ZSL 200 YEARS OF WILDLIFE

PROTECTING NATURE'S BALANCE

The case for a paradigm shift in wildlife health

Male Asiatic lion undergoes CT scan at London Zoo
to determine cause of recurring ear infection.

WILDLIFE HEALTH MATTERS

A MESSAGE FROM ZSL'S CEO

Wildlife health is not a niche concern. It is a global emergency hiding in plain sight.

For two hundred years, ZSL has worked at the frontiers of conservation science. We have watched species decline, tracked diseases across continents and documented the slow unravelling of ecosystems under pressure. In that time, we have learned something fundamental: the health of wildlife is inseparable from the health of the planet, and from our own survival.

That connection became devastatingly clear in 2020. COVID-19 upended lives across the globe, exposing how deeply human health depends on the health of wildlife. Healthy ecosystems act as a buffer against disease. When we degrade them, we invite catastrophe.

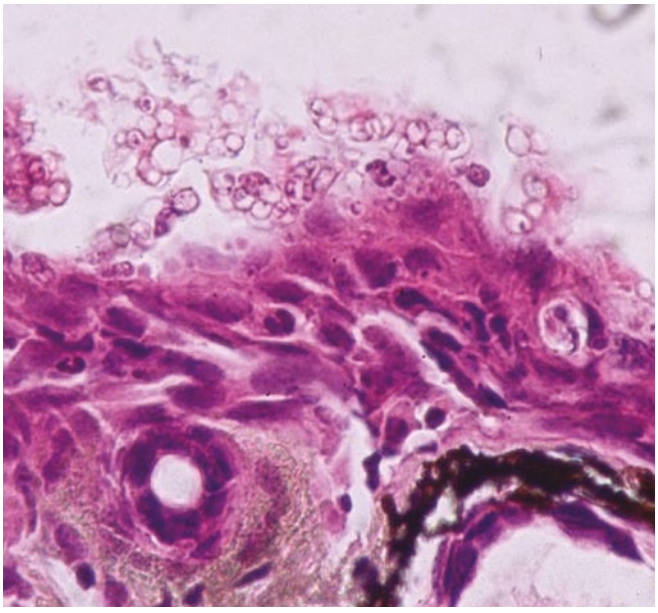
Yet wildlife health remains chronically underfunded, fragmented across institutions and nations, and absent from most of the world's biodiversity hotspots. We monitor human health. We monitor livestock health. We barely monitor wildlife health at all. And this blind spot is becoming more dangerous every year.

With more than thirty years working at the intersection of veterinary care, wildlife health and conservation leadership, I know that rigorous science, operational discipline and mission-driven values drive conservation. Leading ZSL now, I recognise the rarity of holding all three. We have the clinical infrastructure, diagnostic laboratories, research expertise and 200 years of institutional trust. We know effective wildlife health monitoring because we've been doing it – often on tight budgets – for decades.

This report makes the case for organised, visible and adequately resourced wildlife health monitoring and research. For a new way of thinking – one that recognises wildlife health as foundational to pandemic prevention, biodiversity conservation, and planetary resilience – and one that integrates cutting-edge clinical practice with population-level surveillance and research. ZSL's bicentenary year is the moment to articulate this vision and to demonstrate how institutions with depth of expertise, infrastructure and public trust can help drive the One Health agenda forward.

Wildlife health is the weak link in the One Health framework. Strengthening it is not optional, it is a must.

Kathryn England
CEO, ZSL



Histological image of amphibian skin with chytridiomycosis due to *Batrachochytrium dendrobatidis* infection.

FOREWORD

As a developmental biologist, I have spent my career studying how cells communicate to build complex living systems – from the earliest stages of embryonic development through to the formation of tissues and organs.

I've also been fortunate enough to help to shape the UK's biomedical landscape through the establishment of the Francis Crick Institute, a collaborative endeavour bringing scientists together to tackle some of the most pressing challenges in human health.

These experiences reinforce a fundamental insight: that health is not the product of any single system, discipline or species. When we treat human health as separate to the animals and environments around us, we limit our ability to understand and respond to the challenges we face.

Zoonotic diseases – infections that jump from animals to humans – account for most emerging infectious threats. COVID-19, Ebola, HIV, SARS, avian influenza: all began in wildlife. Yet our surveillance systems are overwhelmingly focused on humans and livestock, leaving wild animals – the reservoirs of these pathogens – largely unmonitored. It is a dangerous gap, and one that grows more urgent as deforestation, climate change and wildlife trade accelerate the conditions for spillover.

ZSL has been working at this intersection for decades. Our scientists monitor bat populations for novel viruses, conduct post-mortems on stranded cetaceans to track pollution and disease, screen endangered species before reintroduction to prevent accidental pathogen release into ecosystems, and train the next generation of wildlife health professionals. This is the unglamorous, painstaking work of disease prevention – work that receives a fraction of the funding and attention it deserves.

There is a compelling case for the integration of wildlife health into our global health security infrastructure. It is not just about preventing the next pandemic, though that alone would justify the investment. It is about protecting the ecosystems that sustain us, preserving species on the brink of extinction and ensuring that the science of wildlife health is properly valued.

Professor Sir Jim Smith MA, PhD, FRS, FMedSci, MAE
Chair of Trustees, ZSL
Emeritus Scientist, Francis Crick Institute

EXECUTIVE SUMMARY

The biodiversity crisis and the coronavirus pandemic are two expressions of the same underlying problem: humanity's disrupted relationship with the natural world. ZSL's own Living Planet Index shows wildlife populations have declined by an average of 73% since 1970, with monitored vertebrate populations showing sustained losses across 5,495 species. At the same time, the frequency of zoonotic disease outbreaks – infections that jump from animals to humans – has risen sharply, with three-quarters of all emerging infectious diseases originating in wildlife[1].

Yet wildlife health – the science of monitoring, diagnosing and mitigating disease in wild populations – remains the neglected pillar of global health security. National funding for wildlife health is extremely limited or non-existent in most countries,[2] infrastructure is fragmented, diagnostic capacity is concentrated in wealthy nations and the workforce is under-resourced. This is a structural failure with escalating consequences, not an unfortunate oversight.

The One Health framework – which recognises that human, animal and environmental health are interconnected – has been integrated into international policy, from the WHO Pandemic Agreement[3] to the Quadripartite Joint Plan of Action.[4] But implementation remains patchy and wildlife health remains the vulnerability. Strengthening it requires coordinated action: investment in diagnostic infrastructure, expansion of surveillance networks, development of the specialist workforce and visible public engagement with the science.

ZSL has been at the leading edge of wildlife health for 200 years. Our veterinary team has cared for thousands of animals across hundreds of species. Our scientists have discovered novel pathogens, tracked disease outbreaks across continents, trained hundreds of conservationists from dozens of countries and built surveillance networks that feed into national and international biosecurity systems. We know what works. And we know what is missing.

This paper sets out where action is needed, drawing on ZSL's experience and on evidence from the global research community. It is a case for bringing things together – expertise, infrastructure, training, public visibility – to demonstrate that wildlife health monitoring and research can be organised, scaled and sustained at the level the crisis demands.

TWO HUNDRED YEARS OF VETERINARY EXCELLENCE

Top to bottom: ZSL's first female curator of herpetology, Joan Proctor, examining a snake using her patented device; ZSL scientist Christine Hawkey; vets x-raying African elephant Oojah in 1926; Oliver Graham Jones checks over Chi Chi the panda, 1958.

ZSL was founded in 1826 at a time when exotic animals were most often confined to menageries – places designed for spectacle rather than scientific understanding. From the outset, ZSL set out a different vision: to create a zoological space dedicated to the advancement of wildlife science, where animals would be studied with purpose and care to deepen knowledge of the natural world.

With the opening of ZSL's London Zoo in 1828, this vision became a reality. For the first time, scientists were able to observe living animals closely and systematically – studying behaviour, understanding diets, diagnosing illness and developing new approaches to veterinary care. Within a year ZSL appointed its first veterinarian, Charles Spooner, whose work examining animals and conducting post-mortems laid important foundations for the scientific study of wildlife health.

Over the past two centuries, ZSL has continued to pioneer the field of wildlife health, building a legacy of innovation that remains central to its work today not just with zoo animals but its work with wildlife around the world. Our Wildlife Health Services department draws on this history, delivering evidence-based care across our conservation Zoos and beyond through a combination of clinical medicine, advanced diagnostics, surgery and preventative health programmes.

We have employed veterinarians since the appointment of Charles Spooner in 1829 as a visiting medical attendant. In 1951 we appointed Oliver Graham-Jones, Britain's first dedicated zoo vet. His introduction of systematic clinical records, and the invention of the hand-held dart gun revolutionised veterinary care and his dedication to the animal care gave us ZSL's first fully equipped animal hospital.

Today, our large veterinary team provides clinical care for more than 20,000 individual animals from hundreds of species, many of them endangered or critically endangered in the wild. We maintain on-site microbiology, molecular diagnostics and parasitology laboratories. We conduct systematic post-mortem examinations on every animal that dies in our care, building one of the longest continuous archives of wildlife pathology data in the world – a nearly 200-year record of what kills animals, how diseases present and how patterns shift over time. This is wildlife health surveillance embedded in the daily operation of a modern zoo.

That veterinary foundation supports everything else. Since 1994, ZSL has partnered with the Royal Veterinary College to deliver the MSc in Wild Animal Health – a 30-year programme that has trained hundreds of veterinarians from dozens of countries in the specialist skills required to diagnose, treat and research disease in wild populations. We also deliver the MSc in Wild Animal Biology, a dual-track programme where biologists and veterinarians study alongside each other, and where one in five students goes on to publish peer-reviewed research based on their dissertation work.

For younger audiences, we have built pathways into wildlife science and veterinary medicine from pre-school age. Vets in Action, now in its tenth year, gives visiting families hands-on experience of zoo veterinary work. Our purpose-built roleplay space, ZooTown, introduces the very youngest children to conservation careers. Inside Nature, a first-of-its-kind project, transforms post-mortem examinations into free educational resources for GCSE and A-level students, with dissection videos, animations, microscopic imagery and exam-style worksheets.

Over two centuries, ZSL has developed a unique oversight of wildlife health – clinical, pathological, educational and scientific. What began as care for animals at London Zoo has evolved into a broader expertise in diagnosing and monitoring disease in wild populations. We have emerged as a leader in the field because we invested consistently in the infrastructure, the people and the science when few others did.

Above: ZSL vet Stefan Saverimuttu.
Left: London Zoo's gorilla Kiburi undergoing a CT scan.

THE CRISIS NOW

Chytrid fungus has wiped out at least 90 amphibian species.

The statistics are familiar, but their implications are not widely understood. Wildlife populations have declined by 73% on average since 1970, with losses documented across 5,495 vertebrate species.[5] This is not a distant problem, it is a planetary system in distress, and disease is both a driver of that distress and a symptom of it.

When ecosystems fragment and species lose habitat, when human activity diminishes the distance between wild animals, livestock and people, disease transmission patterns shift. Biodiversity loss – specifically the loss of predator and competitor species – can increase disease risk, because the species that thrive in degraded habitats in their absence (rodents, bats, certain bird species) are frequently better reservoirs for zoonotic pathogens than the species they replace.[6]

In the mid-1990s, ZSL scientist Andrew Cunningham identified a novel chytrid fungus (*Batrachochytrium dendrobatidis*) as the cause of mass amphibian die-offs. His work identified a hypervirulent strain of the fungus – one that had likely emerged through the global amphibian trade. The fungus has now been implicated in declines of more than 500 amphibian species and the extinction of at least 90 worldwide, with ecosystem cascade effects that extend far beyond frogs themselves.[7] ZSL's follow-up research provided the world's first evidence that a wild population could be cleared of the infection.[8]

Disease not only threatens wild populations, it can lead to their collapse with terrifying speed. When peste des petits ruminants (PPR) swept through Mongolian saiga antelope populations in 2016-17, the population declined by 80% in a matter of months.[9] This was not a zoonotic spillover event, it was a livestock pathogen jumping into wildlife and triggering a localised collapse in a species already classified as Critically Endangered.

Zoonotic disease doesn't just threaten biodiversity, it has the potential to reshape human society. Three-quarters of emerging infectious diseases are zoonoses,[1] and the rate of emergence has been increasing for decades. SARS, MERS, Ebola, Nipah, Zika, COVID-19 – all originated in wildlife, and all exploited weaknesses in our capacity to detect, diagnose and contain pathogens before they established transmission chains in human populations.

ZSL's work on bat-borne viruses exemplifies the scale of the challenge. Since 2010, Professor Andrew Cunningham and his team have studied the viruses carried by fruit bats in Ghana: Lagos bat virus (a rabies-related virus), filoviruses (the family that includes Ebola and Marburg), paramyxoviruses (including henipaviruses) and coronaviruses. The research has revealed why bats function as such effective reservoirs: paramyxoviruses, for example, persist in individual bats without causing disease, and viral shedding peaks twice yearly (in July and January), creating windows of heightened spillover risk. Bats represent 22% of all mammal species, and researchers estimate there are approximately 700,000 undiscovered zoonotic viruses in wild birds and mammals.[10] A 2013 paper co-authored by Cunningham identified 137 viruses in bats, 61 of which are known to infect humans.[11]

In April 2020, as COVID-19 overwhelmed health systems globally, Cunningham wrote: "This pandemic was both predictable and preventable."[12] He had warned in the British Medical Journal fifteen years earlier about the dangers of human exploitation of wildlife.[13] SARS-CoV-2, the virus that causes COVID-19, is phylogenetically related to coronaviruses found in bat species. Its case fatality rate (1-3% during the pandemic) is lower than Ebola (~50%) or Nipah (~60-100%), both of which also originate in bats. The implication is stark: we have been fortunate, and we should not rely on fortune.

The crisis is not theoretical, it is measurable, documented and escalating. Wildlife health monitoring is a necessity, not a luxury.

Above: ZSL's Professor Andrew Cunningham.

Below: Mosquitoes carry several diseases dangerous to humans, including malaria, dengue and yellow fever.

Bats play a major role in ecosystem functions, but are highly effective reservoirs for zoonotic diseases.

WILDLIFE HEALTH – AN ESSENTIAL LINK

The One Health framework recognises that human, animal and environmental health are interconnected and require integrated, multi-sector responses. It was anticipated by one of ZSL's own scientists Dr Christine Hawkey, whose work linked animal biology, veterinary science and human health decades before the term was coined. One Health has been articulated in international agreements, embedded in national strategies and endorsed by global institutions. The WHO Pandemic Agreement, adopted in May 2025, references One Health explicitly. The Quadripartite Joint Plan of Action (WHO, FAO, WOAH, UNEP, 2022) commits to integrated surveillance and response across human, animal and environmental health. The G20 and G7 have issued declarations. The United States published a National One Health Framework in 2024.[14]

The policy architecture is in place. What is missing is implementation at scale, and the weakest link in that implementation is wildlife health.

Human health care means there is infrastructure to monitor human health on a global scale. Health surveillance is well funded, with diagnostic laboratories, trained epidemiologists and reporting infrastructure in every country. Livestock health is monitored intensively, particularly in high-income countries, because of its economic value. Wildlife health, by contrast, is chronically under-resourced. National funding for wildlife health is extremely limited or non-existent in many countries.[15] Infrastructure is fragmented. Diagnostic capacity is concentrated in a handful of institutions, predominantly in Europe and North America. The specialist workforce is small, and training pipelines are narrow.

Extensive diagnostic capacity – microbiology, parasitology, pathology, diagnostic imaging, genetic sequencing – and access to extensive tissue archives is urgently needed for the study and surveillance of wildlife health. The ability to conduct a full post-mortem, identify a novel pathogen, sequence its genome and trace its epidemiology within days or weeks rather than months is not a standard feature of wildlife health systems.

The Garden Wildlife Health project, a collaboration between ZSL, the British Trust for Ornithology, Froglife and RSPB, has operated since 2013 as a citizen science initiative. Members of the public report sick or dead garden wildlife – birds, amphibians, reptiles, hedgehogs – and submit samples for analysis. The project has built a national database of wildlife disease incidents and maintains one of the largest wildlife tissue banks in the world. It reports to Defra and the World Organisation for Animal Health (WOAH) through the Great Britain Wildlife Health Surveillance Partnership.

Bovine tuberculosis (bTB) leads to the slaughter of over 20,000 cattle in England each year and inflicts devastation on the livelihoods of farming communities. The disease is largely spread between cattle but can also be spread by wild badgers, leading to the licensed culling of badgers across areas of England. Since 2011, ZSL has been investigating badger management methods, including evaluating badger vaccinations as a wildlife-friendly alternative to culling. The project, led by Professor Rosie Woodroffe, has previously shown that culling cannot clear bTB from chronically infected badger populations because, by encouraging surviving individuals to range more widely, it facilitates badger-to-badger transmission and helps the infection to persist even when numbers are low. This project provided the research that underpinned the UK Government's shift away from badger culling to farmer-led vaccination.

In 1992 ZSL launched the Frog Mortality Project (in partnership with Froglife), which discovered a novel ranavirus in British frogs – the first ranavirus identified in the UK, and the first known to infect amphibians in Europe. The virus was shown to be causing population declines in common frogs, and subsequent research suggested it was likely an incursion from North America. The Frog Mortality Project (later merged into the Garden Wildlife Health project) remains the longest running wildlife disease surveillance project in the UK, and probably the world.

In 1990, ZSL established the Cetacean Strandings Investigation Programme (CSIP), a national surveillance system which conducts post-mortem examinations on stranded whales, dolphins, and porpoises around the UK coast. The programme has made critical discoveries, including the identification of gas embolism disease ('the bends') in deep-diving species, the impacts of persistent organic pollutants on cetacean health, and the role of bycatch and boat-strike in population declines.

In 1989, ZSL initiated the Disease Risk Analysis and Health Surveillance (DRAHS) project to support the red kite reintroduction programme. Health surveillance was integrated into the translocation process from the start, and the work expanded to cover many conservation translocations in the UK. One of DRAHS's most interesting discoveries was that the decline of red squirrels was primarily caused by squirrelpox virus, carried asymptomatically by grey squirrels. This was not obvious before the surveillance infrastructure existed to detect it, and the knowledge has shaped the ambitions for red squirrel conservation.[16]

These programmes represent 40 years of continuous citizen science-enabled disease surveillance in the UK – a model of how organised, visible and sustained efforts can build knowledge, inform policy and safeguard biosecurity. Scaling this model globally requires coordinated investment and institutional will.

Left: A vaccinated badger ready for release.

Above: A health check on a red kite ahead of reintroduction to the wild.

THE ROLE OF THE MODERN CONSERVATION ZOO

Modern conservation zoos occupy a unique position. They are one of the few places where the public, the scientific community and policymakers all engage directly with wildlife. They are sites of care, education, research and conservation action both in the zoos and in the wild. And because they hold living animals – many of them endangered or critically endangered – they maintain clinical and diagnostic infrastructure that is otherwise rare or absent in wildlife health globally.

At ZSL's Zoos, that infrastructure includes not just veterinary expertise and diagnostic laboratories, but also a culture of post-mortem investigation that treats every death as a learning opportunity. This is not standard practice, even among well-resourced zoos. ZSL's Zoos are among fewer than 10 in the UK with full-time vet departments and the only one with a dedicated wildlife pathologist. It requires investment in time, skilled personnel and laboratory capacity. But the payoff is a growing body of knowledge about what kills animals, how diseases present across species, and how to detect emerging threats early.

ZSL's range of public engagement interventions – from ZooTown to Vets in Action, Inside Nature and veterinary career development days, demonstrate another critical function of modern zoos: building the pipeline of future wildlife health professionals and making the science visible to broader audiences. Inside Nature bridges a gap that is rarely acknowledged. Many people, including many students studying biology, will never see a post-mortem. They will never investigate a heart, examine a stomach lining, or observe the microscopic architecture of infected tissue. Being able to lift the veil on what's happening behind the scenes makes that possible, using real dissections filmed at ZSL, with animated explainers aimed at GCSE and A-level learning. Teachers report that students remember these lessons in ways they do not remember textbook diagrams.

The public dimension of this work is important. Wildlife health is an invisible discipline to most people. It does not feature in news coverage unless there is a crisis. It is not taught in schools. It is not part of the cultural conversation about conservation. Making it visible – through education, through public engagement, through demonstrating that the science exists and is being done – builds the social license for investment and institutional support, as well as the chance to shape public discourse.

Above: ZooTown offers veterinary learning opportunities for the Zoo's youngest visitors.

THE NEED AND THE SOLUTION

Strengthening wildlife health to protect species and their habitats and fortify the third pillar of One Health requires action across interconnected areas. These are operational necessities and institutions like ZSL are uniquely positioned to deliver them.

Diagnostic capacity
Wildlife disease diagnosis requires specialist infrastructure: pathology laboratories equipped for post-mortems across a wide range of species, microbiology and parasitology facilities, and genetic sequencing capacity to identify novel pathogens. The ability to build capacity and diagnostic capability anywhere in the world creates impact beyond any geography. Building knowledge in regions where wildlife populations are large and diverse, where human-wildlife contact is most frequent, and where zoonotic spillover risk is highest has the power to shift the dial.

Surveillance networks
Effective surveillance depends on integration across scales: local reporting (often citizen science-enabled), national databases and international coordination. ZSL's Garden Wildlife Health project demonstrates the power of citizen science to detect disease incidents early and at scale. The Cetacean Strandings Investigation Programme (CSIP) shows how sustained surveillance can uncover trends invisible to snapshot studies. Expanding these models requires investment in coordination, data infrastructure and public engagement to ensure that reporting networks are trusted and used.

Training and workforce development
The specialist workforce in wildlife health is small compared to the scale of the challenge and the training pipelines are narrow. ZSL's MSc programmes have trained hundreds of veterinarians and biologists

over three decades. Expanding the workforce further requires investment in a range of training opportunities including practical field courses, residencies and professional development opportunities, particularly in regions where wildlife health expertise is absent or underdeveloped. This is about ensuring that diagnostic and surveillance capacity is staffed by people with deep expertise in the taxa, ecosystems and disease systems they are monitoring.

Public visibility and engagement

Wildlife health is an invisible discipline. Making it visible – through education, public engagement and demonstration that the science is being done – builds the social and political will for sustained investment. ZSL's Inside Nature project, its citizen-science enabled disease surveillance programmes and its role as a trusted institution with 200 years of history position it to do this work at scale. But visibility requires sustained effort, storytelling, outreach, experiential opportunities and integration into public discourse.

Research leadership

Wildlife health research is fragmented across institutions, disciplines and geographies. Leadership is needed to coordinate research priorities, share data and translate findings into policy and practice. ZSL's track record – from chytrid fungus to bat-borne viruses to cetacean strandings – demonstrates the kind of research that drives the field forward. But isolated discoveries are not enough. What is needed is coordinated, sustained research programmes that build on each other and feed directly into surveillance, diagnostics and training.

A CALL FOR ACTION

Wildlife health sits at the centre of pandemic prevention, biodiversity conservation and planetary resilience. Yet the current system – fragmented, under-resourced and largely invisible – is failing to meet the scale of the challenge.

Various policy frameworks cited in this report recognise wildlife health as foundational. But frameworks are not infrastructure and commitments are not capacity. The gap between what is written and what is operational is currently a gulf.

The science exists. The expertise exists. What is missing is recognition that wildlife health deserves the same level of investment, coordination and political attention as human and livestock health. The One Health framework is the right model. But it will only work if all three pillars – human, animal and environmental health – are resourced and integrated.

Left and below: Students learning new skills in the lab and the field.

Photo © David Levene

Closing this gap requires three shifts:

First, fund for the long term, not the crisis. Wildlife health surveillance, diagnostics and research cannot be built on three-year project cycles. Pandemic prevention requires sustained investment in institutions with demonstrated capacity – laboratories that stay open, surveillance networks that run continuously, training programmes that produce specialists year after year. Governments and philanthropic funders must move from reactive grants to core operational funding for institutions that can deliver at scale.

Second, integrate wildlife health into biosecurity systems. Wildlife disease is not a conservation problem with occasional public health consequences. It is a frontline biosecurity issue. National and international biosecurity systems must include wildlife surveillance as a core function, with clear pathways for data to flow between field biologists, veterinarians and public health authorities.

Third, invest where the risk is. Biodiversity hotspots, human-wildlife interfaces and regions with high zoonotic spillover risk are not academic curiosities – they are outbreak flashpoints. Wildlife health training and capacity building in areas of need is critical. Diagnostic infrastructure, trained personnel and surveillance capacity must exist where they are most needed, not only where funding is easiest to secure.

ZSL's 200-year history is a case study in what sustained investment in wildlife science can achieve. We have built diagnostic capacity, trained the workforce, run surveillance networks, made discoveries that have reshaped the field and engaged millions of people with the science. We know what works, and we know what is needed.

The question is not whether we can strengthen wildlife health globally, but whether we will choose to do so before the next crisis forces our hand.

ABOUT ZSL

Founded in 1826, ZSL is an international conservation charity, driven by science, working to restore wildlife in the UK and around the world; by protecting critical species, restoring ecosystems, helping people and wildlife live together and inspiring support for nature.

Through our leading conservation zoos, London and Whipsnade, we bring people closer to nature and use our expertise to protect wildlife today, while inspiring a lifelong love of animals in the conservationists of tomorrow. Visit **www.zsl.org** for more information.

200 Years of Wildlife
This year, ZSL celebrates an extraordinary milestone: 200 years of wildlife. That's two centuries of pioneering science, global conservation, and inspiring connections between people and wildlife. From opening the world's first scientific zoo in 1828 in Regent's Park, transforming how scientists learned about animals, to founding the Institute of Zoology and pioneering global conservation science, ZSL's legacy is one of innovation and optimism.

Find out more at
www.zsl.org/zsl200

Photo © Luke Capeling

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