



Endangered species conservation strategies, population recovery, and long-term survival of threatened wildlife species: A synthesis of evidence and practice

Prakash Rana

Assistant Professor, Department of Education, University of Delhi, Delhi, India

Corresponding Author: Prakash Rana

Volume: 01, Issues: 01, Year: 2026, Page No.: 14-20

Accept Date: 03-09-2026 **Receive Date:** 03-10-2026 **Published Date:** 18-10-2026

Abstract

The global loss of biodiversity has accelerated to the point that monitored vertebrate populations declined by an estimated 73% between 1970 and 2020, and more than 48,000 species are currently classified as threatened with extinction on the IUCN Red List. Against this backdrop, this review synthesises peer-reviewed and institutional evidence on the principal strategies used to conserve endangered species and recover threatened populations, and evaluates the conditions under which these strategies contribute to long-term species survival. Using a structured narrative-review approach, the paper examines six interacting strategy domains: protected areas and landscape connectivity; conservation genetics and genetic rescue; ex situ breeding, reintroduction, and biotechnological tools; community-based protection and enforcement against illegal wildlife trade; climate-change adaptation planning; and international policy and finance mechanisms. Evidence indicates that no single intervention reliably prevents extinction in isolation; rather, documented recoveries — illustrated here through the Iberian lynx, whose population grew from 62 mature individuals in 2001 to more than 2,000 individuals by 2024 — consistently combine habitat restoration, demographic and genetic management, and socially embedded protection. The review also identifies persistent constraints, including an estimated annual global biodiversity finance gap of approximately US\$700 billion, incomplete evidence on corridor and reintroduction efficacy, and the likelihood that current extinction-risk models underestimate climate-driven range loss. The review concludes that durable species recovery depends on integrated, adequately funded, and locally legitimate conservation portfolios rather than isolated technical fixes.

Keywords: Endangered species, population recovery, conservation genetics, protected areas, captive breeding, illegal wildlife trade, climate change adaptation, biodiversity policy

Introduction

Species extinction is a natural evolutionary process, but its current rate is estimated to be tens to hundreds of times higher than the geological background rate, driven overwhelmingly by human activity. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) has placed roughly one million species at risk of extinction within decades in the absence of transformative change (Díaz et al., 2019). More recent monitoring reinforces this picture: the World Wildlife Fund's Living Planet Report 2024 documented an average 73% decline across 34,836 monitored vertebrate population trends between 1970 and 2020, with the steepest losses recorded among freshwater species. As of the IUCN Red List's 2025 update, 172,620 species had been formally assessed and 48,646 were listed as threatened with extinction, a fourfold increase in absolute numbers since the turn of the century, although this reflects both genuine decline and expanded assessment coverage.

Endangered species conservation has therefore matured from an ad hoc, single-species activity into a multidisciplinary field that draws on population genetics, landscape ecology, veterinary and reproductive biology, criminology, development economics, and international law. Yet despite decades of accumulated practice, only a small fraction of assessed species have ever been downlisted to a lower extinction-risk category as a result of genuine recovery — on the order of one in a thousand IUCN-assessed species. This asymmetry between conservation effort and measurable recovery motivates the present review: rather than surveying every conservation technique in isolation, this paper asks what the evidence says about which strategies work, under which conditions, and how they must be combined to produce durable, long-term species survival rather than temporary stabilisation.

This review is not a systematic review or meta-analysis in the formal sense, since it does not apply a single pre-registered search protocol across a bounded set of databases; it is a structured narrative synthesis intended to map the major strategy domains,

compare their documented effectiveness, and identify where the evidence remains genuinely contested. No original empirical data, survey, or statistical model was generated for this manuscript; all quantitative claims are attributed to their original sources.

The Global Extinction Crisis: Scope and Scale

Understanding why conservation strategies are needed — and why some succeed while others fail — requires briefly situating the scale of decline. Habitat loss and fragmentation, overexploitation (including illegal hunting and trade), climate change, pollution, and invasive species and disease are consistently identified as the principal direct drivers of vertebrate and plant decline. These drivers rarely act alone: recent analysis of long-term population time series found that populations exposed to multiple simultaneous pressures declined faster than those facing a single threat, a finding with direct implications for conservation design, since single-threat interventions are unlikely to be sufficient where drivers interact.

The consequences are unevenly distributed. Freshwater species have suffered disproportionately severe declines — sturgeon populations, for example, have fallen by an estimated 91% since 1970 — while bird populations show a rising share in decline, from 44% in 2016 to 61% in the IUCN's October 2025 assessment. Flowering plants account for the largest single share of currently listed threatened species. This unevenness matters for policy: conservation resources allocated on the basis of charisma or public visibility (large mammals, iconic birds) do not necessarily track where extinction risk or ecological importance is greatest.

Climate change adds a layer of urgency that differs qualitatively from other threats because it shifts the spatial template of suitable habitat itself, rather than simply removing habitat in place. Recent methodological work indicates that standard species distribution models used in IUCN Red List assessments may systematically underestimate extinction risk for range-shifting species, because the relationship between habitat loss and population decline is concave rather than linear, meaning that early population impacts are underweighted, and adequate warning time may not be available for the most sensitive species. This suggests that many current threat classifications are conservative rather than alarmist.

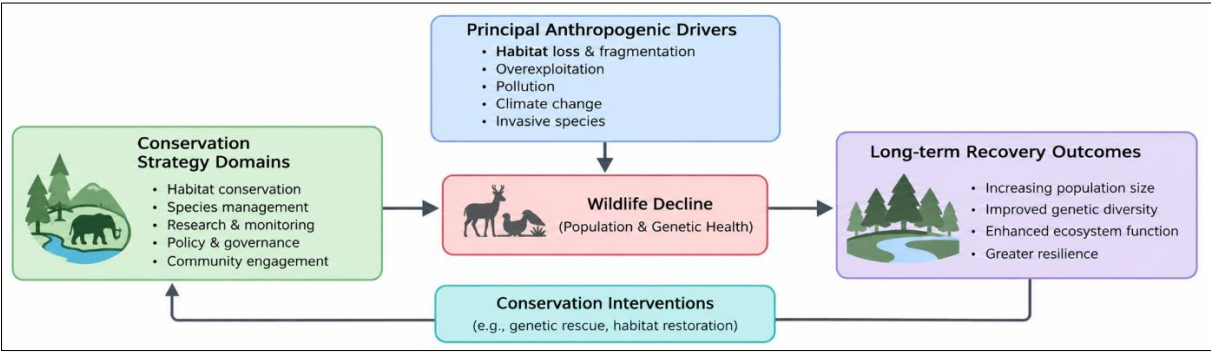


Fig 1: Conceptual framework linking principal anthropogenic drivers of wildlife decline to corresponding conservation strategy domains and their intended long-term recovery outcomes.

Conceptual Framework and Research Gap

A useful organising concept in conservation biology is the extinction vortex, originally articulated by Gilpin and Soulé, which describes how small populations become trapped in a self-reinforcing feedback loop: reduced population size leads to loss of genetic diversity and inbreeding depression, which lowers individual fitness and reproductive output, which in turn accelerates further decline and heightens vulnerability to demographic and environmental stochasticity (Figure 2). This concept is analytically useful because it clarifies why conservation actions targeting only one point in the cycle — for example, habitat protection alone, without addressing genetic erosion in an already-small population — may fail to reverse a species' trajectory even when implemented competently.

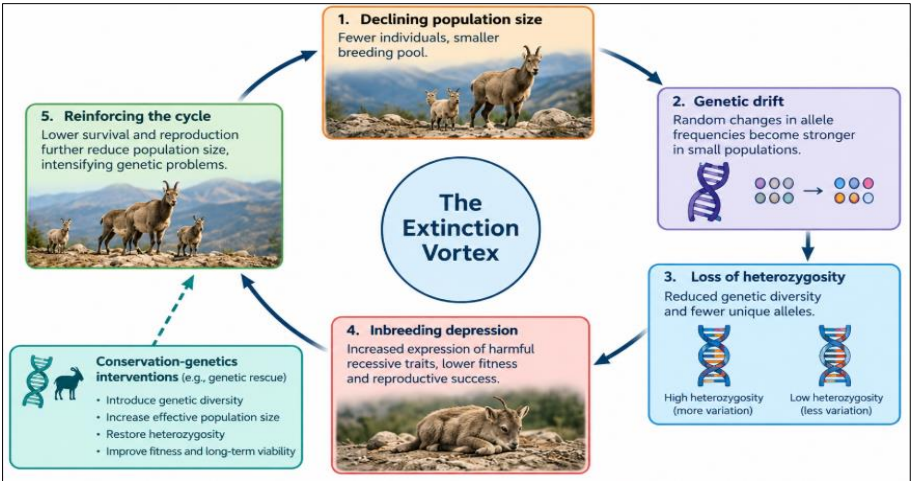


Fig 2: The extinction vortex: a self-reinforcing feedback loop through which small, isolated populations experience compounding genetic and demographic pressures that elevate extinction risk (adapted from the concept originally proposed by Gilpin and Soulé). Targeted conservation interventions can interrupt the cycle.

The research gap this review addresses is primarily a synthesis gap rather than an empirical one: extensive evidence exists on individual strategy domains (protected areas, genetic rescue, captive breeding, anti-poaching, climate adaptation, and finance), but these literatures have developed largely in parallel, with limited cross-referencing of comparative effectiveness. Reviews that do integrate across domains tend to be discipline-specific (for example, conservation genetics reviews rarely engage deeply with illegal-wildlife-trade criminology, and protected-area effectiveness studies rarely incorporate genetic-rescue decision frameworks). This review's objective is therefore to (1) summarise the best-supported evidence within each domain, (2) identify where findings are inconsistent or contested, and (3) synthesise cross-domain lessons for long-term species survival, illustrated through a documented recovery case.

Review Methodology

This narrative synthesis drew on peer-reviewed journal articles, meta-analyses, systematic-review protocols, and reports from authoritative institutional sources (IUCN and its Species Survival Commission specialist groups, IPBES, WWF, national wildlife agencies including the U.S. Fish and Wildlife Service, and international bodies including the Convention on Biological Diversity and its financial mechanisms). Searches were conducted iteratively across general and specialised sources using combinations of terms including endangered species, population recovery, conservation genetics, genetic rescue, protected area effectiveness, wildlife corridor, captive breeding, reintroduction, illegal wildlife trade, community-based conservation, climate change extinction risk, assisted migration, and biodiversity finance. Priority was given to systematic reviews and meta-analyses where available, supplemented by primary studies and case reports for domains where synthesis literature was sparse or where a concrete illustrative example strengthened interpretability. Because this is a narrative rather than systematic review, formal risk-of-bias scoring and PRISMA-style reporting were not applied; this is stated explicitly as a limitation in Section 8.

Thematic Synthesis of Conservation Strategies

1. Habitat-Based Strategies: Protected Areas and Landscape Connectivity

Protected areas remain the most widely used tool in global conservation policy, and the evidence for their ecological value is generally, though not universally, positive. A meta-analysis comparing biodiversity inside and outside 86 protected areas found consistently higher species abundance and richness inside protected boundaries (Coetzee, Gaston, & Chown, 2014) ^[3], and a global-level assessment using counterfactual comparisons found that protected areas measurably reduce habitat conversion, deforestation, and coral loss relative to unprotected land (Geldmann, Manica, Burgess, Coad, & Balmford, 2019) ^[9]. However, effectiveness is highly uneven: a 2024 global analysis of more than 160,000 protected areas found that 73% had experienced measurable habitat alteration between 2003 and 2019, amounting to roughly 1.14 million square kilometres of altered habitat — an area three times the size of Japan — despite their protected status. This heterogeneity underscores that legal designation alone is insufficient; management resourcing, enforcement capacity, and governance quality are recurring predictors of whether protection translates into genuine biodiversity outcomes.

Landscape connectivity — corridors, stepping-stone reserves, and wildlife crossings — addresses a distinct but related problem: even well-protected habitat patches lose value for wide-ranging or dispersal-limited species if they become isolated. A widely cited meta-analysis found that corridors increase movement between habitat patches and help restore gene flow (Gilbert-Norton, Wilson, Stevens, & Beard, 2010) ^[10], and a decade-later follow-up synthesis concluded that, overall, corridors increase species movement, individual fitness, and community-level richness, though not uniformly across all taxa or corridor designs. Contradictory findings persist: a 2002 study in Alberta's boreal forest found no offsetting effect of corridors against logging-driven fragmentation for most bird species, and reviewers caution that most corridor evaluations remain limited to small spatial scales and short time frames, making generalisation to landscape- or decade-scale outcomes difficult. Under climate change, connectivity gains added importance, since habitat fragmentation can block the natural range shifts species would otherwise use to track shifting climatic envelopes.

2. Conservation Genetics and Genetic Rescue

Once a population becomes small and isolated, genetic management becomes as important as habitat protection. Genetic rescue — the deliberate introduction of individuals from a genetically distinct population to restore gene flow — has one of the more robust evidence bases in conservation biology. Frankham's (2015) ^[8] meta-analysis of outcrossing in inbred populations found beneficial fitness effects in 92.9% of 156 cases assessed as low-risk for outbreeding depression, and a related meta-analysis found that these fitness benefits persisted through at least the third filial generation, with median composite-fitness gains of 42%, 84%, and 86% in the F1, F2, and F3 generations respectively. Documented successes include greater prairie chickens in Illinois, Scandinavian adders, and Florida panthers, the latter recovering from severe inbreeding depression after the introduction of Texas cougars in the 1990s.

Genetic rescue nonetheless carries a genuine and occasionally severe risk: outbreeding depression, in which crossing genetically or locally adapted lineages produces offspring with reduced fitness. The best-documented failure involved the introduction of Turkish and Sinai ibex subspecies to a Czechoslovakian population, which produced hybrid offspring that gave birth out of season, causing the entire population to collapse. Frankham and colleagues have proposed decision rules for predicting when outbreeding depression risk is low — generally when source and recipient populations are chromosomally compatible, were separated by human activity within roughly the last 500 years, and are not adapted to strongly divergent environments — and Ralls, Sunnucks, Lacy, and Frankham (2020) ^[19] argue that established guidance to prioritise genetically diverse source populations, rather than minimising the introduction of any novel variation, is better supported by the empirical record. Despite this evidence base, genetic rescue remains underused: it has been attempted in only a small number of documented cases relative to the number of populations that plausibly meet the biological criteria for benefit, a gap attributed in part to institutional caution, uncertainty about source-population suitability, and the practical difficulty of obtaining the genomic data needed to assess risk with confidence.

3. Ex Situ Conservation: Captive Breeding, Reintroduction, and Biotechnology

Captive breeding and reintroduction have produced some of conservation's most visible successes and most persistent controversies. Successes include the California condor, black-footed ferret, and several ungulate and avian species; but systematic reviews of reintroduction outcomes show substantial variability in success rates by taxon. In amphibians, for example, of 58 reintroduced species reviewed, only 18 subsequently bred successfully in the wild, and just 13 established self-sustaining populations, indicating that release alone does not guarantee establishment. Modelling work integrating demographic and genetic processes indicates that the duration of a captive-breeding programme — the time between founding the captive population and the final release event — is among the strongest predictors of reintroduction success, likely because captivity itself relaxes natural selection in ways that can reduce fitness upon release if programmes are too short or too small to counteract this drift. Guidelines developed from decades of practice (for example, Kleiman's widely used 1989 framework)^[17] emphasise that reintroduction should proceed only once the original cause of decline has been corrected, that a self-sustaining captive source population with surplus breeding capacity is required before releases begin, and that pre-release behavioural training (predator recognition, foraging, social integration) materially affects post-release survival. More recent biotechnological tools have extended the ex situ toolkit beyond conventional breeding. In December 2020, the U.S. Fish and Wildlife Service and partner organisations announced the birth of Elizabeth Ann, a cloned black-footed ferret produced from cells cryopreserved more than three decades earlier — the first cloning of an endangered species native to North America. Because the entire living black-footed ferret population descends from just seven founding individuals, cloning was explored specifically as a means of reintroducing genetic variation otherwise lost to the population; by 2024, additional cloned individuals (Antonia and Noreen) had themselves produced litters, demonstrating that cloned lineages can breed successfully, although the technique remains at an early, exploratory stage and is not a substitute for maintaining genetically diverse living populations.

4. Community-Based Conservation and Combating Illegal Wildlife Trade

Poaching and illegal wildlife trade remain primary threats to high-value species such as elephants, rhinoceroses, tigers, and pangolins, driven by both international demand and local socio-economic pressures. Purely militarised anti-poaching enforcement has well-documented limitations, prompting growing investment in community-based approaches that treat local communities as partners rather than as suspects. A synthesis of case studies compiled through the IUCN- and IIED-supported People not Poaching platform found that, of 91 community-based anti-illegal-wildlife-trade interventions reporting on effectiveness, 82 (71%) were assessed as fully effective and a further 6% as partially effective, though the authors note that livelihood outcomes are measured far less rigorously than conservation outcomes, limiting confidence in the durability of community support over time.

Case evidence illustrates both the promise and the fragility of this approach. In Kenya's Northern Rangelands Trust conservancies, community patrols initially failed to contain a sharp poaching spike between 2009 and 2012 but subsequently reduced poaching after increasing investment in community patrols, informants, and collaboration with national wildlife and police services. In Nepal's Shuklaphanta Wildlife Reserve, community-based anti-poaching operations contributed to periods of zero recorded rhino poaching through patrolling, trap removal, and intelligence-sharing. Conversely, a survey of 90 community members in the Zimbabwean portion of the Kavango–Zambezi Transfrontier Conservation Area found that 92% of respondents were unwilling to support anti-poaching activity without direct financial benefit from elephants, underscoring that community engagement is contingent on tangible, equitably distributed incentives rather than goodwill alone. The overall evidence base, while broadly positive, is also acknowledged by its own compilers to suffer from inconsistent monitoring and a shortage of long-term, comparable outcome data.

5. Climate Change Adaptation Strategies

Conventional conservation planning assumes that protecting a species' current range is sufficient; climate change undermines this assumption by shifting the location of suitable climate conditions. Assisted migration — the deliberate relocation of individuals or populations to climatically suitable areas outside their historical range — has moved from theoretical proposal to active, if still limited, practice, including trials in reef corals and forest trees. Simulation modelling suggests assisted migration can materially reduce extinction risk for some species: one modelling study found that a rare Californian conifer achieved 60–120% higher biomass under assisted migration compared with no action, depending on the climate scenario, while community-level metapopulation models found that assisted migration reduced extinction rates even with relatively few relocation events, provided efforts were targeted toward the most vulnerable species rather than spread thinly.

Nonetheless, a large-scale species distribution modelling study projecting the ranges of 67,664 plant species (18% of assessed global flora) to the end of the century found that, although range shifts can sustain local species richness in many regions, they provide little relief from global extinction risk, and recommended that protecting climate refugia and expanding ex situ seed banks and botanic garden networks may be more effective than facilitating migration in isolation, particularly in high-latitude regions where warming outpaces plausible dispersal rates. Combined with evidence that standard extinction-risk models likely underestimate risk for range-shifting species, this suggests that climate adaptation planning should be treated as an urgent, not precautionary, component of species recovery strategy, and integrated with — rather than substituted for — habitat connectivity and ex situ safeguards.

6. International Policy, Governance, and Finance

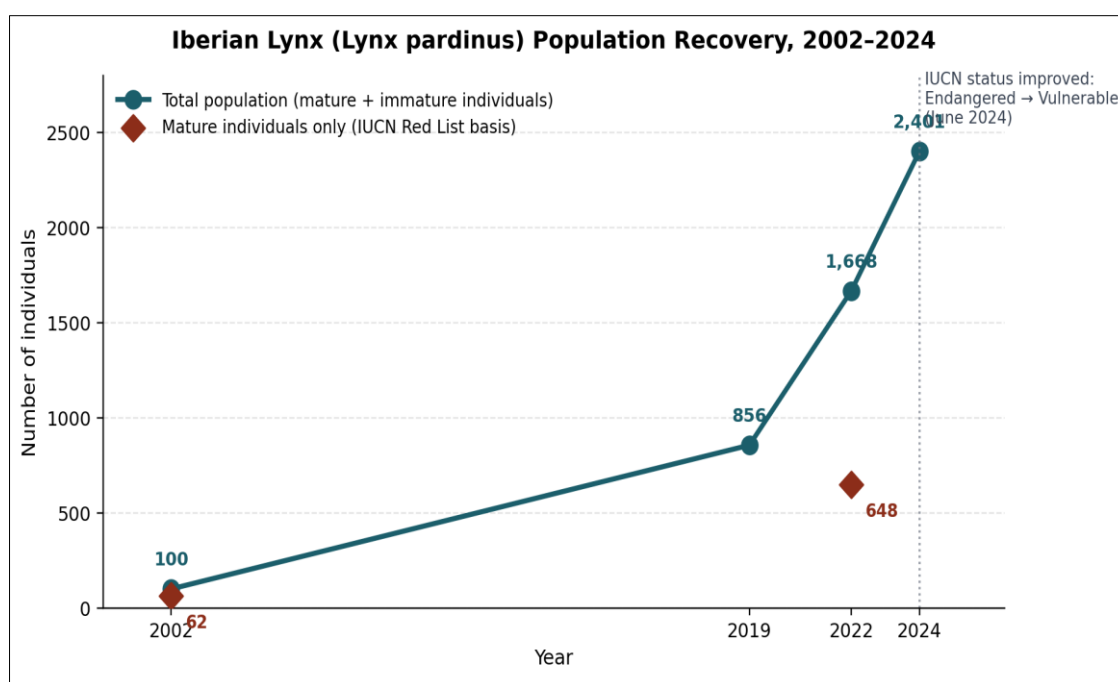
Conservation outcomes are ultimately bounded by the policy and financial architecture that supports them. The Kunming-Montreal Global Biodiversity Framework, adopted under the Convention on Biological Diversity in December 2022, set a target of protecting 30% of the planet's land and water by 2030 ("30x30") and called for closing an estimated global biodiversity finance gap of roughly US\$700 billion per year, alongside a minimum of US\$200 billion in annual investment from all sources

to achieve a nature-positive world. Progress toward these financial targets has been real but insufficient: international biodiversity finance rose from US\$11.4 billion in 2021 to US\$15.4 billion in 2022, and dedicated funding for protected and conserved areas has grown at roughly 11% annually since 2015, yet a 2025 assessment projected that, at current growth rates, international funding would still fall roughly US\$4 billion short of the US\$6 billion annual target for protected-area financing by 2030.

This financing gap has direct operational consequences for the strategies reviewed above: under-resourced protected areas are less able to prevent habitat conversion, community-based programmes cannot sustain the livelihood incentives on which their legitimacy depends, and genetic and ex situ interventions—which require sustained, specialised, and often expensive institutional capacity—compete for a shrinking share of available conservation budgets. The IUCN Red List itself, as the principal instrument used to track global progress toward these targets, has been noted to potentially underestimate the conservation needs of transboundary and nationally functionally extinct populations, since it reports global rather than jurisdiction-specific status, which can misalign national conservation prioritisation with actual local urgency.

Case Illustration: The Iberian Lynx Recovery

The Iberian lynx (*Lynx pardinus*) offers one of the clearest illustrations of how the strategy domains reviewed above interact in a single, well-documented recovery. At the start of the twenty-first century, the species had declined to just 62 mature individuals confined to two isolated subpopulations in Spain, following an 80% contraction of its historical range between 1960 and 1990, driven by habitat loss, prey collapse, and direct persecution. Conservation action combined habitat restoration and expansion of Mediterranean scrub and forest habitat, from roughly 449 square kilometres of occupied range in 2005 to 3,320 square kilometres by 2022; recovery of the European rabbit population, the species' near-exclusive prey base; an ex situ breeding programme; and more than 400 translocations and reintroductions carried out since 2010 to restore genetic diversity and establish new breeding nuclei in Portugal and additional Spanish regions.



By 2022, the mature population had grown to 648 individuals across five subpopulations, and by 2024 the total population — including juveniles — was estimated at more than 2,000 individuals, prompting the IUCN in June 2024 to move the species from Endangered to Vulnerable on the Red List, an outcome described by IUCN as the greatest recovery of a cat species ever achieved through conservation. The case is instructive precisely because no single strategy domain was sufficient: habitat restoration without genetic management would have left a demographically larger but still severely inbred population; ex situ breeding without habitat and prey recovery would have produced captive animals with nowhere suitable to be released; and none of this would have been achievable without sustained, multi-decade funding from Spanish and Portuguese authorities, the European Union's LIFE programme, and non-governmental partners. The IUCN's own Green Status assessment nonetheless classifies the species as only 'largely depleted' relative to its ecological potential, with a Species Recovery Score of 22%, underscoring that formal Red List improvement does not equate to full ecological recovery, and that continued investment remains necessary given ongoing threats from rabbit disease outbreaks, roadkill, and climate-driven habitat change.

Integrated Discussion: Toward Long-Term Survival

Drawing the strategy-specific evidence together, several cross-cutting patterns emerge that bear directly on long-term species survival rather than short-term population stabilisation. First, durable recoveries in the literature are consistently multi-strategy: the Iberian lynx case, alongside broader evidence from meta-analyses of targeted conservation actions, indicates that combinations of habitat, genetic, and socio-economic interventions outperform single-domain efforts, consistent with the extinction-vortex framework's implication that intervening at only one point in a compounding feedback loop is unlikely to

reverse it. Second, formal status improvement (IUCN downlisting) is a conservative and relatively rare marker of success — occurring in roughly one in a thousand assessed species — meaning that the absence of downlisting should not be read as absence of conservation value; many programmes prevent extinction or arrest decline without yet achieving reclassification, and reviewers of the U.S. Endangered Species Act's 50-year record similarly describe many listed species as 'conservation-reliant': extinction has been prevented, but self-sustaining recovery without continued intervention remains elusive for the majority. Third, the evidence base itself is uneven across domains in ways that should inform future resource allocation. Genetic rescue has one of the more consistent and quantified evidence bases in conservation biology, yet remains among the least-used tools, suggesting an implementation gap rather than an evidence gap. Community-based anti-poaching approaches show generally positive but inconsistently measured outcomes, particularly regarding whether livelihood benefits are distributed equitably enough to sustain community cooperation over time. Climate adaptation strategies, by contrast, may represent a genuine evidence gap: current extinction-risk assessment tools appear to systematically underestimate risk for range-shifting species, implying that present conservation prioritisation may be miscalibrated for a warming world. Finally, all strategy domains are constrained by an underlying resource gap — the estimated US\$700 billion annual biodiversity finance shortfall — that likely limits not the availability of effective techniques but the scale and consistency at which they can be deployed and sustained over the multi-decade timeframes that species recovery typically requires.

Limitations of Current Evidence and Practice

Several limitations apply both to the underlying conservation evidence base and to this review itself. This is a narrative rather than a systematic review: search terms were applied iteratively rather than through a single pre-registered protocol, formal inclusion and exclusion criteria were not fixed in advance, and no formal risk-of-bias or quality-appraisal instrument was applied to included sources, so publication and visibility bias toward charismatic, well-funded species and well-documented programmes cannot be excluded. Several domain-specific evidence bases are themselves limited: corridor-effectiveness studies remain concentrated at small spatial and short temporal scales; community-based anti-poaching evaluations rely heavily on self-reported effectiveness with inconsistent independent verification; and reintroduction-outcome statistics vary substantially by taxon, meaning that success rates for well-studied groups such as birds and mammals should not be assumed to generalise to amphibians, reptiles, invertebrates, or plants. Numerical figures drawn from secondary and journalistic sources — particularly the Iberian lynx case's earlier-year population estimates — combine total and mature-individual counts collected through differing survey methods across years, and should be interpreted as an indicative recovery trend rather than a continuous, standardised census; this limitation is stated in the caption to Figure 3. No claim of causal certainty is made regarding any single intervention's contribution to a given recovery; the associations reported here reflect the interpretations offered in the cited sources, most of which describe correlational or programme-evaluation evidence rather than randomised or fully controlled experimental designs, which are rarely feasible at the scale of whole-population conservation.

Contribution of This Review

Existing literature has established strong domain-specific evidence for individual conservation strategies but has done so largely within disciplinary silos. This review's principal contribution is synthetic: it brings protected-area science, conservation genetics, ex situ biology, conservation criminology, climate ecology, and biodiversity finance into a single evidentiary frame, organised around the extinction-vortex concept and illustrated through a single, well-documented case that demonstrates how these domains interact in practice. This synthesis is intended to support conservation planners, funders, and policy audiences in recognising that strategy selection is not a matter of choosing the single 'best' tool, but of assembling a coherent, adequately resourced portfolio matched to the specific combination of threats a given species faces.

Conclusion

The evidence reviewed here indicates that endangered species recovery is achievable, but that documented successes share a common structure: sustained, multi-decade investment across habitat, genetic, demographic, and social dimensions simultaneously, rather than reliance on any single flagship technique. Protected areas and connectivity measures address the spatial dimension of decline; genetic rescue and, increasingly, biotechnological tools such as cloning address the demographic-genetic dimension; ex situ breeding and reintroduction provide a bridge back to self-sustaining wild populations when combined with corrected underlying threats; community-based protection addresses the human dimension of illegal exploitation; and climate-adaptive planning is an increasingly urgent, not optional, addition to this portfolio. The persistent and substantial global biodiversity finance gap remains the most significant structural constraint on scaling these individually well-evidenced strategies to the scope of the current extinction crisis. Long-term survival of threatened wildlife will depend less on the discovery of novel techniques than on the sustained, integrated, and adequately funded application of tools whose effectiveness, under the right conditions, is already reasonably well established.

References

1. Bolam FC, et al. Over half of threatened species require targeted recovery actions to avert human-induced extinction. *Front Ecol Environ*. 2021.
2. Campaign for Nature. State of international 30x30 funding. 2025. Report by Indufor, Campaign for Nature, The Pew Charitable Trusts, and Rainforest Foundation Norway.
3. Coetzee BWT, Gaston KJ, Chown SL. Local scale comparisons of biodiversity as a test for global protected area ecological performance: a meta-analysis. *PLoS One*. 2014;9(8):105824.
4. Convention on Biological Diversity. Kunming-Montreal Global Biodiversity Framework. 15th meeting of the Conference of the Parties; 2022.

5. Davis MA, Mengelkoch JM, Parkos JJ, McIntyre S, Di Giovanni AJ, McElrath TC, et al. Tracking species recovery status to improve U.S. Endangered Species Act decisions. *Conserv Sci Pract.* 2024;6:13159.
6. Davis MA, et al. A new metric for conducting 5-year reviews to evaluate recovery progress under the Endangered Species Act. *Conserv Sci Pract.* 2024.
7. Díaz S, Settele J, Brondízio ES, Ngo HT, editors. Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). Bonn: IPBES Secretariat; 2019.
8. Frankham R. Genetic rescue of small inbred populations: meta-analysis reveals large and consistent benefits of gene flow. *Mol Ecol.* 2015;24(10):2610-8.
9. Geldmann J, Manica A, Burgess ND, Coad L, Balmford A. A global-level assessment of the effectiveness of protected areas at resisting anthropogenic pressure. *Proc Natl Acad Sci U S A.* 2019.
10. Gilbert-Norton L, Wilson R, Stevens JR, Beard KH. A meta-analytic review of corridor effectiveness. *Conserv Biol.* 2010;24(3):660-8.
11. International Institute for Environment and Development. First line of defence? A review of evidence on the effectiveness of engaging communities to tackle illegal wildlife trade. 2020.
12. International Union for Conservation of Nature. Iberian lynx rebounding thanks to conservation action [press release]. 2024 Jun 20.
13. International Union for Conservation of Nature. Recovery of the Iberian lynx: a conservation success in Spain [news release]. 2024.
14. International Union for Conservation of Nature. Kunming-Montreal Global Biodiversity Framework [issues brief]. 2024.
15. International Union for Conservation of Nature. The IUCN Red List of Threatened Species: summary statistics. Version 2025-1. 2025.
16. IUCN Cat Specialist Group. Living species: Iberian lynx (*Lynx pardinus*). 2024.
17. Kleiman DG. Reintroduction of captive mammals for conservation: guidelines for reintroducing endangered species into the wild. *BioScience.* 1989;39(3):152-61.
18. The Pew Charitable Trusts. Protected areas face multibillion-dollar funding gap. 2025.
19. Ralls K, Sunnucks P, Lacy RC, Frankham R. Genetic rescue: a critique of the evidence supports maximizing genetic diversity rather than minimizing the introduction of putatively harmful genetic variation. *Biol Conserv.* 2020.
20. Roe D, Booker F. Engaging local communities in tackling illegal wildlife trade: a synthesis of approaches and lessons for best practice. *Conserv Sci Pract.* 2019;1(5):26.
21. Smithsonian's National Zoo and Conservation Biology Institute. Genetic research provides hope for black-footed ferrets [news release]. 2024.
22. The Nature Conservancy. Biodiversity Finance Trends 2025. 2025.
23. U.S. Fish and Wildlife Service. Black-footed ferret named Elizabeth Ann becomes first cloned endangered species native to North America [press release]. 2021 Feb 18.
24. U.S. Fish and Wildlife Service. Recovery planning and implementation under the Endangered Species Act. 2023.
25. Whiteley AR, Fitzpatrick SW, Funk WC, Tallmon DA. Genetic rescue to the rescue. *Trends Ecol Evol.* 2015;30(1):42-9.
26. World Wildlife Fund. Living Planet Report 2024: a system in peril. 2024.
27. Community-based approaches to tackling illegal wildlife trade—what works and how is it measured? *Front Conserv Sci.* 2021.
28. Quantifying the capacity for assisted migration to achieve conservation and forestry goals under climate change [preprint]. *bioRxiv.* 2022.
29. Climate-induced range shifts support local plant diversity but don't reduce extinction risk. *Science.* 2025.
30. Red List criteria underestimate climate-related extinction risk of range-shifting species [preprint]. 2025.
31. Mixed effectiveness of global protected areas in resisting habitat loss. 2024.