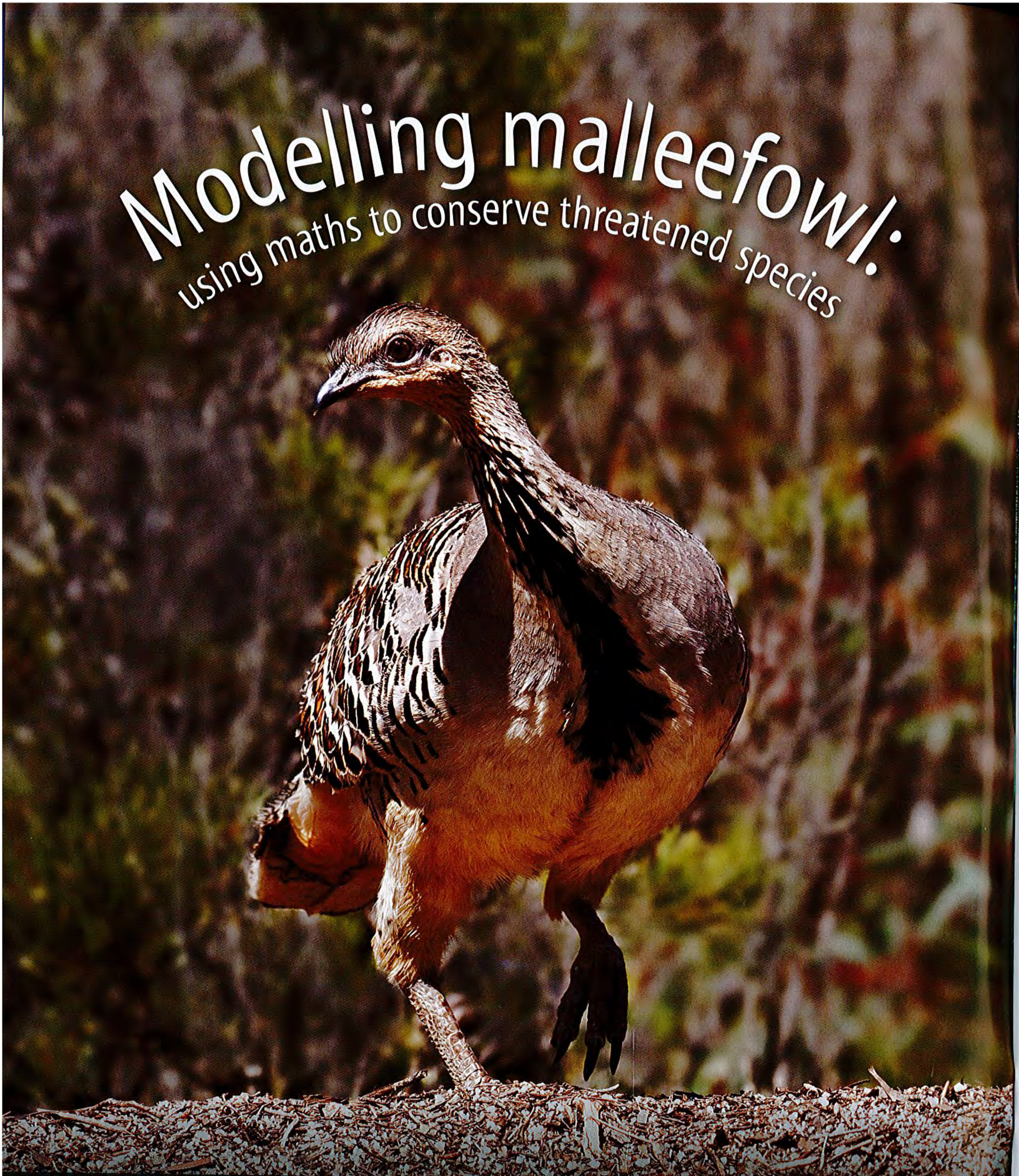
Modelling malleefowl: using maths to conserve threatened species



A research project in the Great Western Woodlands is using an advanced technique to find the best and most cost-effective way to protect the fascinating malleefowl.

by Karl Brennan and Michael Bode

In the TV show *Numb3rs*, the FBI is aided in its attempts to catch criminals by mathematician Charlie Eppes, who uses equations to help solve crimes. The show demonstrates how mathematics and policing can work together to find solutions to problems that are otherwise elusive. Similar to the TV show, mathematical equations and partnerships between mathematical modellers and land managers can also reveal clues that lead to informed decisions about conservation. A good example is recent research into malleefowl (*Leipoa ocellata*) undertaken for the Cliffs Natural Resources-Department of Environment and Conservation Land Management Project in the Great Western Woodlands.

Malleefowl are large, secretive birds inhabiting arid and semi-arid central and southern Australia. Although these birds are rarely seen, the mounds of earth, rocks and leaves they construct to incubate their eggs—structures which can be up to five metres across—are sometimes seen in southern semi-arid and arid Australia. Heat from the decomposing leaf litter keeps the eggs warm, with the male bird continually piling the mound higher, or opening it up to make sure it stays at the right temperature. The birds' curious behaviour and intense work ethic have long attracted the attention of both naturalists and landholders, and hundreds of volunteers take part in a national survey of malleefowl mound activity each year.

Facing threats

Despite this goodwill, malleefowl face many threats. The habitat that once supported the greatest malleefowl densities has been extensively cleared for agriculture, and the isolated fragments that remain are often degraded by stock. Worse, malleefowl are preyed upon by introduced foxes (*Vulpes vulpes*) and cats (*Felis catus*). Bushfires can also kill birds by removing the vegetation that keeps mounds warm and hides the birds from predators.

Malleefowl epitomise the complex land management issues that confront much of semi-arid and arid Australia. For more than a decade, private property owners, government and non-government organisations have made a concerted effort to increase malleefowl populations (see 'Saving the malleefowl', *LANDSCOPE*, Summer 1999–2000). Fencing out stock, shooting and baiting introduced predators, and breeding programs in zoos have all been tried but, despite a century of research, it's still not clear which actions are most effective.

Opposite page
Malleefowl are large birds—adults can weigh up to 2.2 kilograms.
Photo – David Bettini

Top A malleefowl chick.
Photo – Hans and Judy Beste/Lochman Transparencies

Above Malleefowl use the heat produced from decomposing leaf litter to incubate their eggs in a mound.
Photo – Cliffs Natural Resources

Maths to the rescue

So how can mathematics help? To start with, we created a computer model of the malleefowl population. This computer model—known to ecological scientists as a population viability analysis (PVA)—simulates a small population of the birds, watching each computer bird as it grows, reproduces and then dies. We know something about each of these events. For example, it is known how many eggs each malleefowl normally lays, and there are estimates of how long an adult can live. The problem is that no-one has joined them up into a single picture of a malleefowl's life. The PVA model does just that. Using the model, it's possible to simulate 50 years of changes in a small population within a few seconds.

Armed with this information, researchers can then 'try out' different management actions, such as releasing captive bred chicks from a breeding program, or baiting for foxes to enable more chicks to survive to adulthood. It's true that a computer model isn't the same as the real thing, but in some ways it's better. Hundreds of actions can be trialled in a single day. One management option can be 'trialled' for a simulated period of 10 years, then we can go back and see if all that effort was necessary. Importantly, we can instantaneously compare the performance of various conservation actions with their different costs, looking for the best return on investment.

Answers

So what did the modelling for malleefowl show? The PVA showed that if nothing is done to save it, an isolated population of 32 adult birds will decline to extinction within 20 years. If we release captive-reared chicks, this decline rate slows, but doesn't stop. However, if we invest in fox baiting in the Great Western Woodlands, we could turn this decline around and enable the population to grow, as well as help other species that are affected by foxes.

Developing a PVA model for malleefowl also tells us where to focus future research. Some of the data used in the model wasn't of very high quality. For example, maximum age was estimated based on a single captive malleefowl that lived in a zoo until it was 30, but no-one really knows how long the animal can live for in the wild. We wouldn't estimate the maximum age of a human by going into a retirement home and asking a random person how old they were. If we wanted to, we could spend tens of thousands of dollars and decades researching malleefowl age statistics. But if we run the PVA model thousands of times, with maximum ages ranging from 20 to 50, we find out that it doesn't really make a difference to our best choice of management. No matter how long a malleefowl lives, the model still shows that it is better to bait for foxes than to release captive-reared chicks. So, even when some of the input information isn't good, a computer model can tell us useful things.

Just like in *Numb3rs*, a partnership between a mathematical modeller and an ecologist has given new insight into a detective case—in this instance, how to save the malleefowl. Importantly, it has also helped assess the cost-effectiveness of alternative conservation actions, and identified some priorities for future research.

Top A male and female malleefowl near Ongerup, about 150 kilometres north-east of Albany.
Photo – David Bettini

Above Introduced predators such as the fox impact on malleefowl populations.
Photo – Sallyanne Cousans

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For more information see the scientific paper: Bode M and Brennan KEC. 'Using population viability analysis to guide research and conservation actions for Australia's threatened malleefowl Leipoa ocellata'. Oryx. Vol. 45, pp 513–521.

To view a video of a malleefowl pair recorded as part of this project go to www.youtube.com/user/OneCliffs.

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