revive & restore

GENETIC RESCUE OF ENDANGERED AND EXTINCT SPECIES

5-year Strategic Plan 2024 - 2029

Summer 2024

www.ReviveRestore.org

Artwork:
Detail from *Back*, a painting by Isabella Kirkland, featuring 48 species brought back from the brink of extinction

Table Of Contents

03 **Our Mission**
Revive & Restore has a unique role. Discover the mission and vision that drive our work.

04 **The Challenge**
Biodiversity is in crisis globally. Learn the challenges our projects address.

06 **The Opportunity**
Biotechnologies can improve conservation outcomes. Meet the Genetic Rescue Toolkit.

08 **Theory of Change**
Learn how the Genetic Rescue Toolkit drives innovation for wildlife conservation.

10 **Our Approach**
Discover our 3-pronged approach to building and applying biotechnologies.

12 **Meet Our Team**
Meet our team of science, development, and conservation professionals.

14 **Our Portfolio**
Our portfolio spans the breadth of the Genetic Rescue Toolkit, from sequencing to cloning.

16 **Programs**
Discover our genetic rescue programs, comprising 70+ individual projects.

22 **Our Impact**
Explore our major accomplishments over the last 10 years.

24 **Partners & Media**
Innovation needs collaboration. Meet our project and media partners.

26 **Future Directions**
Explore some of the conservation technologies on the horizon at Revive & Restore.

28 **Long-Term Outcomes**
Genetic rescue can turn the tide on biodiversity loss. Discover our plan for impact.

Our mission is to revive biodiversity and restore ecosystems through the genetic rescue of endangered and extinct species.

Ecosystems worldwide face unparalleled biodiversity loss. The consequences of extinction extend far beyond the natural world, degrading economies, livelihoods, and the well-being of communities. Biodiversity loss will take decades to reverse and could result in a planet unable to sustain future generations.

While traditional conservation tools, including habitat restoration and captive breeding, are critical aspects of species recovery, they cannot keep pace with the extinction crisis and cannot restore genetic diversity lost from living populations. Biotechnologies can enhance conservation outcomes by accelerating evolutionary processes, restoring genetic diversity, and fostering the long-term recovery of endangered species. This is why we are creating the Genetic Rescue Toolkit.

Revive & Restore is the only wildlife conservation nonprofit solely focused on advancing biotechnologies to solve wildlife conservation challenges.

The Challenge

The current global extinction crisis demands immediate attention. With species disappearing at an alarming rate—*10,000 times higher than historical averages*—we face an ongoing mass extinction. This not only endangers the natural world but also threatens critical ecological functions supporting life on Earth.

Our work addresses key conservation challenges, including

- **Wildlife disease**
- **Invasive species**
- **Loss of genetic diversity**
- **Coral bleaching**
- **Wildlife poaching & trafficking**
- **Climate Change**

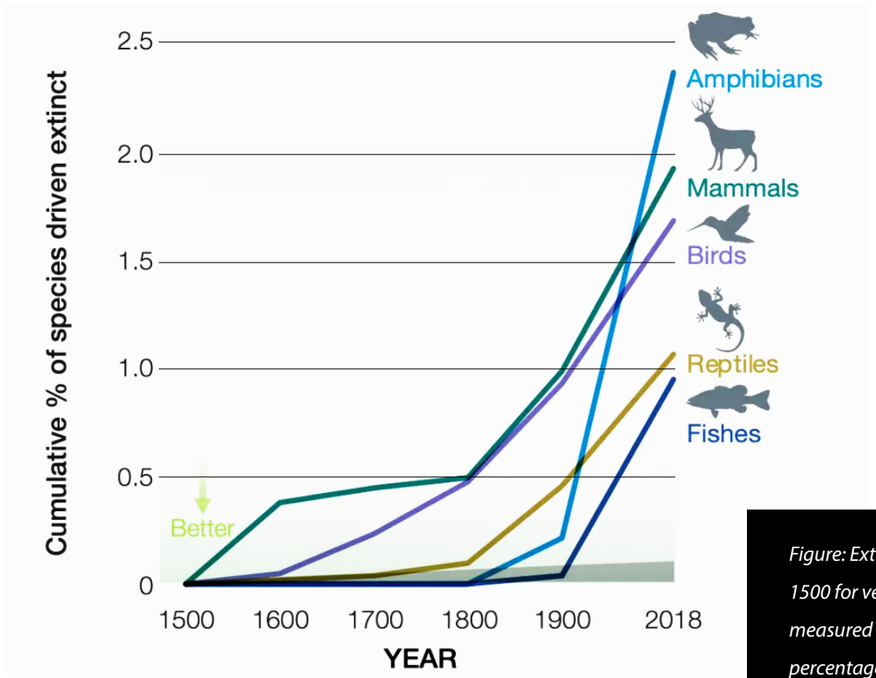


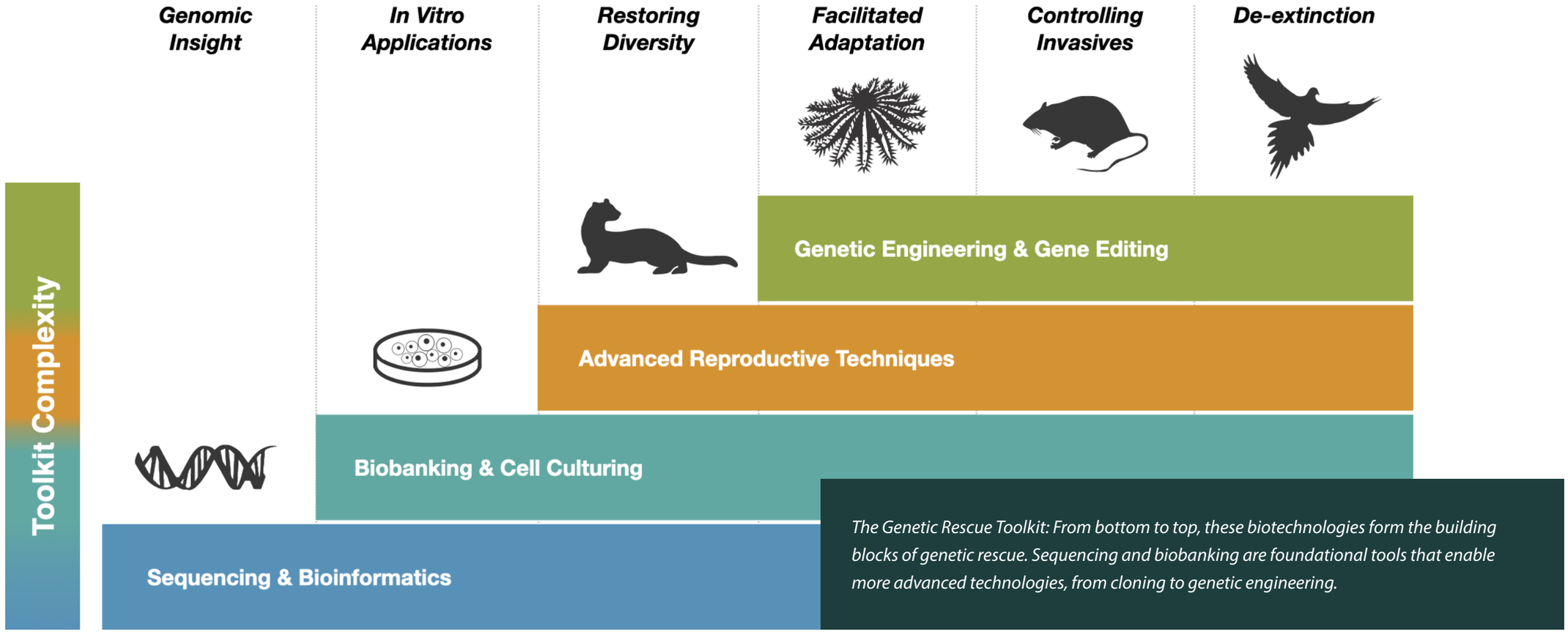
Figure: Extinctions since 1500 for vertebrate groups, measured by cumulative percentage of species-driven extinct | Wildlife Society 2019

The Opportunity

With the increasing affordability of genomic sequencing and the expansion of gene-editing technologies, there is an opportunity to develop new genetic rescue tools that complement conventional conservation practices. To advance biotechnologies for wildlife, Revive & Restore is building the **Genetic Rescue Toolkit**, a suite of biotechnology tools that help solve some of the world's most pressing conservation challenges.

As threats to wildlife increase with the pace of climate change, so too must our conservation strategies. By advancing the Genetic Rescue Toolkit, we are laying the foundation for unprecedented conservation approaches to tackle unprecedented conservation challenges. Genetic rescue is the goal, and the Genetic Rescue Toolkit provides the tools we need to get there.

The Genetic Rescue Toolkit for Wildlife Conservation



The Genetic Rescue Toolkit: From bottom to top, these biotechnologies form the building blocks of genetic rescue. Sequencing and biobanking are foundational tools that enable more advanced technologies, from cloning to genetic engineering.

Our Theory of Change

Conventional tools, including habitat restoration and captive breeding, struggle to keep pace with today's threats to wildlife. The number of species becoming endangered vastly exceeds those saved. **Extinctions continue.**

The failure of conventional approaches has led to a stagnation of ideas and inertia to innovate. A sense of despair has created donor fatigue, funding cuts, and worse - conservationists prematurely abandoning promising interventions.

The Genetic Rescue Toolkit is the foundation for our theory of change: it provides biotechnology tools that can accelerate evolutionary processes and foster adaptations at the pace needed to save species. By creating and promoting new tools, Revive & Restore inspires conservation practitioners to field-test new strategies, advocate for widespread adoption, and drive innovation further.

Revive & Restore is uniquely positioned to de-risk conservation biotechnologies, from research to implementation. We can improve our stagnant methodologies and expand our toolkit to save species and restore ecosystems.

Our Theory of Change: In order to turn the tide on biodiversity loss, we must fully realize the potential of the Genetic Rescue Toolkit, from technology development to widespread adoption and deployment in the conservation community.

Our Approach

Revive & Restore provides funds to researcher partners worldwide to develop new tools for the Genetic Rescue Toolkit, which help revive species and restore ecosystems. We support early-stage, proof-of-concept projects that translate advanced biotechnologies to wildlife conservation applications that currently lack viable solutions. Our projects come with a lot of technical risk, but offer the potential of major rewards for species restoration.

In 2023, Dr. Mary Hagedorn (Left) and colleagues developed the first successful technique for cryopreserving and reviving coral fragments, funded by Revive & Restore.
Credit: Smithsonian Institution

Identify the White Space

Revive & Restore brings together conservationists, geneticists, technology developers, and field scientists to identify opportunities for conservation innovation.

Advance Technologies

We fund the research and development of cutting-edge biotechnologies, including applied genomics, biobanking, and advanced reproductive tools.

Enable Application

We amplify the impact of our work by building communities of practice, advocating for the adoption of new technologies, and getting these tools deployed in the field.

Meet Our Team

Revive & Restore was founded in 2012 by Stewart Brand and Ryan Phelan, who brought together a group of passionate scientists, conservationists, and philanthropists to address the urgent need for innovative approaches to conservation. Today, we are a lean and agile team of dedicated professionals who have raised over $25M to support catalytic research at partner institutions worldwide.

Co-Founders

Ryan Phelan

Co-Founder, Executive Director

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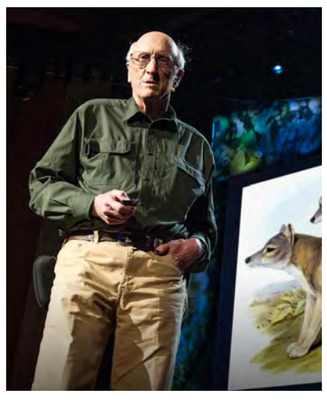
As the Co-Founder and Executive Director of Revive & Restore, Ryan works with the world's leading molecular biologists, conservation biologists, and conservation organizations to envision and develop pioneering projects that apply cutting-edge biotechnologies to seemingly intractable conservation challenges.

For two decades prior to her conservation work, she was a leader in patient-oriented healthcare.



Stewart Brand

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Sausalito, CA 94965

Stewart Brand is the co-founder of Revive & Restore, the Long Now Foundation, and the Global Business Network.

Stewart has been an ardent conservationist since he was 10. He earned his degree in Biology from Stanford in 1960, focusing on ecology and evolution. He created and edited the Whole Earth Catalog (National Book Award), widely considered a founding pillar of the modern environmental movement.

Ashlee Hutchinson, PhD

Program Manager

As Program Manager, Ashlee develops and oversees applied genetic rescue projects for threatened and endangered species. She manages the Stem Cell program, which advances stem-cell focused projects that enhance wildlife conservation efforts.

Ben Novak, MSc

Lead Scientist, Progam Manager

Ben pioneers new tools for genetic rescue and de-extinction. As lead scientist, he heads Revive & Restore's de-extinction efforts and is the lead coordinator for conservation cloning projects. In 2022, his role expanded to include Program Manager for the newly launched Biotechnology for Bird Conservation program.

Kika Tuff, PhD

Director of Communication

Kika develops communication campaigns around genetic rescue and the successes happening at Revive & Restore. As the Communications Director, she collaboratively manages stories, media, and communication strategies for ongoing projects.

Liv Williamson, PhD

Program Manager

As Program Manager, Liv develops and oversees applied genetic rescue projects for endangered species around the world and helps craft Revive & Restore's scientific focus. She manages the Advanced Coral Toolkit, which supports the development and field testing of cutting-edge biotechnologies for coral conservation.

Marmee Manack

Director of Operations

Marmee serves Revive & Restore as Director of Operations, helping to keep the organization running gracefully. Marmee oversees daily operations, including donor management, accounting, administration, and ensuring the dynamic Revive & Restore global community stays connected.

Nan Farley

Executive Assistant

As Executive Assistant, Nan supports senior management across tasks and projects. Nan aids in expediting Ryan's communication while also managing her calendar and tasks efficiently. Given the speed at which Ryan operates, Nan likes this work to being the pit crew for a race track driver.

Traci Eckels

Grants Manager

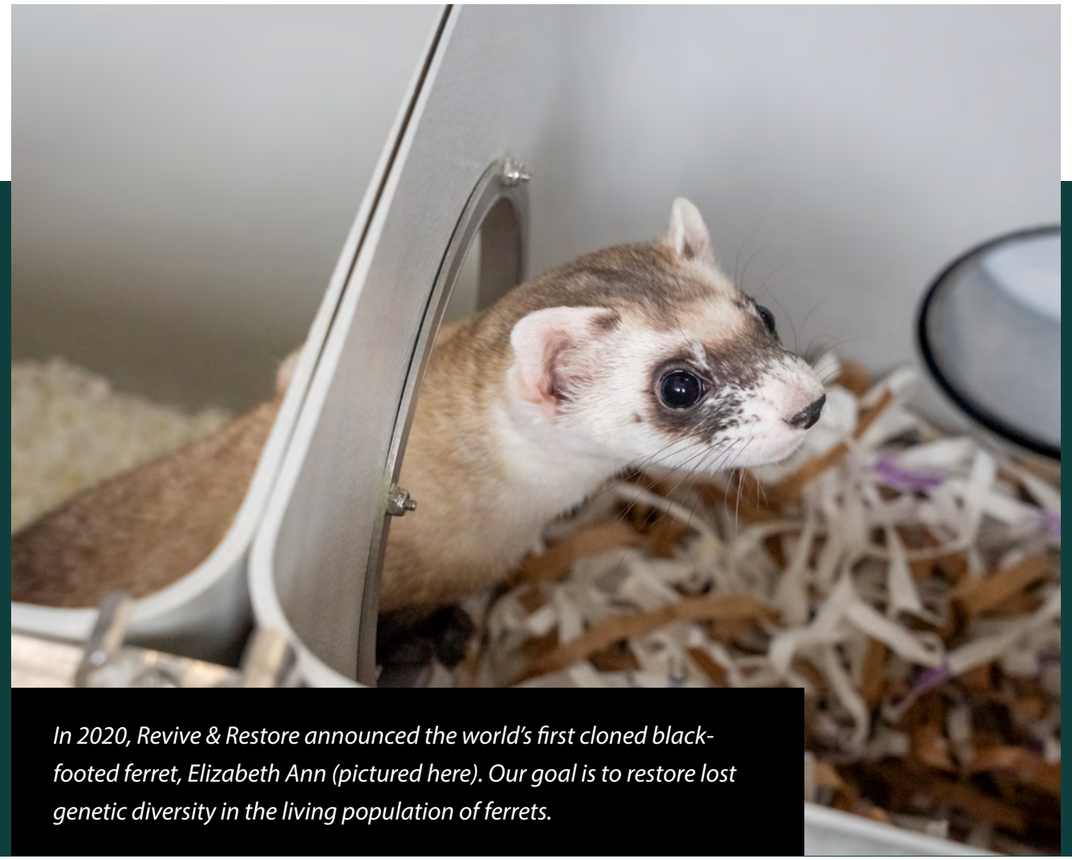
Traci has had a multi-decade career in non-profit fundraising and management, including securing funding for Public Media, national parks, universities, and affordable housing. Her role as Grants Manager at Revive & Restore brings together her experience in fundraising and non-profit administration to the benefit of the organization.

Our Portfolio

Our projects support the research, development and field testing of new genetic rescue tools that address global conservation crises. Our portfolio spans the breadth of the Genetic Rescue Toolkit, from genome sequencing to advanced reproductive techniques to the de-extinction of lost species.

In the following pages, we will explore three programs from our research portfolio:

- Wild Genomes
- Advanced Coral Toolkit
- Biotechnology for Bird Conservation



In 2020, Revive & Restore announced the world's first cloned black-footed ferret, Elizabeth Ann (pictured here). Our goal is to restore lost genetic diversity in the living population of ferrets.

To date, we have funded over 70 genetic rescue projects, with more than 98 focal species. Our projects span 60 institutions across 26 nations. The projects we fund are often the first to demonstrate the measurable impact genetic rescue tools can have on wildlife conservation. As a small and agile organization, we are both opportunistic and strategic with our projects to better meet the needs of conservation.

All Revive & Restore projects meet the following criteria:

1. Address a significant conservation problem or build new capacity for conservation practice via genetic rescue tools
2. Provide compelling and inspiring examples of the value of genetic rescue technologies for wildlife conservation
3. Have clear potential for application

"Revive & Restore is an invaluable partner in our genetic preservation and cloning efforts. The list of accomplishments is impressive today, but we are only beginning to see the benefits that we can create together. We share a bold vision for using proven technology for positive change."

Blake Russell
President, ViaGen Pets & Equine

Wild Genomes

As wildlife populations become smaller and more isolated, species' genetic health can decline. While genomic tools provide a simple way to assess genetic health, these resources do not exist for most endangered species.

Without reference genomes and sequencing, scientists cannot detect inbreeding or disease susceptibility in vulnerable populations, identify opportunities for genetic rescue, or make informed decisions for wildlife management. Moreover, basic knowledge about the biology of endangered species remains unknown, making it impossible to use more advanced methods such as cloning, hybridization, or engineered resilience.

Genetic rescue tools are urgently needed to turn the tide for species on the brink. Launched in 2019, Wild Genomes is a funding program that provides state-of-the-art genomic tools to the people who need them most: field scientists, wildlife managers, and citizens working to protect their local biodiversity.

Broadly, our goals are to:

- Expand the availability of genetic resources for endangered species
- Encourage the integration of genomic resources into species recovery plans
- Improve understanding of how to use genomic data in wildlife management
- Develop field-ready tools for non-invasive tissue sampling

Our goal is to accelerate the uptake of genomic sequencing for applied wildlife conservation.

How We Measure Impact

The Wild Genomes program will be successful when high-quality reference genomes and tractable genetic methods (i.e. sampling, sequencing, and analysis) are well developed for a wide range of endangered species across many taxa, accessible to field scientists, and incorporated in applied wildlife management to enable genetic rescue for vulnerable populations.

Project Milestones

4 Programs Launched

Each Wild Genomes funding call focuses on an important conservation problem, ecosystem, or taxonomic group. To date, we have launched 4 programs: Kelp forests (2023), Amphibians (2023), Marine ecosystems (2021), and Terrestrial ecosystems (2020).

31 Projects Underway

Wild Genomes puts the fundamental tools of genetic rescue into the hands of people who manage wildlife. Projects are evaluated according to urgency, the ecological role of the targeted species, and the potential impact of the project. To date, we have funded 31+ projects globally.

Accelerating Uptake

Every other month, we host a team call with our science partners to showcase a project from the Wild Genomes portfolio. During that call, the project lead presents their research and conservation outcomes. Our goal is to accelerate the uptake of genomic tools in conservation.

Advanced Coral Toolkit

Often referred to as the "rainforests of the sea," coral reefs are among the most important - and most imperiled - ecosystems on the planet. A billion people worldwide depend on corals for the ecosystem services they provide. Sadly, over half of the world's coral reefs have been lost in recent decades, and as much as 90% could be lost by 2050.

Although restoration efforts have made strides to bring living corals back to degraded reefs, it is not enough to simply replace the corals that have been lost, as they often succumb to the same pressures that killed their predecessors. If coral reefs stand a chance, restoration activities must be complemented by new genetic rescue technologies that help corals thrive into the future, despite the stressors around them.

Launched in 2019, the Advanced Coral Toolkit supports the development and field testing of new biotechnologies that have the potential to greatly benefit coral resilience and restoration efforts.

Broadly, our goals are to:

- Mainstream the use of genetic rescue tools in coral reef conservation
- Accelerate reef restoration efforts
- Reverse the decline of critical reef-building species

Our vision for the Advanced Coral Toolkit is a global community of practice aligned around collective priorities to bring back thriving reefs on meaningful scales.

With further funding, we aim to achieve:

- Corals genetically engineered to tolerate high temperatures produced and tested in the field
- Biobanking for corals adopted as a standard management practice
- Coral stem cells approved for therapeutic use in the field
- Probiotics deployed to prevent the spread of disease
- Genetic rescue technologies normalized and integrated into conservation efforts

Project Milestones

$8 Million Raised

The threats that corals face demand urgent, bold action. We have raised over $8 million to launch a research and development program that adapts biotechnologies to (1) advance the scope, scale, and efficiency of reef restoration and (2) increase coral population diversity and resilience on meaningful scales.

13 Projects Underway

Few genetic rescue tools exist for corals. We have funded 13+ projects supporting the development and field testing of new biotechnologies for coral resilience and restoration efforts. Throughout the lifecycle of our projects, we collaborate with awardees to understand how to make these tools most effective for applied conservation.

2023 Breakthrough

Scientists in our Advanced Coral Toolkit announced the first successful technique for cryopreserving and reviving entire coral fragments. This proof-of-concept project, funded by Revive & Restore, opens the door to rapid, large-scale coral biobanking that will safe-guard remaining genetic diversity and prevent further loss.

Biotech for Birds

Half of the world's 11,000 bird species are in decline. Without novel approaches to intervene, many species could go extinct in our lifetime – **now is the time for innovation.**

The unique reproductive biology of birds makes it difficult to directly translate key technologies used for genetic rescue in mammals, like in vitro fertilization and cloning. An alternative to cloning, called germ-line transmission, has been pioneered for domestic chickens by biomedical researchers. With the right optimization, this technology could unlock a versatility of genetic rescue capabilities for use with wild birds.

Our vision is to create and deploy the genetic rescue toolkit for endangered and extinct birds. We have assembled the world's leading scientists to develop a suite of biotechnologies capable of helping birds thrive in a world increasingly shaped by human-driven change.

Broadly, our goals are to:

- Establish proof-of-concepts of a suite of cellular & reproductive techniques in a diversity of common bird species
- Establish gene-editing capabilities in birds at scales that can facilitate adaptation and even achieve de-extinction
- Foster a community of early adopters ready to apply biotech tools

Our goal is to transform the future of bird conservation through advanced reproductive and genetic technologies.

With further funding, we aim to achieve:

- Application of new tools to endangered bird species
- Demonstrate the far reaching abilities of biotechnology for conservation: the revival of the extinct Passenger Pigeon
- Gain public and stakeholder support to scale up genetic rescue de-extinction efforts

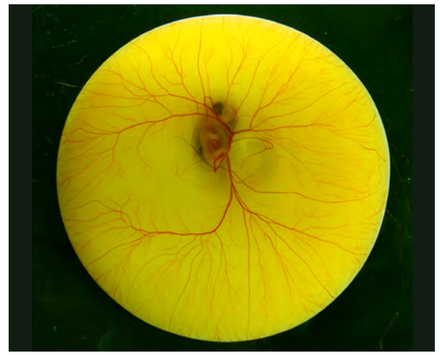
Project Milestones

Consortium Formed

In 2021, we formed an international Avian Genetic Rescue Consortium to ensure our innovations will meet the demands of the real-world logistics faced by conservationists. Today the consortium includes 68 members from 47 institutions (Government, NGO, Commercial, Zoo, University) spanning 14 nations across all inhabited continents.

$10 Million Raised

Dozens of birds have gone extinct in historic times, and today one of every eight bird species is threatened with extinction despite conservation's best available tools. We have raised just over $10 million to launch a research and development program focused on avian reproductive and genetic technologies with the intent to stop extinctions, and even reverse them.



12 Projects Underway

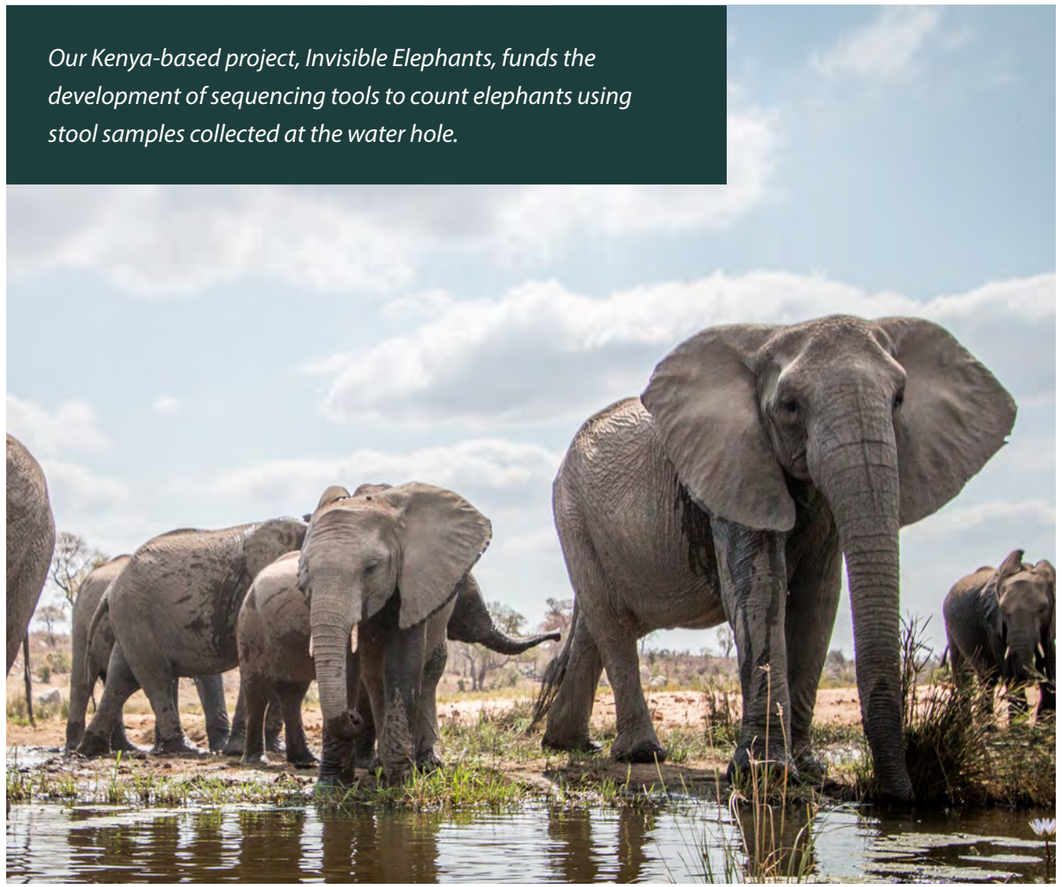
This program invites scientists to leverage biomedical advances made with domestic chickens and innovate entirely new systems, to create versatile pathways to the recovery of birds. We have funded 12+ projects supporting the development of new biotechnologies that will enable the restoration of genetic diversity, facilitate adaptation, and achieve de-extinction.

Our Impact

Revive & Restore is the leading wildlife conservation organization promoting the incorporation of biotechnologies into standard conservation practice. To date, we have raised over $25M to support catalytic research and development projects worldwide.

As a small and agile organization, we are both opportunistic and strategic with our projects to better meet the needs of conservation. By integrating biotechnology, genetics, and conservation science, Revive & Restore enhances the resilience of ecosystems and positively impacts species that are on the brink of extinction.

Our Kenya-based project, Invisible Elephants, funds the development of sequencing tools to count elephants using stool samples collected at the water hole.



Over the past 10 years, we have

Successfully cloned multiple individuals of two endangered species, the black-footed ferret and the Przewalski's horse

These successes provide evidence that cloning is an increasingly viable tool for species conservation and restoring lost genetic diversity.

Established a partnership and pipeline with the U.S. Fish & Wildlife Service to biobank U.S. endangered species

This is the first time the U.S. Fish and Wildlife Service has partnered on an agency-wide biobanking initiative.

Pioneered new cryopreservation methods to biobank endangered coral species

This proof-of-concept project, funded by Revive & Restore, established a new method to preserve entire coral fragments easily and rapidly at an urgent moment for coral worldwide.

Cultivated a growing community of conservation practitioners applying biotechnologies in the field

Our vision is to advance biotechnology tools and approaches that see widespread adoption in the conservation community. Our role is to inspire and enable a technological revolution in conservation.

Strategic Partners

Revive & Restore has forged strategic partnerships to propel genetic rescue technologies forward. Collaborating with leading scientific institutions, conservation organizations, and technology companies, we leverage diverse expertise and resources to advance approaches to species conservation and genetic rescue. By fostering partnerships, we accelerate progress in genetic rescue technologies, conservation strategies, and public engagement.

Our goal is to cultivate a collaborative ecosystem where knowledge is shared, spread, and radically advanced together.

Our Funders & Partners

San Diego Zoo Wildlife Alliance
VIAGEN PETS & EQUINE
U.S. FISH & WILDLIFE SERVICE
Promega
oceankind
MORRIS ANIMAL FOUNDATION
WEBB FAMILY FOUNDATION
The Nature Conservancy
re:wild
Smithsonian
Cantata Bio

Media & Coverage

We collaborate with influential media partners to amplify our message and expose new audiences to genetic rescue approaches. Through our media partnerships, we leverage the power of storytelling, science-driven journalism, and multimedia platforms to communicate the importance of innovation in conservation and highlight the potential of cutting-edge technologies to address biodiversity challenges.

By collaborating with media outlets, we can reach diverse audiences, engage with policymakers, and cultivate public support for novel conservation strategies.

Featured Media Partners

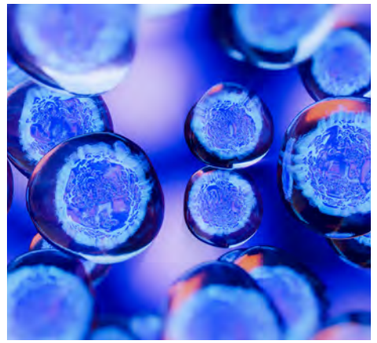
bioGraphic
BBC
Discover MAGAZINE
SCIENTIFIC AMERICAN
nature
Science
The New York Times
NATIONAL GEOGRAPHIC
POPULAR SCIENCE

Future Directions

Through collaborative efforts with science, conservation, and technology partners, we have made significant strides in advancing genetic rescue technologies and raising awareness about the need for interventions in conservation. **And we're just getting started.**

Looking ahead, our organization is poised to expand the Genetic Rescue Toolkit, field-test emerging technologies, and expand our communities of practice. By leveraging the power of the Genetic Rescue Toolkit, we will continue to build meaningful change in conservation practices that turn the tide on biodiversity loss.

Stem Cell Development

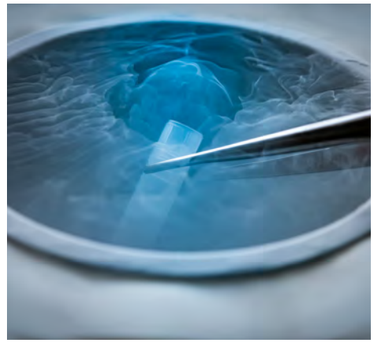


Revive & Restore's newest program leverages ethical stem cell technology for wildlife conservation. In addition to improving biobanking, stem cells offer (1) New ways to create sperm, eggs, and embryos, (2) Solutions to wildlife disease, and (3) An opportunity for engineered resilience. Yet, stem cell technologies remain severely underdeveloped for wildlife.

A.I. for Wildlife Conservation

AI holds immense potential to revolutionize genetic rescue tools with unprecedented efficiency, scale, and precision. Through machine learning algorithms, AI can analyze vast amounts of genomic and biological data to identify patterns, problems, and solutions. By harnessing AI, Revive & Restore can accelerate genomic technologies for conservation.

Expanding Biobanking



By preserving living cells, biobanking offers a safeguard for the genetic diversity of species. Biobanking also provides a foundation for advanced genetic rescue technologies and can reveal genetic strategies to mitigate disease and climate change. Our goal is to make biobanking standard practice in wildlife conservation.

Long-Term Outcomes

Revive & Restore's efforts promise long-term outcomes that extend far beyond the conservation of individual species. Biodiversity is the foundation of stable ecosystems and resilient communities. By harnessing the power of the Genetic Rescue Toolkit, we are building a future where species thrive, ecosystems flourish, and humanity becomes an active partner in rebuilding the nature we've lost.

By leveraging cutting-edge biotechnologies, such as cloning, gene editing, and de-extinction, we pioneer bold solutions to the extinction crisis. Simultaneously, we catalyze a global movement to embrace our responsibility to undo the ecological damage humanity has wrought. Through collaborations with science, technology, and conservation practitioners, we cultivate a sense of shared responsibility and collective action, uniting diverse skill sets for a common cause.

As we navigate complex conservation challenges, the importance of innovation cannot be overstated. Staring down the pathway toward a sixth mass extinction, we stand at a critical juncture in history. Yet, amidst the challenges, we find cause for hope in the transformative potential of genetic rescue technologies. By embracing innovation and genetic rescue, we chart a course toward a brighter, sustainable future. The sixth mass extinction does not have to come to pass - with biotechnologies we can stop it. We can reverse it. We can revive species and restore ecosystems for millennia to come.

"It's an honor to support an organization so effectively devoted to developing answers to the environmental challenges that we face and to preserving the diversity of the species with which we live and on which we depend. Revive & Restore's continued progress is both a comfort and an inspiration."

LAWRENCE WILKINSON
Recurring Donor to Revive & Restore

revive & restore

GENETIC RESCUE OF ENDANGERED AND EXTINCT SPECIES

Thank you for your support. Together, we can turn the tide on biodiversity loss.

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www.ReviveRestore.org