Describing her project and research interests to someone from another field allowed Ann-Kathrin to take a step back from the focussed lab work and detailed analysis and see the bigger picture. For me, it was chance to engage with ideas and vocabulary of genetics, and to look beyond landscape as a view to gain a greater understanding of the workings of the environment.

Ann-Kathrin Schlesselmann is an ecologist, conservationist and researcher. In the past nine years, she has called several parts of Germany and New Zealand home. She holds a Bachelor of Science in Biology from the University of Auckland and a Postgraduate Diploma in Science in Wildlife Management from the University of Otago. Among many other special creatures, Ann-Kathrin had the privilege of working with the world's biggest owl, the eagle owl, the tiny rock wren, and the kakapo. After starting her Master of Science on the conservation genetics of the black-fronted terns at the University of Otago, the project has grown and become a PhD project. She is currently finalising the last part of the lab analysis of DNA samples before immersing herself in the statistical analysis and write-up of her PhD.

Based in Dunedin, **Becky Cameron** holds an Masters of Arts in art conservation, and in 2013 completed a Bachelor of Visual Arts with Honours at the Dunedin School of Art. She has been exhibiting since 2008, and in 2016 was the recipient of the Caselberg Trust Creative Connections residency, which resulted in the ceramics and drawings of the "Hereweka Project" exhibition. Cameron's practice explores landscape, memory, belonging and home, and she is currently working towards an exhibition based on daily sketches done while walking the length of the South Island on the Te Araroa trail.

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