WILL MOVING ENDANGERED SPECIES SAVE THEM FROM CLIMATE CHANGE?

Some of the most threatened animals might not survive in their current habitat. Researchers are testing a controversial strategy to relocate them before it's too late — starting with Australia's rarest reptile. **By Clare Watson**

In a remote national park on Australia's most southwestern tip, a lone radio tower stands above a quiet wetland. Every five seconds, it collects signals from a few dozen young tortoises hiding out beneath the glassy waters. The tiny tortoises don't journey far, but researchers are tracking their every move. The fate of a species — one of the most endangered in the world — might depend on these data.

There are fewer than 70 adult western swamp tortoises (*Pseudemydura umbrina*) living in the wild in two small wetland reserves north of Perth, Australia. These spots are all that remains of the creatures' native habitat, and they are drying out, owing to rising temperatures and a reduction in rainfall. So, in August last year, scientists selected 41 juvenile tortoises from a captive-breeding programme in a zoo and released them into this national park, some 330 kilometres south of where the tortoises are naturally found. The aim is to see whether the animals can tolerate cooler climates, and whether this new habitat might ensure the species' future as the planet warms.

This experiment is part of a series of closely monitored field trials testing one of the most controversial strategies for saving a species — a concept called assisted migration. The tortoise is thought to be the first vertebrate to be moved beyond its historical range because of climate change.

Nicki Mitchell, a herpetologist at the University of Western Australia in Perth, is leading the project that is trying to save the tortoise. Her team is now on their fourth trial of releasing captive-bred tortoises into selected wetlands to test the potential of assisted migration, also called assisted colonization. It's a high-stakes strategy — and one that researchers have long debated. "It is a demonstration project for the world, and we particularly want to make sure there are no perverse outcomes," Mitchell says.

Conservation biologists and land managers have long resisted the idea of assisted migration, mainly because introduced species could become invasive pests, carry diseases or upend existing ecosystems. Few places know the risks better than Australia, which has waged war against cane toads, rabbits and other invasive species that people purposefully introduced to the continent in ill-fated schemes.

But attitudes towards assisted migration are slowly shifting as conservationists realise just how fast the climate is changing. Several projects are in the works, only a step or two behind the swamp tortoise experiments. Researchers in eastern Australia are testing plans to move critically endangered pygmy possums, which are threatened by increasing temperatures and droughts, and scientists in Hawaii are relocating seabirds to higher ground, to protect them from rising seas that are fast destroying their nesting habitat.

"We may have to turn to assisted migration more often."

Those leading the charge are urging their peers to confront difficult decisions head-on, lest more species go extinct. And as a first test, the swamp tortoise trials are in the spotlight as researchers wait to see whether the project proves successful. Early results suggest that the juveniles are growing as expected, but the researchers say it's still too early to reach a conclusion; in a previous trial, the tortoises failed to thrive in another southern location that had looked good on paper.

"What changes perception more than anything," says Lindsay Young, a conservation biologist working in Hawaii on the seabird project, "is establishing a precedent for having done it successfully."

Nowhere to go

For a species at the forefront of research and conservation, the swamp tortoise is an unassuming creature. No bigger than a human hand, they have dark, plain shells and spend the wetter months in shallow ponds. When those dry out during the heat of summer, the animals settle under bushes and logs, entering a dormant state called aestivation until the rains return.

This rare and elusive tortoise was presumed extinct when it was first described from a museum specimen in 1901. Half a century later, in 1953, it was rediscovered in the wild. But the tortoise has nowhere to go. The last fragments of its known wetland habitat on the outskirts of Perth are now fenced in, surrounded by the expanding city and drying out despite efforts to pump water into them. Predators, poachers and wildfires also threaten the tortoises' existence.

The strategy of assisted migration is not a new one. It was first proposed in 1985, but it has not seen widespread use. Barely a dozen species of tree, lichen and butterfly have been moved to cooler climes because of foreseen changes to their climatic niche. Many more have been shifted to avoid predators, pathogens or human construction — which are more immediate, localized threats than climate change.

MATTHEW ABBOTT/*NEW YORK TIMES*/REDUX/EYEVINE

Nicki Mitchell holds two western swamp tortoises that are part of trials in a strategy called assisted migration.

Shifting a species within its known range or restocking wild populations with captive-bred animals is common practice in conservation. But assisted migration oversteps ecological boundaries and makes many conservation scientists feel uneasy. "It's an enormous thing for conservation to do, to change the range of a species to keep it alive," says Kylie Soanes, a conservation biologist at the University of Melbourne, Australia.

Nevertheless, Mitchell sees trialling assisted colonization as a better alternative to watching the last remaining captive populations of an iconic species dwindle to extinction.

Mitchell hatched the idea to shift the tortoise south with Gerald Kuchling, a herpetologist at the Western Australian government's Department of Biodiversity, Conservation and Attractions, and principal scientist of the department's swamp tortoise recovery team. Given the tortoises' rarity, the researchers had to devise methods of predicting where suitable wetlands for the tortoise were likely to occur two decades from now, on the basis of wetland hydrology, local climate projections and the tortoises' physiology[1]. That modelling, which screened more than 13,000 locations, led the researchers to one spot: an area in the southwest corner of Western Australia with plenty of seasonal wetlands, two of which would become the site of the first assisted colonization trial in 2016.

The team released a dozen captive-bred tortoises at each southern site as part of the trial and, at first, it looked like a good move. The introduced tortoises, which had small radio transmitters glued to their shells, grew as well as their northern kin[2]. In 2021 a bushfire destroyed 90% of the tortoises' original habitat. But then data started trickling in from the next trial, which involved releasing another 48 radio-tagged juveniles in 2018.

The results, published in May[3], suggest that the tortoises released in the southernmost wetland basked less and grew more slowly than did those in their home haunt. The wetland, the researchers discovered, was fed by a chilly stream and it rained there more often than it did in the creatures' home habitat. That meant that the introduced tortoises were less active; which might have impeded their growth.

Despite those results, Mitchell says the 2018 trial still yielded important insights about how swamp tortoises spend their days, thanks to custom-made data-loggers glued to their shells that gauged when the animals were basking in the shallows and when they were submerged deep underwater. "None of that was known because they're an incredibly cryptic species," she says. "You very rarely observe them in the wild."

Past and current trials have been approved on the proviso that the team can monitor the tortoises closely, recapture them and return them to Perth Zoo. "Which is why we're aiming to find every animal we can, as often as we can," says Mitchell, whose team did recapture the tortoises that were released in the first few trials. The tortoises are unlikely to become invasive or encroach on other threatened species, she adds, because they grow so slowly and eat only small aquatic insects and tadpoles.

But monitoring is arduous and expensive, and the cost of the field work is draining the researchers' remaining funding. Mitchell and her team of graduate students and volunteers are continuing their data collection until at least the end of 2023 with financial support from World Wildlife Fund Australia.

Despite her hopes for the project, Mitchell says that assisted colonization won't be suitable or feasible for every species at risk. "There are millions of species," she says, "and we're not going to get to many of them."

Climate concerns

Sean Williamson is one conservation biologist eager to see how the programme delivers. Based at Monash University in Melbourne, he's been watching its progress from afar. He says Mitchell's research has kindled cautious

interest among conservation biologists about whether assisted migration could work for other egg-laying reptiles, such as green sea turtles (*Chelonia mydas*), which nest on low-lying islands throughout the tropics.

Williamson, like all of the researchers *Nature* spoke to, is wary of the risks that assisted migration poses. But, when faced with losing an "unfathomable" number of species to climate change, he says conservation biologists should consider every tool at their disposal, including assisted migration.

Researchers are exploring this option with a population of mountain pygmy possums (*Burramys parvus*). In the wild, these palm-sized possums are marooned in the highest reaches of the Australian Alps, in a fragmented area totalling less than 7 square kilometres. The possums survive winter by hibernating under a blanket of snow. But with less snow and fewer moths to eat in drought years, the possums are living on the edge in their current habitat.

Yet, fossil evidence suggests that their ancestors lived in lowland rainforests 25 million years ago[4]. So researchers built a facility near Lithgow, Australia — some 500 km from where the animals are usually found — to test whether modern possums could survive in the same environment as their forebears.

Hayley Bates, a biologist at the University of New South Wales in Sydney, Australia, and her colleagues moved 14 possums in 2022 from another facility to open-air enclosures with artificial rock walls and nesting boxes that mimic the animal's home boulder fields. "So far, they're doing pretty well," she says.

The possums have started breeding, which suggests they can adapt to lower elevations with occasional snow. Bates says seeing the possums breed is an important milestone in the project, which is built on a decade of field work to understand the species. The long-term plan is to release the possums into a series of small, fenced enclosures in the bounds of the wildlife sanctuary where the breeding facility is built.

Any potential releases into outdoor fenced sites are still another 5 to 10 years away, and hinge on many more experiments with captive-bred possums, to work out what they might eat in their new home, and how they fare with unfamiliar predators.

Meanwhile, in Hawaii, Young and her team at the non-profit organization Pacific Rim Conservation based in Honolulu, where she is the executive director, are working to save seabird species that aren't yet critically endangered, but nest on the edge of low-lying islands. Rising seas and storm surges are already wiping out countless nests, Young says, and hurricanes have erased some of Hawaii's northwestern atolls. These threats will only intensify as the planet warms.

Pacific Rim Conservation is working to make sure enough black-footed albatross (*Phoebastria nigripes*) chicks survive to sustain future populations. In 2017, the team began relocating weeks-old chicks from Hawaii's northwestern atolls to Oahu, an island on which black-foots don't usually nest.

Operating under state and federal permits, Young and her colleagues housed each chick in its own A-frame shelter at the new nesting ground, a state park, some 225 km from their usual breeding spot, and hand-fed them fish milkshakes until they fledged[5].

It will be a few years yet before the relocated black-foots reach maturity and possibly begin breeding at their new nesting site, alongside other seabird species. Being long-lived birds that feed at sea, the albatrosses aren't expected to become invasive or impinge on other land-dwelling species, Young says.

Unpredictable risks

For a long time, some conservation scientists said that assisted colonization wasn't an idea their peers should even be discussing. However, a survey conducted from 2016 to 2021 in Hawaii suggests that attitudes are changing, particularly among wildlife managers who realise their past inaction and their unwillingness to accept risk might have led to some extinctions. This is especially palpable on small island nations where species are hemmed in by rising seas.

"We're just on the front lines here," says Melissa Price, a wildlife ecologist at the University of Hawaii in Manoa, who conducted the survey[6] of 22 conservation practitioners.

LINDSAY YOUNG/PACIFIC RIM CONSERVATION

Black-footed albatross chicks were moved to Oahu, Hawaii, to establish a nesting colony there.

Scientists who are normally cautious are now considering making bold moves to save some Hawaiian species from disappearing, which "tells me how dire the situation is", she says.

Some researchers who once opposed assisted migration are reconsidering their stance. Mark Schwartz, a conservation scientist at the University of California, Davis, says he has become more accepting of assisted colonization now that he has seen researchers working methodically to assess the risks of moving species, such as with the western swamp tortoise.

"But that doesn't mean that I don't deeply worry about our capacity to do it right," Schwartz says. That's why he and other researchers are calling for the establishment of global standards on assisted colonization to guide its responsible implementation[7].

Other researchers and organizations are ambivalent. In a statement outlining its position to *Nature*, the Ecological Society of Australia says that moving species into new habitats is expensive and risky, making assisted colonization a 'last resort' option in conservation planning. But the society acknowledges that as climate change worsens, "we may have to turn to assisted migration more often". It also says that cutting greenhouse-gas emissions and halting habitat loss are the two best ways to safeguard against extinctions.

Ali Chauvenet, an ecological modeller at Griffith University in Brisbane, Australia, says that there are many tools available to help in making decisions about assisted migration. These include modelling techniques to estimate the possible impact on ecosystems and risk-assessment frameworks to judge the likelihood that an introduced species will become invasive, or survive in a new place.

Invasive-species biologists tend to oppose the idea because of what could go wrong. One study tried to compute the consequences of assisted migration and the likelihood of its success[8]. In a model simulation, it found that there is a good chance of saving selected species with assisted migration, but a recipient ecosystem might lose nearly half of its species on a rare occasion. However, the model simulated assisted migration in an artificial ecosystem of just 15 species. "It's very hard to predict what's going to happen," Chauvenet says.

Despite some researchers warming to the idea of assisted colonization, there are major regulatory hurdles to moving species into new areas, says Lesley Hughes, an ecologist at Macquarie University in Sydney. Government agencies, at least in Australia, rarely recognize assisted migration — or any interventionist action — as a valid option in threatened species recovery plans, according to a review[9] of 100 plans that Hughes conducted in 2018. Since then, there has been some progress, she says, "but it's at a glacial pace".

In the past few years, the US National Park Service and Parks Canada have both enlisted the help of researchers to develop frameworks and evidence maps[10] on assisted migration. And in June last year, the US Fish and Wildlife Service announced proposed changes to the US Endangered Species Act that would make it easier for conservationists and wildlife officials to consider assisted migration as a conservation tactic, say researchers.

TAMARA DEAN

Hayley Bates hopes to transfer mountain pygmy possums to lowland environments.

However, the thought of moving species across ecosystem boundaries raises questions about who gets to make those decisions and draw those lines. Indigenous people, for example, have long been excluded from conservation circles, says Jacqueline Beggs, an invasive-species biologist at the University of Auckland, New Zealand, who is of Ngāti Awa descent.

"There are millions of species, and we're not going to get to many of them."

"There's going to be a lot of deep conversations required," Beggs says, "to think our way through the issues, particularly from an Indigenous perspective."

A colder home

The swamp tortoises' wintertime wetlands are, for now, brimming with water. But come December or early January, they will dry out, at which point the tortoises will hunker down and aestivate. Before then, Mitchell and her team will ramp up their monthly monitoring to fortnightly welfare checks — to save any radio transmitters from falling off during the juveniles' growth spurt. But there's nothing to stop the tortoises from getting picked off by predators or waddling out of range.

The animals could get some help from the authorities. In October, Australia's Commonwealth government added the swamp tortoise to a priority list of the top 110 threatened species and included moving the tortoise to southern climate refugia as an action item. Mitchell hopes the federal government will supply funding for the project; then her team could hand over the reins to a locally based team that could monitor the tortoises' movements, growth and survival.

To keep costs down, Mitchell's team are exploring other monitoring approaches besides radio tracking, such as measuring traces of DNA the tortoises leave behind and tracking the sounds they make using underwater hydrophones.

One big question for the future is how well the tortoises can reproduce in colder climates. Mitchell says it could be another 10–15 years before any of the juveniles released last year reach breeding age — if they survive in their new home that long. For the shy, slow-growing swamp tortoise, there simply aren't any quick answers to these burning questions.

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