Second-chance conservation

Roman Goergen reports on how cloning techniques are among those that have helped bring the black-footed ferret back from the edge of extinction, and asks whether genetic rescue can overcome the plague and politics of the prairie

In the summer of 2024, in a quiet facility nestled in the grasslands of the US state of Virginia, two small ferret kits blinked into the world, unaware that their birth marked a global first. With dark eye-rings that resemble a bandit's mask, the kits Sibert and Red Cloud are black-footed ferrets (*Mustela nigripes*), one of North America's most endangered mammals. What sets them apart isn't just their rarity, but their lineage: their mother, Antonia, is a clone.

Born in 2023, Antonia was created from the preserved cells of a female ferret named Willa, who died in 1988 without leaving any offspring. Thanks to cryopreservation at the San Diego Frozen Zoo – a pioneering biobank that, since the 1970s, has preserved thousands of genetic samples from endangered species – and a complex cloning process, Willa became the genetic source of Elizabeth Ann, the first cloned ferret in US conservation history.

When Elizabeth Ann proved infertile, Antonia and her twin Noreen were produced using a refined method, and then last year, to the astonishment of scientists, Antonia gave birth by reproducing naturally. Her kits are now the first descendants of a cloned animal ever born in a conservation breeding programme.

Ben Novak, lead scientist at Revive & Restore, a nonprofit dedicated to biotechnology for conservation, explains: "I think the best part about that story is that Antonia was presented with a mate, she accepted him, they bred naturally, she gave birth naturally, and she raised her own offspring to weaning. This is exactly what people want to see from these technologies – that human intervention isn't required from start to finish, but that the animals can still work within the natural systems in place."

Black-footed ferrets were once abundant across the Great Plains, with populations stretching from Canada to northern Mexico. But their fortunes changed dramatically in the 20th century. Prairie dog colonies, essential to ferret survival as both habitat and food source, were wiped out through government-supported extermination programmes to make room for livestock. Habitat loss and sylvatic plague pushed the species to the edge. The plague, a deadly disease carried by fleas on rats from Asian trading ships in the early 1900s, kills both black-footed ferrets and prairie dogs. By the late 1970s, the ferret species was believed extinct.

A last-chance discovery came in 1981, when a remnant population was found on a Wyoming ranch. Conservationists captured the remaining individuals, and from just seven breeding ferrets they launched a captive breeding programme. Every black-footed ferret alive today descends from those seven founders.

That number is at the heart of the problem. A population descended from so few individuals is more likely to suffer from reduced genetic diversity, which in turn increases the risk of infertility or vulnerability to disease and environmental change. So far, scientists have not observed any birth defects in the population, but they have detected early signs of declining fertility, particularly among females, which suggests that intervention is prudent.

Enter Willa. Although she left no offspring during her lifetime, her cryopreserved cells contained a valuable genetic variation not found in the modern population. When Antonia – Willa's genetic copy – successfully passed this variation to her kits, the long-dead ferret was effectively added as an eighth founder. Genetic testing suggests that her DNA could significantly increase the diversity found in today's wild-born ferrets.

Similar biotechnological strategies are being explored elsewhere. Revive & Restore, in partnership with ViaGen

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Pets & Equine and using genetic material from the San Diego Zoo Wildlife Alliance Biodiversity Bank's Frozen Zoo, has also successfully cloned a Przewalski's horse named Kurt from cells frozen since 1980, as part of efforts to restore genetic diversity to this once extinct-in-the-wild species.

The BioRescue consortium in Berlin is attempting to save the northern white rhino through in-vitro fertilisation (IVF), combining egg cells from the last two females with sperm from deceased males. And in Hawaii, researchers are using gene editing to try to make native honeycreepers resistant to avian malaria, a disease that has pushed several species to the brink. While the methods differ, they share a common goal: rebuilding resilience where natural evolution no longer keeps pace.

In the case of the black-footed ferret, these efforts are already beginning to show promise – not just in the lab, but also through natural reproduction. Oliver Ryder, director of genetics at the San Diego Zoo Wildlife Alliance, explains: "Before we introduce the genes of these cloned animals into the wild population, we'll assess the fitness of their offspring. Noreen and Antonia are still growing up, but Antonia has already produced offspring. That's a good sign. We'll observe how those offspring grow and behave."

PLAGUE REMAINS A THREAT

The single most successful reintroduction site for black-footed ferrets today is the Conata Basin in South Dakota, where more than half the known wild population survives – over 230 individuals as of the most recent count. This success is due in large part to the relentless fieldwork of Travis Livieri and his team at Prairie Wildlife Research.

Since 1994, Livieri has worked in the region, helping to reintroduce ferrets and later focusing on vaccinating and monitoring wild-born individuals. In his words, "ferret time" means two to three months each year living out of a trailer on the prairie, trapping ferrets at night with headlamps and retrofitted pickups, vaccinating them in a mobile lab, and releasing them before dawn. To date, he's personally vaccinated over 1,500 animals.

Despite these efforts, plague remains a constant threat. Once sylvatic plague reached the Conata Basin in 2008, ferret numbers plunged. Only extensive vaccination campaigns, flea control using Fipronil-laced baits, and ongoing habitat protection have helped the population recover. Even so, every outbreak threatens to undo decades of progress.

But genetics offer more than new founders. Livieri confirms that all wild-born ferrets are assumed to be non-immune unless vaccinated. Each animal must be caught twice to receive the full course – a major logistical hurdle for field teams already stretched thin.

To solve this, Novak's team is engineering what he calls "self-vaccinating ferrets". The idea: insert a gene into the ferret genome that temporarily produces a vaccine antigen during early development. The gene would then delete itself from active cells to minimise long-term effects but remain in reproductive cells, allowing the immunity trait to pass to future generations.

But technological solutions alone won't be enough. Safeguarding the species requires attention not just to genetics, but also to the ecological fabric that sustains ferrets in the wild.

Kristy Bly of the World Wide Fund for Nature (WWF) emphasises this complementary approach, highlighting the importance of landscape-level recovery: "If we can restore even 3,000–5,000 to 10,000 acres (roughly 1,200 to 4,000 hectares) of prairie dog ecosystems in thirty or more places, then recovery of this endangered species is possible, as well as maintaining our connection to this landscape and the animals that call it home."

Her team at WWF has helped pioneer field techniques to control plague in prairie dogs, including bait-based vaccines and flea treatments distributed by drone. These efforts aim to protect not just individual animals, but also the ecological networks both species depend on.

If the recovery succeeds, it won't be thanks to one big breakthrough, but to many small victories – in the lab, on the land, and in the long nights spent catching ferrets one by one. In this way, the black-footed ferret may not only be saved, but also help rewrite the future of conservation itself. R

Roman Goergen is a journalist reporting on natural sciences, biology and ecology. In 2021, after spending more than a decade in Southern Africa, he moved to London, from where he continues to focus on international conservation issues.

Back from the edge

The 48 species of plants and animals shown in the artwork 'Back' by Isabella Kirkland (on page 10), went to the brink of extinction but returned. Some were carefully nurtured into survival by various levels of human intervention, including habitat manipulation, captive breeding, and reintroduction. Others were presumed extinct and then re-found, by accident or design. Such a species lucky enough to return from the edge of oblivion is sometimes referred to as '*Lazarus taxon*'. Here we share a full list of the species.

Forest owlet *(Athene blewitti)*
Cebu flowerpecker *(Dicaeum quadricolor)*
Golden-crowned manakin *(Lepidothrix vilasboasi)*
Hairy-eared dwarf lemur *(Allocebus trichotis)*
Fender's blue *(Icaricia icarioides fenderi)*
Madagascar red owl *(Tyto soumagnei)*
Jamaican rock iguana *(Cyclura collei)*
Laysan finch *(Telespiza cantans)*
Kobushi magnolia *(Magnolia kobus)*
Colorful puffleg *(Eriocnemis mirabilis)*
Kakapo or Taonga *(Strigops habroptila)*
Whooping crane egg *(Grus americana)*
Brown pelican egg *(Pelecanus occidentalis)*
Shasta owl's clover *(Orthocarpus pachystachyus)*
Peregrine falcon egg *(Falco peregrinus)*
Arctic lupine seeds *(Lupinus arcticus)*
Relict leopard frog *(Lithobates onca)*
Bald eagle egg *(Haliaeetus leucocephalus)*
Nene egg *(Brante sandvicensis)*
Showy Indian clover *(Trifolium amoenum)*
Large blue butterfly *(Maculinea arion)*
Wollemi pine *(Wollemia nobilis)*
Deppea *(Deppea splendens)*
Yadkin River goldenrod *(Solidago plumosa)*
Ventura marsh milkvetch *(Astragalus pycnostachyus var. lanosissimus)*
Koki'o *(Kokia cookei)*
Golden pennant *(Glyschrocaryon)*
Winteraceae *(Takhtajania perrieri)*
Orchid *(Dendrobium biloculare)*
Orchid *(Bulbophyllum rothschildianum)*
Pale-headed brush-finch *(Atlapetes pallidiceps)*
Franklin tree *(Franklinia alatamaha)*
Antiguan racer *(Alsophis antiguae)*
Snail darter *(Percina tanasi)*
Owens pupfish *(Cyprinodon radiosus)*
Na'u *(Gardenia brighamii)*
Hualalai han kuahiwi *(Hibiscadelphus hualalaiensis)*
Short-tailed albatross egg *(Phoebastria albatrus)*
Hawaiian damselfly or Flying earwig *(Megalagrion nesiotes)*
Noisy scrubbird *(Atrichornis clamosus)*
Servaline genet *(Genetta servalina)*
Jewel scarab *(Chrysina spectabilis)*
Kinglet calyptura *(Calyptura cristata)*
Black-footed ferret *(Mustela nigripes)*
Cherry-throated tanager *(Nemosia rourei)*
Lord Howe Island stick insect *(Dryococelus australis)*
Lange's metalmark *(Apodemia mormo langei)*
Mauritius kestrel *(Falco punctatus)*

Back by Isabella Kirkland
Courtesy of the artist and Hosfelt Gallery
www.isabellakirkland.com

To view a version of the painting with the species identified by number, visit www.tinyurl.com/48species