DNA

UNLOCKING SECRETS

DNA profiling has come a long way since it was first discovered by Swiss physician Friedrich Miescher in 1869. Nearly 150 years later, Parks and Wildlife scientists and managers are using genetics to discover and understand species, inform decisions, solve mysteries and fight crime. And that's just the beginning.

BY RHIANNA KING, KYM OTTEWELL, DAVE COATES AND MARGARET BYRNE

Using DNA to solve crimes and unlock mysteries has long captured the imagination of scientists, novelists and script writers alike. The ability to burrow down to the blueprint of all known organisms to reveal their growth, development, functioning and reproductive characteristics provides us with a precise way to identify and discriminate between individuals, populations and species. And while it's not exactly how it's portrayed in the crime shows – where mysteries are neatly solved usually thanks to a combination of science and extremely good luck – DNA sequencing and genetic studies are being used extensively by Parks and Wildlife scientists in a range of applications to help biodiversity conservation.

THEN AND NOW

What began as a small laboratory in the Wildlife Research Centre at Woodvale nearly 30 years ago has developed into one of Australia's leading agencies in the application of DNA technology to biodiversity conservation. The initially small plant genetics research group, which subsequently moved to the WA Herbarium, has expanded into a sophisticated and highly regarded program under the impetus of botanist Dr Margaret Byrne – now the department's director of science and conservation – and senior principal research scientist David Coates. This expansion, carried out in collaboration with other organisations and tertiary institutions, has seen the use of genetic information being integrated across the department in a myriad of ways.

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Following the adage 'all creatures great and small', Parks and Wildlife scientists situated in the Sid James Conservation Genetics Lab at the Keiran McNamara Conservation Science Centre are involved in a range of ground-breaking projects. Within the team is Parks and Wildlife research scientist Kym Ottewell, who is no stranger to exciting discoveries – she was the scientist who did the DNA profiling on a mystery whale, which turned out to be a rare Omura's whale, that had washed up on an Exmouth beach (see 'Scientific serendipity', *LANDSCOPE*, Spring 2015). This was a truly significant find as it was the second record in Australia and extended the species' known distribution.

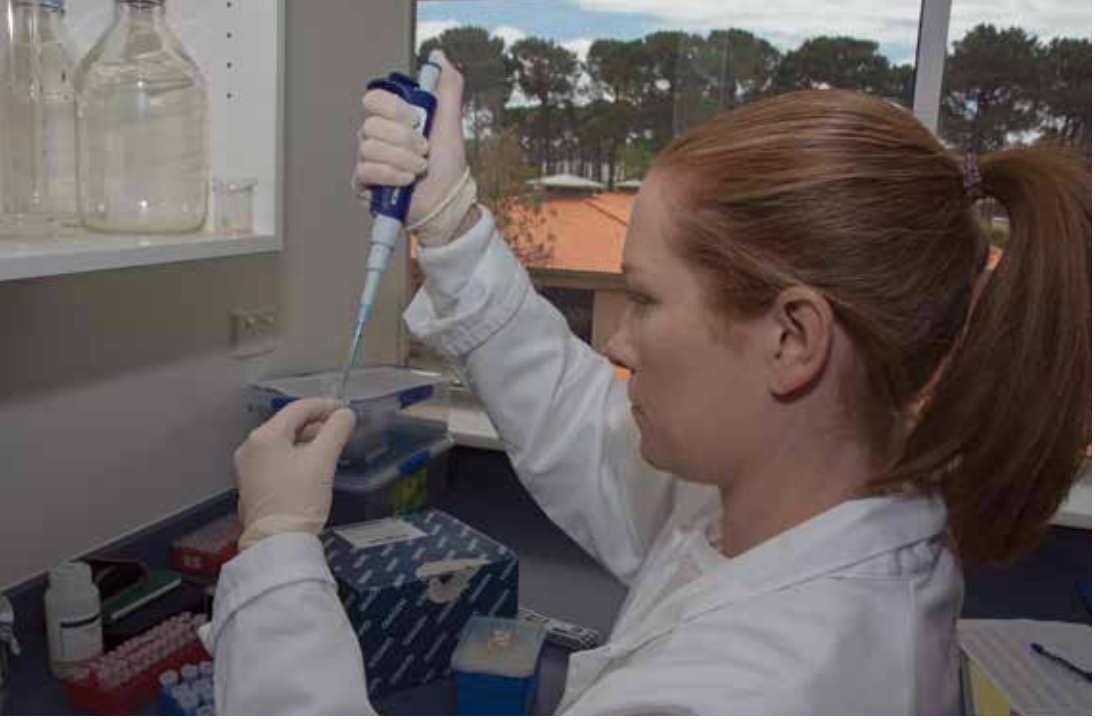
Kym and her colleagues use genetics to map the DNA profile of WA's native animals to help inform projects around the State, as well as monitor recent native wildlife translocations such as the one to Matuwa (formerly known as Lorna Glen) (see 'A sacred partnership: managing Matuwa and Kurrara Kurrara', *LANDSCOPE*, Summer 2015–16). Using genetic samples taken from animals before their release at Matuwa, and from animals born at the site, researchers have been able to monitor how populations of golden bandicoots, brushtail possums, and burrowing bettongs (boodies) have fared since being reintroduced to the area. High genetic diversity and low inbreeding are signs that the populations are doing well and that they are increasing in size. Monitoring these populations at regular intervals enables Parks and Wildlife to practice adaptive management, which will help to ensure the long-term success of this important fauna restoration project.

For species that are difficult to capture, scientists have devised more innovative ways of collecting DNA. Bilbies are elusive, highly dispersed and notoriously difficult to capture in traps. But, as a species of national significance, it is vital that we keep a handle on their population health, especially in northern WA, where there are multiple threats to wild populations. Parks and Wildlife research scientist Martin Dziminski and technical officer Fiona Carpenter spend time in the Pilbara with their eagle eyes to the ground, looking for bilby scats to collect and bring back to the genetics laboratory where the DNA is extracted. While collecting bilby scats might not be everyone's cup of tea, this work provides valuable insight into the number of animals or individuals within sub-populations and allows for understanding of gene flow between sub-populations, which can be used to better inform management and conservation measures.

Opposite page
Main Kristy Quinlan carefully prepares a beetle specimen for DNA extraction.
Photo – Peter Nicholas/Parks and Wildlife
Inset left Fiona Carpenter and Frank Morris collecting bilby scats.
Photo – Martin Dziminski/Parks and Wildlife

Above DNA from beetle larvae helps inform surveys of wetland systems.
Photo – Peter Nicholas/Parks and Wildlife

Above right The critically endangered feather-leaved banksia.
Photo – Sarah Barrett/Parks and Wildlife



Similarly, species or specimens that are difficult to identify – for example, juvenile animals that have yet to develop the adult morphological features that are used to characterise them – can be identified using a technique known as DNA barcoding. This is where a short DNA sequence from the unidentified specimen is compared against an international database of DNA sequences from known species. Parks and Wildlife technical officer Kirsty Quinlan has been successfully using DNA barcoding to identify species of aquatic beetle larvae (which obviously lack the identification features of adults) collected in biodiversity surveys of WA aquatic ecosystems conducted by research scientist Adrian Pinder. These analyses enable Adrian and his team to provide a more complete taxonomic survey of wetland systems as well as extending our understanding of the distribution and diversity of WA aquatic invertebrates.

Parks and Wildlife also uses genetic surveying to map seed collection zones for key species used in revegetation and mine site rehabilitation. This work provides mining companies and their consultants with information about patterns of genetic diversity and where to source seeds for restoration. In some cases these recommendations must include adjustments made for our changing climate and other environmental factors. Margaret Byrne and her colleagues have been investigating signals of genetic adaptation to climate in widespread species distributed across broad climatic zones, and the results suggest that seed can be sourced from the more arid areas for planting in more mesic areas to spread the climate adaptation genes into mesic populations ahead of changes in climate. While investigating genetic signatures of adaptation to climate in the iconic gimlet (*Eucalyptus salubris*), they also found two cryptic genetic lineages that may represent different taxa.

One rare plant that has been the subject of genetic research, is the feather-leaved banksia (*Banksia brownii*) – a critically endangered species that occurs in small populations on the south coast and is highly susceptible to *Phytophthora* dieback. David Coates and his team have been conducting genetic surveys on this species to assess the impact of *Phytophthora* and to understand the genetic differences between geographically isolated population clusters. Using seeds from now-extinct populations, they were able to show that more than a third of the total genetic variation assessed in this species has been lost due to extinction caused by *Phytophthora* dieback. They also found that the Stirling Range populations were genetically different from more southerly populations near Albany and thus separate translocations in *Phytophthora*-free sites were established for the Stirling Range and the southern populations. Further genetic studies are underway to establish how the translocated populations are tracking genetically and help resolve whether they will be self-sustaining in the future.

In addition to doing work on known species, staff and volunteers at Parks and Wildlife's WA Herbarium examine plant specimens to ascertain whether they are new to science. A recent discovery was a new sub-species of *Eremophila microtheca* that is now listed as critically endangered. Genetic studies by Parks and Wildlife flora conservation officer Tanya Llorens and colleagues revealed strong genetic differences between geographically disparate populations, one near Eneabba and the others in Kalbarri National Park. The small isolated Eneabba population was subsequently recognised as a new sub-species and is in the process of being described by Parks and Wildlife botanists.

Opposite page
Far left Parks and Wildlife technical officer Fiona Carpenter working to extract DNA from bilby scats.
Photo – Peter Nicholas/Parks and Wildlife
Below far left A new subspecies of *Eremophila microtheca* was confirmed using DNA sampling.
Photo – Andrew Brown/Parks and Wildlife
Right Red-tailed black cockatoos are the subject of poaching.
Photo – Rick Dawson/Parks and Wildlife

Left Taking a cheek swab from a snake.
Photo – Peter Nicholas/Parks and Wildlife

X-FILES

Another way the department uses DNA is in the investigation and prosecution of cases of illegal poaching and smuggling of native wildlife – a burgeoning black market. Parks and Wildlife officers investigate many cases each year (see 'A scaly tale', *LANDSCOPE*, Autumn 2016) and are increasingly using genetic sampling to build cases that lead to successful prosecutions.

The department has teamed up with Dr Peter Spencer at Murdoch University to build a wildlife forensics capability. One of the early cases occurred in 2010 when a member of the public photographed a man up a ladder allegedly taking a red-tailed black cockatoo chick from its nest. Wildlife officers travelled to the nest site where they collected discarded egg shells and sampled DNA left by the mother on the outside of the shell. When they tracked down the offender at his home in Morawa, they discovered a red-tailed black cockatoo, which they alleged was the bird taken from the nest. However, they did not need to proceed with testing, as the offender volunteered his guilt and was charged with two counts of taking fauna.

In a case of 'right place at the right time', the wildlife officers at the property at Morawa heard screeches of red-tailed and Carnaby's black cockatoo nestlings coming from a property next door. An investigation led to the wildlife officers discovering 14 cockatoos at the property. DNA material from one of the nestlings was closely related to an adult sample taken 10 years earlier in Bindoon (150 kilometres away). This match proved that the nestlings had been poached from the wild, and not bred in captivity (as was claimed). After being presented with the DNA evidence, the accused pleaded guilty to unlawful possession, was fined $4,610 and required to forfeit his bird cages.

DNA sampling is also used as evidence in some cases of animal cruelty. In one case, a man was found guilty of kicking a quokka on Rottnest Island after DNA tests revealed that blood on his shoes belonged to the quokka.

Parks and Wildlife is developing a DNA database of reptiles that can be used to positively identify species of seized animals. In many cases, juvenile reptiles can look markedly different to the adults, so a positive visual identification is not always easy. In some cases, officers are presented with exotic reptiles that come from overseas or atypical specimens such as albinos or hybrids. This database will help establish whether animals kept in WA are native to the State or have been illegally imported. It will also help determine parent-progeny relationships and whether licensed keepers are illegally breeding animals they hold licenses for. Parks and Wildlife officers have established a technique for gathering cells from inside a snake's mouth (similar to a cheek swab in humans) that enables them to take DNA without having to mark or scar the animal.

MOVING FORWARD

Genetic tools are becoming commonplace in plant and animal management and Parks and Wildlife continues to lead the way in their application in conservation. And with the amazing recent developments in genomics there will be many more innovative ways in which genetics and molecular biology can contribute to wildlife management in ways that were not even thought of a few years ago.

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