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for saving species

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Saving the brush-tailed rabbit-rat

Australia's most imperilled animals

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Threatened Species Recovery Hub

National Environmental Science Programme

IMAGE: BY JOHN DAVIES

No surprises, no regrets: identifying Australia's most imperilled animal species

It was only in 1929 that thylacines were first afforded any protection under legislation. Seven years later they were added to the list of protected wildlife, but the last known individual died that same year. The Christmas Island forest skink was first included on Australia's list of threatened species in January 2014. Just four months later, the last known individual died. Both extinctions could almost certainly have been prevented if action had been taken earlier. The gnawing question 'what if we had known earlier...?' is a recurring theme of frustration and failure in much conservation biology – as it is in human experience generally. When recognition of the imminence of a serious and irretrievable loss is belated, opportunities for better outcomes are fatally lost.

The trajectory and timetable of species to extinction is at least partly predictable. To provide forewarnings, a TSR Hub project, is identifying the Australian animal species at greatest risk and estimating the likelihood that they will become extinct over the next 20-year period, if there is no change in current management. Our rationale is that if governments, managers and the community are aware of which species are most imperilled, they can take emergency care to seek to prevent such extinctions – to act before it is too late.

To some extent, the proximity of a species to extinction is already described by a species' international, national or state/territory conservation status. Species listed as Critically Endangered are closer to the abyss than are species listed as Vulnerable, and even more so than the sadly dismissive category of Least Concern. However, many imperilled species have not yet had their conservation status formally assessed: the forest skink provides a valuable lesson that species not listed as threatened can still be at risk. Furthermore, the existing conservation status codings are broad categories and do not effectively indicate the amount of time managers may have to act.

Our starting point in this research was to assemble many experts and all relevant information for Australian birds and mammals. Based on this information, every expert was asked to rate the likelihood of extinction within 20 years for the most threatened species, and their degree of confidence in that assessment. Estimates were pooled across experts, with weighting by this confidence level. From this information, we ordered species by their likelihood of extinction, and then summed these estimates across species to derive estimates of the number of species likely to be become extinct in 20 years, assuming current management.

Our purpose is not to present a doomsday book of damned Australian nature, but rather to alert responsible agencies and the community of what will be lost if they do not act. And act soon, and act decisively.

But our results (published at http://www.publish.csiro.au/PC/PC18006) are disconcerting. We are predicting that the extinction rate for birds and mammals will be higher than at any other time since European settlement of Australia: we expect seven mammal and ten bird taxa will disappear in the next two decades.

Many of the most imperilled species (see table) are poorly known and have previously received little public attention or conservation investment. Happily, Birdlife Australia is now campaigning for some of these uncharismatic but much-troubled birds ('Save the Forgotten Flock': see http://www.birdlife.org.au/current-appeal).

Perhaps unexpectedly, given the higher recent rate of extinctions of Australian mammals than of birds, our assessment found that extinction was looming larger for the most imperilled birds than for mammals. This may be because many of the most imperilled mammals have had some recent reprieves through translocations to predator exclosures and cat-free islands.

One feature of the project to date has been the cooperative involvement of managers and experts from Australian, state and territory agencies, and conservation organisations. This involvement has given the process and results considerable traction among government agencies and NGOs.

The project rolls on. Recently, we repeated the process for the most imperilled fish, under the guidance of and in collaboration with the Australian Society for Fish Biology. Those results were fascinating and of serious concern. Many of the native fish species considered are not yet listed as threatened under Australian or state legislation, but the experts generally rated them as at greater risk of extinction than most listed threatened bird and mammal species.

Further assessments are now being conducted or are proposed for many other animal groups.

John Woinarski
Hayley Geyle
Stephen Garnett

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Threatened Species Recovery Hub

National Environmental Science Programme

The 20 Australian birds most at risk of extinction over the next 20 years

Rank	Species or sub-species	Mean likelihood of extinction within 20 years (%)
1	King Island brown thornbill *Acanthiza pusilla archibaldi*	94
2	Orange-bellied parrot *Neophema chrysogaster**	87
3	King Island scrubtit *Acanthornis magna greeniana*	83
4	Western ground parrot *Pezoporus wallicus flaviventris**	75
5	Houtman Abrolhos painted button-quail *Turnix varius scintillans*	71
6	Plains-wanderer *Pedionomus torquatus**	64
7	Regent honeyeater *Anthochaera phrygia**	57
8	Grey-range thick-billed grasswren *Amytornis modestus obscurior*	53
9	Herald petrel *Pterodroma heraldica^*	52
10	Black-eared miner *Manorina melanotis*	47
11	Northern eastern bristlebird* *Dasyornis brachypterus monoides*	39
12	Mallee emu-wren *Stipiturus mallee**	34
13	Swift parrot *Lathamus discolor**	31
14	Norfolk Island boobook *Ninox novaeseelandiae undulata**	27
15	Mount Lofty Ranges chestnut-rumped heathwren *Calamanthus pyrrhopygia parkeri*	24
16	Fleurieu Peninsula southern emu-wren *Stipiturus malachurus intermedius*	17
17	Helmeted honeyeater *Lichenostomus melanops cassidix**	17
18	Cocos buff-banded rail *Hypotaenidia philippensis andrewsi*	17
19	Western bristlebird *Dasyornis longirostris*	16
20	Alligator Rivers yellow chat *Epthianura crocea tunneyi**	15

^ Refers to Australian breeding population. *Australia's Threatened Species Strategy (2016) includes ten birds from Table 1 as priorities species.

The 20 Australian mammals most at risk of extinction over the next 20 years

Rank	Species or sub-species	Mean likelihood of extinction within 20 years (%)
1	Central rock-rat *Zyzomys pedunculatus**	65
2	Northern hopping-mouse *Notomys aquilo**	48
3	Carpentarian rock-rat *Zyzomys palatalis*	44
4	Christmas Island flying-fox *Pteropus natalis**	41
5	Black-footed tree-rat (Kimberley and mainland NT) *Mesembriomys gouldii gouldii*	39
6	Gilbert's potoroo *Potorous gilbertii**	36
7	Leadbeater's possum *Gymnobelideus leadbeateri**	29
8	Nabarlek (Top End) *Petrogale concinna canescens*	29
9	Brush-tailed phascogale (Kimberley) *Phascogale tapoatafa kimberleyensis*	28
10	Brush-tailed rabbit-rat (Kimberley, Top End) *Conilurus penicillatus penicillatus**	25
11	Western ringtail possum *Pseudocheirus occidentalis**	25
12	Northern brush-tailed phascogale *Phascogale pirata*	23
13	Mountain pygmy-possum *Burramys parvus**	22
14	Kangaroo Island dunnart *Sminthopsis griseoventer aitkeni**	22
15	Brush-tailed rabbit-rat (Tiwi Islands) *Conilurus penicillatus melibius**	21
16	Silver-headed antechinus *Antechinus argentus*	20
17	Southern bent-winged bat *Miniopterus orianae bassanii*	18
18	Black-tailed antechinus *Antechinus arktos*	17
19	Northern bettong *Bettongia tropica*	14
20	Tasman Peninsula dusky antechinus *Antechinus vandycki*	14

*Australia's Threatened Species Strategy (2016) includes ten mammals from Table 1 as priority species.

No. 1: *Central rock rat*

No. 11: *Western ringtail possum*

No. 11: *Black-eared miner*

No. 2: *Orange-bellied parrot*

Detecting and protecting the **Kangaroo Island dunnart**

IMAGE: ROSEMARY HOHNEN

ABOVE: Volunteers Sarah Leeson and Alex Hartshorn sit down to weigh, measure and identify animals caught at a trapping site on western Kangaroo Island.

The Endangered Kangaroo Island dunnart has been identified as one of the top 20 Australian mammals at risk of extinction. Efforts to recover the species will be greatly helped by filling knowledge gaps about the ecology of the species and how it responds to conservation actions. The mouse-sized carnivorous marsupial has only rarely been seen in the past 20 years and **TSR Hub** researcher **Rosemary Hohnen** is on the job working with local partners to develop better monitoring methods for the elusive species, and to evaluate the impact of feral cats on its persistence. Here she gives us a taste of the action, and despite the tiny size of the mammal there is a lot of heavy lifting…

After five months of trapping, it was our last night attempting to catch a Kangaroo Island dunnart. At about 2.30 am the rain hit, sending big sheets cracking against the tin roof of the research station. Alex and I pulled on our rain gear and stumbled down the driveway to faithful Betty, our red Hilux ute. By the time we'd arrived at the site, the pitfall traps had about a foot of water in them and for the first time in a long time, I was relieved to not find anything in the pits but a few fairly happy frogs and a precariously balanced stick insect.

Catching a Kangaroo Island dunnart was never going to be an easy task. When we started the project in April 2017, they had been seen at only eight sites on western Kangaroo Island in the past 20 years. Extensive survey work in 2001 suggested they breed during early summer, eat mostly insects, and sleep during the day in hollow logs and in the skirts of ancient grass trees.

Across Australia, feral cats are recognised as a key threat to wildlife. Kangaroo Island is one of five Australian islands where islanders and government agencies have begun the task of eradicating the pest.

To help out with this ambitious objective, we were interested in understanding how cat control would impact the Kangaroo Island dunnart. As the last extensive survey work for the dunnart was done almost 20 years ago, we hoped also to use some fresh detection methods to assess their status today, find them in some new locations and learn a little more about what they need to survive in the landscape.

For five months in 2017 and 2018 we trapped for dunnarts at 42 sites across western Kangaroo Island using four methods:

- Pitfall traps (three sizes)
- Elliott traps (metal box traps)
- Camera traps facing fence lines
- Camera traps facing baits

Pitfall trapping of course requires a lot of digging holes, digging trenches and rolling around in the dirt. That said, we caught a lot of wonderful things. Pygmy possums were a particular delight, as we often found them on cold mornings curled in a tight furry ball as the bottom of the pit, and we'd pull them out and slowly warm them up in our mittens.

We detected dunnarts on camera seven times at five sites. Four of those sites were new, previously unsurveyed sites, and one site had a historical record. Unfortunately, dunnarts were not detected at six of the seven sites with historical records. Camera traps placed to face long, heavy duty plastic drift fence lines were the most effective detection method.

Although our pit traps failed to catch our target species, we found that wide deep pits were most effective at catching other small mammals such as native bush rats and western pygmy possums. This indicates that if dunnarts need to be caught, for example, to collect genetic samples, wide pits are likely to be the most effective method.

From our camera traps we detected dunnarts in recently burnt (0–10 years post-fire), regenerating (10–20 years postfire) and long unburnt habitats (>20 years postfire), so there was no evidence the dunnarts prefer one particular age of post-fire vegetation. They were detected most frequently at open low mallee sites dominated by Kangaroo Island mallee ash (*Eucalyptus remota*), but also at one open woodland site dominated by messmate (*Eucalyptus obliqua*).

The three pit fall trap sizes used in the survey (left to right): wide deep, narrow deep and wide shallow.

An infra-red camera trap image of a Kangaroo Island dunnart.

We are currently conducting a more detailed analysis of habitat preferences.

We also assessed the density of feral cats in the region, to understand the extent to which cats might threaten the population, and provide information to support the planned cat eradication. Arrays of 50 remote infrared cameras were deployed to detect cats in farmland, at the border of the national park, and within the national park. On the border of the forest and farmland the density of feral cats is 0.27 cats/km^2, similar to the mean density on mainland Australia. The arrays deployed within the park and on farmland are still being analysed.

In August this year, we'll also start the final stage of the project where we'll examine how broad-scale feral cat baiting will impact resident small mammal ('non-target') species. Currently 1080-based "Eradicat" baits are the only commercially available, feral cat-specific bait in Australia. Feral cat baiting is likely to be used in the national parks of western Kangaroo Island as much of the park is inaccessible by road, and baits can be dropped aerially in these areas.

Some small mammals on western Kangaroo Island have a reasonably low tolerance to 1080 and there is a possibility some could die if they eat a sufficient amount of the feral cat baits. We currently don't know if small mammals will eat the baits. To test this, we will use non-toxic baits that contain a biomarker called Rhodamine B. If an animal consumes a bait, the harmless Rhodamine will be deposited in the animal's whiskers and will be visible under UV light. So by taking whisker samples from resident small mammals, we will gain an idea of the proportion of the population that has potential to be impacted by toxic baiting.

Overall, we managed to detect Kangaroo Island dunnarts at five of the 42 sites surveyed, suggesting they may be in low numbers on western Kangaroo Island. Feral cat control could potentially really benefit the species, and hopefully the results from the non-toxic bait trials this year will allow us to determine the feasibility of broad-scale feral cat baiting, which may be an important tool in supporting this species' persistence in the future.

Western pygmy possums (*Cercartetus concinnus*) are frequently caught in the camera traps.

The project is being led by Charles Darwin University, working collaboratively with: SA Department for Environment and Water; Natural Resources Kangaroo Island; Australian National University, the University of Queensland, the University of Sydney and the local Kangaroo Island community.

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LEFT: Kangaroo Island dunnarts are visibly distinguished from other small mammals by their pointed snout and wide, almost square-shaped, ears.

Filling the breeding knowledge gap

Bioacoustic monitoring of endangered black-cockatoos

LEFT: An adult male Kangaroo Island glossy black-cockatoo.

Monitoring the nests of endangered species of cockatoos has not always been practical using traditional methods. However, new bioacoustic methods being developed at The University of Queensland may hold the key to accurate monitoring of nesting and breeding behaviour. The innovative monitoring method is now being applied to the breeding behaviour of two endangered sub-species of cockatoo in southern Australia, the south-eastern red-tailed black-cockatoo and the Kangaroo Island glossy black-cockatoo. It also promises to shed light on the breeding behaviour of black-cockatoos in Queensland, about which little is so far known. **Daniella Teixeira**, PhD candidate at **The University of Queensland**, takes up the story.

Recent advances in bioacoustic technology have opened new channels for wildlife monitoring. Scientists are increasingly using bioacoustic methods to find cryptic species, to measure population abundance and density, and even to track and monitor individuals through time. Bioacoustics can offer effective alternative methods of monitoring where physical human efforts can be burdensome or impractical. It is also less invasive for the species being monitored. For my PhD research at The University of Queensland, I am developing and applying bioacoustic methods to monitor breeding in two endangered populations of black-cockatoo, the south-eastern red-tailed black-cockatoo and the Kangaroo Island glossy black-cockatoo.

The south-eastern red-tailed black-cockatoo

The endangered south-eastern red-tailed black-cockatoo (*Calyptorhynchus banksii graptogyne*) is persisting as an isolated population in south-west Victoria and south-east South Australia. Feeding exclusively on stringybark and buloke, their distribution is largely confined to the patches of remnant forest that remain across a largely agricultural landscape.

Annual flock counts by the recovery team and volunteers suggest a population of just 1500. We have seen an apparent decrease in the proportion of females and juveniles (who are difficult to distinguish in the field), which indicates that, unfortunately, breeding success is decreasing. We suspect that the availability of suitable breeding habitat is becoming very limited. Most known nests are from ringbarked paddock trees, which are collapsing. Fire (wildfire and prescribed burning) is thought to significantly reduce this cockatoo's specialised food sources.

However, because the nests of the south-eastern red-tailed black-cockatoo tend to be difficult to access, it is usually not feasible to directly monitor them. This means we still have a limited understanding of where nesting occurs and – most importantly – how success rates vary across the landscape.

The Kangaroo Island glossy black-cockatoo

The situation for the endangered Kangaroo Island glossy black-cockatoo (*Calyptorhynchus lathami halmaturinus*) is different. Although the population numbers only about 400, this

Artificial hollows are being used to overcome a shortage of tree hollows on Kangaroo Island.

is a substantial increase from an estimated 115–150 in the 1980s. Intense recovery efforts since the 1990s have largely controlled the major threat, nest predation by the common brushtail possum. Field officers physically check many nests during the breeding season, often several times, and monitor others with camera traps. As a result, extensive data is now available about the breeding of this cockatoo.

However, under limited funding, the crucial work of nest maintenance (which includes possum exclusion) is prioritised over monitoring nest outcomes or flock demographics.

Bioacoustic monitoring: An efficient solution

Bioacoustics represents a practical and efficient method of monitoring breeding for both endangered cockatoo species. Once developed, the method may be transferred to other threatened populations of red-tailed and glossy black-cockatoo that are currently unmonitored. In Queensland, the glossy black-cockatoo is listed as vulnerable and although the Glossy Black Conservancy coordinates annual counts, most reports are of feeding birds. Very little is known about their breeding. Most of the known nests are in locations that are impractical for routine monitoring. This project is developing the bioacoustic methods on Kangaroo Island, where nests are easily accessible, with the aim of applying them in east coast populations.

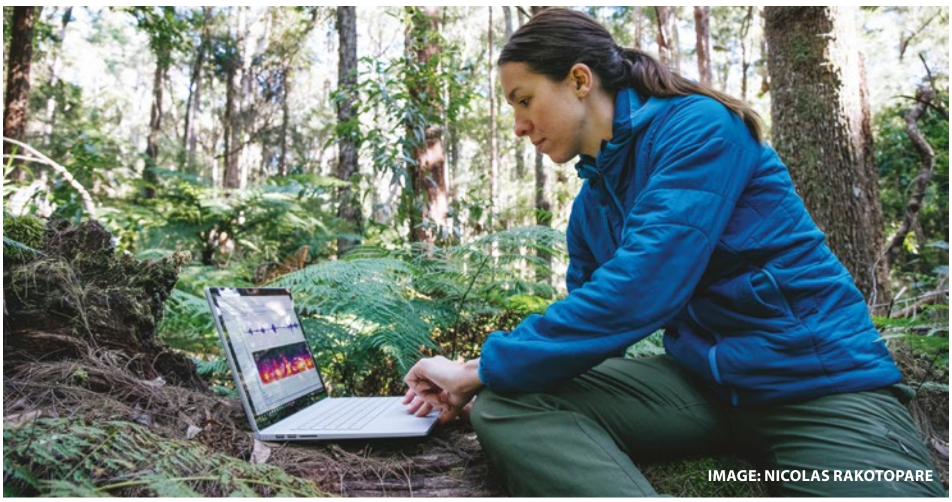
Interpreting 'cockatoo'

To develop the bioacoustic method, I am currently describing the vocal behaviours of these cockatoos at nests. I am installing autonomous sound recorders at nest trees, which collect sound data at pre-programmed time intervals over the nesting period, and combining that with extensive behavioural observations.

Although much of these data are still to be processed, I have been able to identify the key vocal behaviours: the vocalisations by older nestlings (near fledging) and the vocal commotion that takes place at the time of fledging. Other vocalisations, like the parents' flight calls to and from the nest, the female's nest entry call, begging calls, and the male's soft contact call are also useful for examining behavioural patterns. Since these behaviours can be detected from recordings, bioacoustics can remotely monitor whether a nest is successful and, if not, at what stage it failed. This will allow us to better understand the dynamics of breeding, and in turn, better inform decision-making to improve breeding outcomes (e.g., fire planning, food habitat regeneration, artificial nest hollows).

Automating analysis

Bioacoustic monitoring, however, will only be useful if it is user-friendly for conservation managers. So far, I have found that a major limitation of the method is the large volume of sound data. Major advances have been made in call recognition algorithms recently and, for some species, accuracy is very high. I have begun testing automation with calls from the red-tailed and glossy black-cockatoos and these preliminary trials seem promising. Fortunately, black-cockatoo vocalisations are loud and distinctive; plus, I am making the recordings at nest trees, so successfully recording their calls is guaranteed. Next, we will investigate applying these call algorithms in open-source software, which will make the method easy to use for managers.



Researcher Daniella Teixeira is using Bioacoustics to monitor breeding success.

A south-eastern red-tailed black-cockatoo nestling.

Moreover, the method could be used in non-breeding contexts, such as monitoring common contact and flight calls.

Filling an important knowledge gap

Currently no rigorous nest-monitoring program is in place for any threatened red-tailed or glossy black-cockatoo population, including Kangaroo Island. For the south-eastern red-tailed black-cockatoo, improving breeding outcomes is becoming increasingly important. In Queensland, almost nothing is understood about the breeding dynamics of endangered cockatoos.

If we can automate data extraction, bioacoustic monitoring may provide a feasible solution to these problems. A single autonomous sound recorder could be deployed for the whole nesting period to non-invasively monitor breeding activity. And if rolled out on a larger scale, this may substantially improve the data that conservation managers have to use for their decision-making.

The University of Queensland is working with the Victorian Government's Department of Environment, Land, Water and Planning, the South Australian Government, Natural Resources Kangaroo Island and the Ecosounds Lab at Queensland University of Technology. The project is also supported by the Glossy Black Conservancy and Birdlife Australia's South-eastern Red-tailed Black-cockatoo Recovery Team.

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Refuges offer hope for the **spotted tree frog**

A spotted tree frog.

IMAGE: MICHAEL WILLIAMS IT'S A WILDLIFE

Conserving threatened species is a difficult and complex endeavour. The spotted tree frog is facing twin threats from chytridiomycosis and predation on tadpoles by non-native fish and the combined impact is devastating. While the research team is seeking sites that are refuges from these threats for translocations, they are also celebrating a major breakthrough in partnering with the recreational fishing community for the protection of the spotted tree frog. **Matt West** from the **University of Melbourne** describes some of the challenges and achievements in conserving this threatened frog.

IMAGE: RENAE AYRES

ABOVE: Assessing the social value of sites with the Recreational Fishing Advisory Committee.

The spotted tree frog was first recorded in 1901 and is found in cool, rocky mountain streams in south-eastern Australia. By the late 1980s the species was suspected to be declining, but we did not have the monitoring data to be sure or to work out what was going on. This was around the same time as a global amphibian crisis was being recognised. Since then, we have used long-term monitoring strategies, including mark-recapture and occupancy surveys, to understand population make-up and trajectories so we can distinguish population declines from natural population fluctuations.

This has not been easy. Surveys are best conducted at night and the sites are mostly remote and far apart, meaning lots of time on the road, very wet feet and very little sleep.

We have also needed specialised statistical methods to evaluate the precision of our survey and monitoring methods in order to be confident of our evaluations of patterns of decline. The long-term monitoring work now provides strong evidence that the spotted tree frog has disappeared from 50% of known historic sites, is rare at all remaining sites and is likely to continue to decline unless we intervene.

Causes of declines

The threats causing spotted tree frog declines have also been challenging to identify. Habitat disturbances, including mining activities (eductor dredging river gravel looking for gold) are likely to have caused some of the early changes – but those activities are no longer permitted. Ongoing changes were suspected of being caused by non-native fish species introduced for recreational fishing; subsequent experiments confirmed that these fish species eat spotted tree frog tadpoles. Importantly, this is completely different to native fish, who rarely eat the tadpoles.

In the late 1990s, another threat was recognised. Chytridiomycosis, a disease caused by chytrid fungus, not only turned up in spotted tree frog populations, but was quickly linked to an emerging global amphibian crisis. This disease caused a rapid decline and extinction in the only New South Wales spotted tree frog population.

We began to investigate the potential role of chytridiomycosis in spotted tree frog declines using a long-term mark-recapture program. This research confirmed that chytrid fungus was linked to population declines at other sites. We also found that populations could not withstand the combined impacts of chytrid fungus and tadpole predation by non-native fish. However, the findings also provided a glimmer of hope: under some circumstances, spotted tree frogs could cope with one of these two threats, but not both simultaneously.

Technical challenges

Chytrid fungus, the cause of chytridiomycosis, is a microscopic fungal pathogen with a free-swimming life stage that can survive in the environment and on other host species for extended periods. It has minimal effect on tadpoles but can be deadly to adults. Currently, there are no feasible methods to eliminate chytrid in mountain streams.

More technically feasible, at least in some circumstances, is removing non-native fish. While there are a variety of methods that could be used, this approach is far from simple:

mountain streams are challenging because they provide fish plenty of places to hide, and their slippery rocks, deep pools, fast-flowing water, fallen timber and overhanging vegetation make them difficult to work in.

Social challenges

In addition to the technical challenges, there are social challenges when saving the spotted tree frog; in particular the high value placed on many non-native fish species, such as brown and rainbow trout, by the recreational fishing community. When we first proposed experimentally removing non-native fish from one site in the mid-2000s, the recreational fishing community were not supportive, and the initiative stalled.

Since then, a lot of work has gone into engagement and building relationships and trust with these groups, helping them to understand the plight of the frog and allowing us to better understand the values and areas that are important to recreational fishers. We hope frog refuge sites will be identified that have low recreational fishing value, so social impacts from non-native fish management will be minimised. We are all in agreement that both frogs and recreational fish species benefit from effective management of catchments.

Finding refuges

Given the technical and social challenges to threat mitigation, we have focused on seeking sites where one or both threats are absent. One such site has been found in New South Wales, and frogs have recently been released there. The early signs of this introduction are promising; however, this alone is not enough to conserve the spotted tree frog, particularly in Victoria where the vast majority of the species' habitat occurs.

We are continuing our search for sites in Victoria where the twin threats are absent or reduced, but we are yet to successfully improve the conservation outlook for the species in that state.

BELOW: Spotted tree frog habitat.

We're also hoping that we might resolve the technical challenges of managing chytrid infection or the concerns of the community over managing non-native fish.

Partnering is key

Over the past 18 months, the relationship with the recreational fishing community has really strengthened, and they are now key supporters of actions to conserve spotted tree frogs. The Australian Trout Foundation, VRFish (the Victorian Recreational Fishing Peak Body) and Native Fish Australia (Vic) are all now providing advice to the Spotted Tree Frog Recovery Team, which includes representatives from the Victorian Department Environment, Land, Water and Planning, New South Wales Office of Environment, Arthur Rylah Institute, Zoos Victoria, Amphibian Research Centre, Northern Territory Government and The University of Melbourne. Together we are considering options to trial fish management, while we continue to look for sites where the impacts of non-native fish and chytrid fungus are low.

These fishing groups are also supporting our conservation efforts, by writing and posting articles on spotted tree frogs, educating their members, and providing information that will be crucial in our next steps to save this species.

Species conservation is clearly difficult. However, we are experiencing renewed hope. With the new partnership with recreational fishing groups and the support of key funding organisations, we may soon be able to overcome technical challenges to threat management and help conserve the endangered spotted tree frog.

ABOVE: A spotted tree frog.

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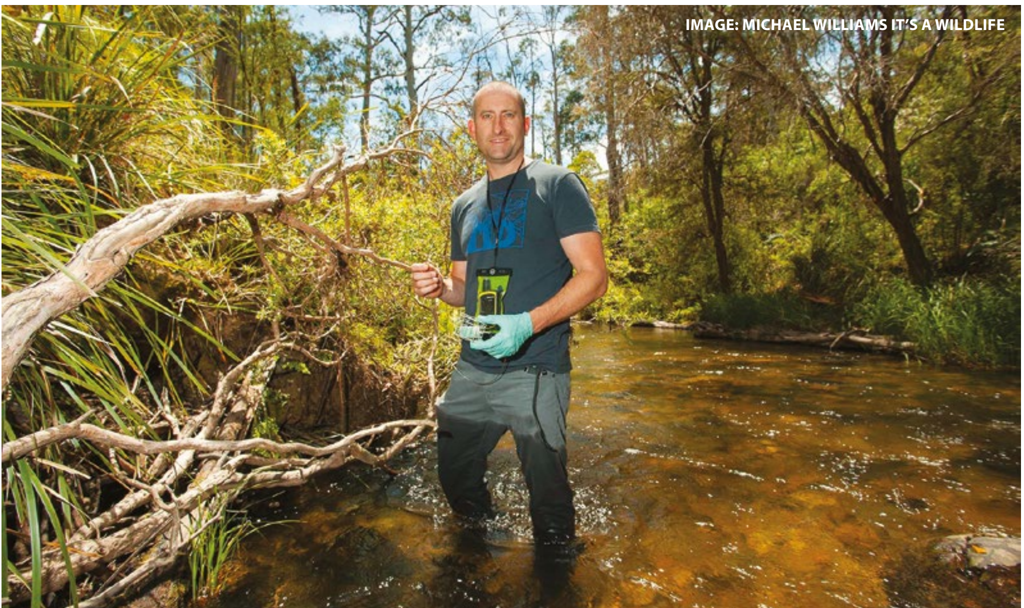


LEFT: Researcher Matt West during spotted tree frog surveys.

Tiwi Island mammals: **Saving the brush-tailed rabbit-rat**

ABOVE: A brush-tailed rabbit-rat on the Tiwi Islands.

The Tiwi Islands are one of the last regions in Australia with an intact mammal community, and they are home to several threatened mammals like the brush-tailed rabbit-rat and Butler's dunnart. While the mammal populations on the islands have remained relatively intact compared to other areas of northern Australia, they may be showing the first indications of decline. As native mammals play an important role in maintaining healthy country and culture, this is a major concern for the Tiwi Traditional Owners. **Hugh Davies** from **Charles Darwin University**, looks at what mammal surveys in 2000 and 2015 can tell us, and outlines new collaborative research which aims to help underpin recovery efforts.

Mammal declines in northern Australia

Over recent decades, numerous native mammal species across northern Australia have suffered significant decline. Worryingly, the species that have suffered the greatest decline across northern Australia are similar to the mammal species that were earlier driven to extinction throughout southern and arid Australia. If these declines continue, more species may soon be lost forever.

The decline of native mammals across northern Australia has been linked to predation by feral cats, the loss of traditional Aboriginal burning practices, and grazing by large, exotic herbivores (such as cattle, horses and water buffalo). However, as these drivers of decline interact in complex ways, uncertainty still surrounds both the relative contribution of each of these drivers to the decline of native mammals, as well as the best approach to remedial management.

Surveying mammals on the Tiwi Islands

My PhD was a collaborative project between the Tiwi Land Council, the University of Melbourne, the Northern Territory Government's Department of Environment and Natural Resources, and Charles Darwin University. Beginning in 2013, one of the main aims was to conduct a health-check of Tiwi Island mammal populations and see if there has been any evidence of recent decline.

As the Tiwi Islands still support high densities of native mammals compared to most of northern Australia, this also provided an opportunity to further investigate the drivers of mammal decline. In 2015, I re-surveyed 88 sites across Melville Island (the larger of the two main Tiwi Islands) that were previously surveyed between 2000 and 2002. At each of these sites, I repeated the original live-trapping survey method and conducted five weeks of camera-trapping.

Hub researcher Hugh Davies holding a brush-tailed rabbit-rat trapped during monitoring activities.

Bandicoot, tree-rat and rabbit-rat numbers down

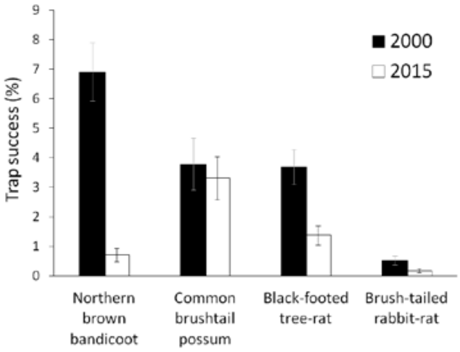
The trap-success rate for the northern brown bandicoot, black-footed tree-rat and brush-tailed rabbit-rat were all significantly lower in 2015 (see figure). I found no significant change in trap-success for the common brushtail possum.

While this drop in numbers for three mammal species bodes ill, it is only based on surveys at two points in time. Surveys at other points in time will be needed to confirm the trend and rule out natural fluctuations in response to long-term variation in weather conditions. For example, the Tiwi Islands had experienced a number of dry years leading up to 2015. It remains to be seen if (and how much) populations will recover after a good wet season.

However, as these declines are similar to those recorded earlier on mainland northern Australia, they may also represent the first evidence of mammal decline on the Tiwi Islands.

Findings a call to action

The research results suggest that while the mammal populations of the Tiwi Islands have so far been more resilient than in other areas of northern Australia, they may be exhibiting the initial signs of decline. As such, these results should be a call to action. If nothing is done, these populations may continue to decline to the highly degraded state of those on the mainland. The loss of these animals from the Tiwi Islands would represent significant ecological and cultural loss.



Feral cats and fire: The usual suspects

The 2015 surveys revealed important findings: brush-tailed rabbit-rats were once more widespread on Melville Island but have now contracted to areas with a dense understorey where feral cats were not detected. Black-footed tree-rats were also largely found in areas with a dense understorey.

While the results of my PhD research suggest that feral cats are a significant threat to Tiwi Island mammal populations, they also suggest that a dense understorey may be beneficial. It appears that a dense understorey provides more cover for native mammals and makes hunting less efficient for predators such as feral cats.

Future research on mitigating cat impacts

Currently, we have no effective way of directly mitigating the impact of feral cats at the landscape scale. The next stage of this research will investigate how and why feral cat density varies across the Tiwi Islands and if we can reduce the impact of feral cats by using fire to promote a dense understorey.


IMAGE: HUGH DAVIES

A low intensity early dry season burn undertaken by Tiwi Land Rangers.

This work has already begun, and is a collaboration between the Tiwi Land Council, Tiwi Land Rangers, Charles Darwin University, and the Northern Territory Government's Department of Environment and Natural Resources. It is also receiving support from the Norman Wettenhall Foundation.

In 2017, we deployed two large grids of camera traps to estimate the density of feral cats on the Tiwi Islands. We deployed one grid at Pickataramoor on Melville Island and one near Ranku on Bathurst Island. This work is already producing interesting results. While we detected plenty of cats around Pickataramoor, we did not record any from Ranku, suggesting that the density of feral cats varies between these two areas.

We will extend this work to other areas on the Tiwi Islands over the next two years to try and work out why these densities vary. We also plan to use experimental fire plots on the Tiwi Islands to discover how and why the manipulation of fire frequency influences native mammal density.

For further information

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Related publications:

Hugh F. Davies, Michael A. McCarthy, Ronald S. C. Firth, John C. Z. Woinarski, Graeme R. Gillespie, Alan N. Andersen, Hayley M. Geyle, Emily Nicholson, Brett P. Murphy (2017) Top-down control of species distributions: feral cats driving the regional extinction of a threatened rodent in northern Australia. *Diversity and Distributions*, 23, 272–283.

Hugh F. Davies, Michael A. McCarthy, Ronald S. C. Firth, John C. Z. Woinarski, Graeme R. Gillespie, Alan N. Andersen, Willie Rioli, José Puruntatameri, Willie Roberts, Colin Kerinaiua, Vivian Kerinauia, Kim Brooks *Womatakimi*, Brett P. Murphy (2018) Declining populations in one of the last refuges for threatened mammal species in northern Australia. *Austral Ecology*, DOI: 10.1111/aec.12596.


IMAGE: JOHN DAVIES

LEFT: Hugh Davies, José Puruntatameri holding a hair trap and Colin Kerinaiua with a motion detection camera used during fauna surveys.

Now hiring: **The missing mammals of Booderee**

IMAGE: PARKS AUSTRALIA

ABOVE: A southern brown bandicoot in Booderee National Park

Investigating **mammal declines in a national park**

Fifteen years of monitoring shows mammal collapse

Fifteen years of comprehensive biodiversity monitoring in Booderee National Park has revealed a major ecological surprise: localised collapses of populations of many of the park's mammal species over the period. At many long-term sites across the park, the number of native mammals almost halved between 2003 and 2016.

The biodiversity monitoring encompassed a range of vertebrate groups including mammals, birds, reptiles and frogs, as well as native vegetation. This has clearly established that it is mammal species only that have experienced these losses in Booderee.

The period has seen the apparent local extinctions of the tree-dwelling greater glider (last seen in 2006) and common ringtail possum (last seen in 2014). There have also been major declines of other mammal species like the bush rat, the tree-climbing marsupial the brown antechinus, and the ground-dwelling long-nosed bandicoot. Each of these is now uncommon or rare and found in just a fraction of the sites they occupied in 2003.

The losses and declines from this well-managed park are even more surprising as these species still persist in surrounding areas outside of the park.

Park management activities

The three key activities of park management have been control of foxes and weeds and the careful application of prescribed fire. It has been possible to eliminate each of them as independent causes of the mammal declines.

The start of the monitoring program coincided with the intensification in 2003 of an existing poison-baiting program for the exotic predator, the red fox. The baiting program greatly reduced the numbers of foxes in the park. It was expected that reducing fox numbers would lead to the recovery of native fauna. However, researchers instead observed the steep declines of some species and the local extinction of others.

The declines in Booderee were not only unexpected but also counter-intuitive with respect to fox control. The common ringtail possum, for example, was expected to benefit from fox control as a major prey of foxes, but has instead declined dramatically and may even be locally extinct.

Identifying the causes

Many hypotheses about the causes of declines and extinctions have been considered and tested, but after five years of careful study, the reasons are still unknown.

Booderee National Park – an iconic Australian reserve

Booderee National Park is located in Jervis Bay in south-eastern Australia, around 200 km south of Sydney on the New South Wales coast between Nowra and Ulladulla. First established as a national park in 1992, it is a 6600 ha reserve that supports more than 200 terrestrial vertebrate species, including threatened species and threatened ecological communities.

Booderee National Park is a highly effective science–manager partnership between Parks Australia, the Wreck Bay Aboriginal Community and the Threatened Species Recovery Hub. It was ranked as one of Australia's best-managed protected areas by WWF Australia in 2008.

In addition to fox control, weed control and fire management, wildfire has also been eliminated as a potential cause of the declines. A large wildfire burnt half the park in 2003, the same year the fox-baiting program was intensified and species monitoring program began, but many species were either minimally affected or have recovered from it. In addition, the species that declined were lost from both burned and unburned areas.

Neither can blame be assigned to cats. They are rare in Booderee National Park, and there is no evidence their numbers have increased with the decline in foxes.

Other potential reasons for the native mammal collapse have been ruled out. These include:

- Competition among hollow-using species
- Native herbivore release and over-browsing
- Native predator release
- Exotic herbivore release
- Food limitation
- Consumption of poison baits
- Disease
- Climate change
- Invasive plant species
- Natural population patterns

Additional causes are being considered that have yet to be comprehensively tested. Chief among these is that the declines and losses may ultimately be due to a combination of stressors, including those already ruled out as independent causes and possibly other causes that have not yet been identified. Even management practices with a compelling case for widespread application, such as fox control, should be re-examined for their potential to produce unintended perverse effects when combined with other factors.

Isolation is another factor that is being considered. Booderee National Park occupies a peninsula surrounded by considerable (and rapidly increasing) urbanisation. On peninsulas, population declines and losses may not be able to be reversed by immigration. Isolation impacts may explain past mammal extinctions in the park, such as losses of the spotted-tail quoll and the yellow-bellied glider in the 1980s, and could also go some way to explaining the unreversed losses observed now.


IMAGE: NATASHA ROBINSON

ABOVE: ANU field ecologists Chris MacGregor and Thea O'Loughlin and volunteers monitoring team taking a well earned break in the Park.

Another factor to consider is that important ecological roles played by some (now declining or lost) species may have already been lost from the park and this is having flow-on effects to remaining species. Although foxes may have played a key role in the demise of these species, the removal of foxes from the park cannot restore species that no longer exist.

Positions vacant

Some of the park's ecological niches are now vacant. The top native mammal predator in Booderee was lost with the local extinction of the spotted-tailed quoll in the 1980s. The recent losses of greater glider and common ringtail possum mean the community of arboreal marsupials is also greatly depleted.

Parks Australia is already working with many partners to undertake mammal reintroductions, with the aim of replenishing vacant niches and restoring the depleted community of mammals. The reintroductions include the recent reintroduction of the meso-predator, the eastern quoll.

Southern brown bandicoot and long-nosed potoroo reintroductions and translocations have also been conducted.

The TSR Hub is working closely with Booderee National Park and other partners to carefully monitor the reintroductions. The information will allow managers to adapt the management of the park to achieve the best possible outcomes for the animals released.

The pathway to recovery

The pathway to recovery may be much more complex than simply removing an apparent initial threat, such as foxes.

Park managers must be alert to declines as they emerge, so they are able to alter management regimes before it is too late. The research also suggests that (even subtle) changes in animal communities need to be tracked rather than just those of individual species. This means that monitoring must continue and early signs of losses identified so that critical changes can be detected in time to act.

This is a joint project of the Australian National University and Parks Australia. Wreck Bay Aboriginal Community have been consulted and support the project.

For further information

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IMAGE: THEA OLOUGHLIN

LEFT and BELOW: Natasha Robinson, Chris MacGregor and volunteers during monitoring activities in Booderee National Park.


IMAGE: JAS ALLNUTT

Bundles of quoll joy in Booderee

IMAGE: NATASHA ROBINSON

RIGHT: An eastern quoll in Booderee National Park.

Fifteen tiny quoll pouch-young have been born to three female eastern quolls from a pioneer group of 20 animals released into Booderee National Park. In a big win for the reintroduction project, these are the first eastern quolls known to be born in the wild on the Australian mainland for more than 50 years. The pilot project released the quolls into the park in March 2018, sourcing the animals from two captive breeding sanctuaries in Tasmania.

Pilot teething issues

Reintroductions are inherently risky. Worldwide, first attempts typically result in losses, often even up to 100%. Multiple attempts are usually required before a population can successfully establish. This makes three animals already with pouch-young a very encouraging result.

This pilot is a vital first step in identifying the challenges that the quolls face in the wild. Such knowledge then enables an appropriate management action to be implemented to improve the chances of these animals being able to successfully re-establish in the park.

Intensive monitoring of the quolls gave us detailed insight into key threats, and which management actions were working and which weren't. Despite being raised in captivity, we found that the animals had no problems foraging for food or finding places to den. Regular monitoring found them in good health.

But, over the first three months there were 14 deaths. Investigations showed that predation was the main cause of death. Three deaths were likely due to foxes and one to a dog. Two quolls were attacked by native diamond pythons, one succumbing and the other escaping but later dying of a bacterial infection.

Of the remaining eight deaths, four were due to road trauma, with the cause of the final four still under investigation.

Controlling for threats from cars and foxes

A major objective of the project is to determine the suitability of conditions in Booderee and whether more management actions will be needed before more quolls can be released.

The relatively high number of road deaths was unexpected, and the project team has responded by relocating quolls away from high-risk collision areas. There are also plans to install quoll road signs, while the team is engaging with park users and nearby residents about the need to slow down between dusk and dawn.

Foxes, on the other hand, were an anticipated threat. Parks Australia has been undertaking intensive fox control in the park for 15 years. In preparation for the quoll release, Rewilding Australia stepped up the control to include off-park baiting on private land to create a buffer to fox incursions to the park. Following the loss of several animals to foxes, additional and more targeted fox control measures were deployed.

IMAGE: RACHEL MORGAIN

LEFT: Students at Jervis Bay School have painted signs to raise awareness about the quolls within the Wreck Bay community and amongst visitors to the Park.

ABOVE: Hub researcher Natasha Robinson from ANU talking to students and Wreck Bay community members about how the quoll reintroduction has gone.

One fox was successfully detected on camera triggering a Canid Pest Ejector poison control tool. No further deaths due to fox predation have been recorded.

Future translocations: Applying the learnings

The learnings about fox incursion have led to NSW National Parks increasing fox baiting on land it manages immediately outside Booderee National Park, and monitoring for results from this heightened buffer-zone strategy. The team also acquired new understandings about smaller-scale fox–quoll interactions – both species use tracks and both are attracted to carrion, which means they are quite likely to interact in the park. Future monitoring of such tracks when more eastern quolls are released into the park will help identify fox incursion more quickly.

The project has proven that captive-bred eastern quolls reintroduced to Booderee can successfully forage, den and breed.

It has also demonstrated the capacity of managers to respond to research findings to improve the survival rate of the quolls. The learnings in this pilot will help refine how future translocations of eastern quolls are implemented. Further releases are planned for 2019.

This project is a collaboration between Parks Australia, the Australian National University, Rewilding Australia, Taronga Conservation Society and WWF Australia, with support from Wreck Bay Aboriginal Community Council, Shoalhaven Landcare, and the Tasmanian Quoll Conservation Program sanctuaries Devils@Cradle and Trowunna Wildlife Sanctuary.

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Thoughts on the quoll program from Indigenous Ranger Phillip Brown-Smith

"I thought the quoll program was good. I found out about using tracking equipment. I had never used this equipment before.

I found out that the quolls live by the sea. I thought they'd live in among the trees, in the forest area. Finding the quolls living in Wreckie was surprising. It was good that they were living there. We [Wreck Bay Village folk] had never seen a quoll in Wreckie before. It was real different. Other Wreckie folk thought that having quolls live in the village was good; it was a new thing for them too.

Their territorial behaviour was surprising. The way that they spend time in a particular area. Also I didn't think they'd attack each other but seeing them fight was interesting. [2 males were seen fighting in WBV]

I saw the quolls eating crabs. While on a boat with my uncle, I saw the one at Kitty's beach eating crabs in the afternoon.

The employment with Parks has been good. I'm learning something new every day. My favourite part of job is trapping for small mammals and being a part of the quoll program. Definitely yes to seeing the quoll program continue. It's a good program."

ABOVE: Pouch young were about 2–4 weeks old when they were first observed at the end of June during regular monitoring.

RIGHT: (L to R) Rangers Tyson Simpson-Brown and Phillip Brown-Smith using a radio tracking receiver to locate one of the released quolls.

John Kanowski: A life in ecology

I grew up in a large family in country Queensland. Dad was a forester, mum a teacher. The foresters cared about bush, and fought to protect forests from conversion to agriculture, but they also valued their role in bringing jobs and development to rural Queensland.

When I first went to university, I ran as far as I could from this background. I studied English literature, philosophy and history, and got involved in progressive causes. This was during Bjelke-Petersen's reign as premier. After completing my degree I moved to the bush, this time in northern New South Wales, where I lived on a community. I learnt how to build and to garden, and I planted a lot of trees. I felt a deep connection to the land.

In 1988, I ended up in Borneo with a couple of friends, trying to 'save' the Penan – indigenous hunter-gatherers whose land was being logged and livelihood displaced by a rapacious, corrupt frontier system. The Penan ended up saving us, carrying us out of the forest when we came down with jungle fever. The Malaysians arrested and deported us.

I arrived back in Australia with a strong desire to help in conservation, but aware how little I knew. I went back to university and studied conservation science, and then did a PhD in rainforest ecology in north Queensland. As a post-doc, I worked for nearly a decade on a project looking at the restoration of biodiversity in rainforest plantings. I worked under a really good ecologist, Carla Catterall.

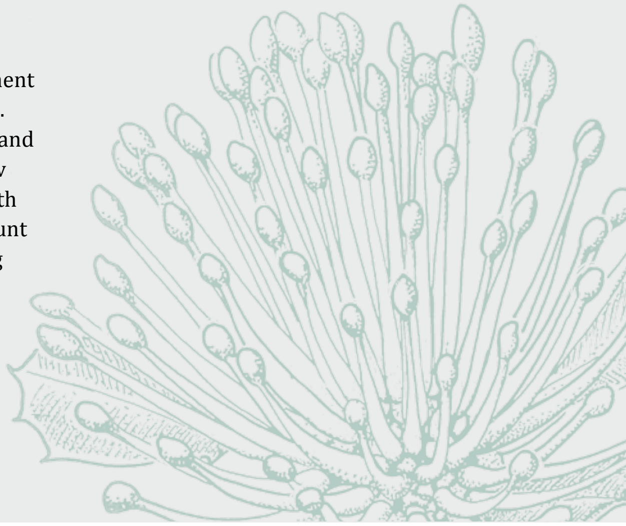
Over time, working in rainforest restoration – although close to my heart – started to feel constrained. A mate contacted me about working for a private nature conservation and land management outfit, Australian Wildlife Conservancy. At the time, I'd not heard of it, but I trusted my friend and took the job. For the next five years I worked as Regional Ecologist for north-east Australia, conducting surveys in remote northern Australia, managing a small team and learning a lot of new ecology. I became personally responsible for conservation on AWC properties. This was both wonderful and scary: the 'acid test' of my ecological knowledge.

Since 2014, I've been managing AWC's science program, including our involvement in the Threatened Species Recovery Hub. Over this time, AWC has doubled in size and the number of ecologists we employ now exceeds 50. We've taken on contracts with governments and are being held to account to deliver. We've developed a monitoring program that we think best meets our needs, and are conducting a range of ecological research projects.

John Kanowski manages the science program of the Australian Wildlife Conservancy, whose sanctuaries support over 60 nationally threatened animal species.

While our work is strongly focused on improving conservation outcomes on our wildlife sanctuaries, we also engage with the broader scientific community, to keep abreast of what's new, to share what we've learnt, to collaborate and to host academic research.

AWC's mission is the conservation of Australian wildlife. That's a goal I share. I don't want to see any more extinctions.



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COVER IMAGE: RESEARCHER HUGH DAVIES HOLDING A BRUSH-TAILED RABBIT-RAT (SEE PAGE 10 FOR THE FULL STORY). IMAGE: JOHN DAVIES

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