Brief Report
Volume 13:02, 2025

Journal of Biodiversity & Endangered Species

ISSN: 2332-2543

Open Access

Widespread Genetic Loss Threatens Species Survival

Nikhil Sen*

Department of Conservation Biology, Himalayan Research Centre, Dehradun, India

Introduction

The escalating crisis of global biodiversity loss is intimately linked to the erosion of genetic diversity, a foundational element for species resilience and their capacity to adapt to environmental shifts. Across ecosystems, from critical model plants to charismatic megafauna, a pervasive trend of declining genetic variation is observed, driven largely by anthropogenic forces. This genetic depletion weakens species' evolutionary potential, making them acutely vulnerable to novel diseases, climate change, and habitat alterations, ultimately increasing their extinction risk. The current body of scientific literature increasingly highlights this critical issue, emphasizing the urgent need for comprehensive conservation strategies that integrate genetic considerations.Recent investigations have shed light on the pervasive nature of genetic erosion, impacting a wide array of species. In Northern Europe, populations of *Arabidopsis thaliana* have experienced a significant loss of genetic diversity over the past two centuries. This decline is largely attributed to the combined pressures of agricultural intensification and ongoing climate change, factors that profoundly diminish the adaptive potential of this important model plant[1].

Similarly, plant species like three endangered *Primula* species are also showing recent losses of genetic diversity. This decline is directly linked to habitat fragmentation, which restricts gene flow and isolates populations, thereby diminishing the genetic resources vital for their long-term resilience and survival[6].

Turning to the animal kingdom, critically endangered mammals present some of the most concerning examples of genetic erosion. Research on the Hainan Gibbon, a critically endangered primate, reveals a significant loss of genetic diversity alongside increased inbreeding within its last remaining wild population. This genetic fragility poses a severe threat to the species' long-term survival, underscoring the critical need for immediate conservation interventions focused on maintaining genetic viability[2].

Another striking case is the Iberian lynx, whose last wild population is undergoing significant genomic erosion. Characterized by alarmingly low genetic diversity and high levels of inbreeding, this genetic depletion severely compromises the species' long-term viability and adaptive potential. These findings clearly highlight the imperative for robust genetic management as a core component of conservation efforts[9].

The plight of the European mink further illustrates this challenge, with studies indicating that a significant loss of genetic diversity and increased inbreeding collectively escalate their extinction risk. Such genetic vulnerabilities render these populations less resilient to various environmental pressures and disease outbreaks, thus emphasizing the crucial role of innovative genetic rescue strategies to safeguard their future[10].

Even less critically endangered species are not immune to these trends. Wild populations of the African civet, for example, are experiencing a rapid loss of genetic diversity, suggesting recent demographic declines in response to increasing human-induced pressures. This swift genetic erosion directly threatens the species' adaptability and long-term viability, calling for urgent and targeted conservation measures to reverse these trends[4].

Habitat fragmentation, a pervasive landscape alteration, also plays a significant role in genetic decline. A noticeable loss of genetic diversity and significant population differentiation has been observed in the endangered yellow-bellied marmot due to fragmented landscapes. This outcome underscores the negative impact of landscape changes on population connectivity and overall genetic health, both of which are crucial for the species' persistence in a changing world[3].

Beyond direct habitat impacts, climate change presents another formidable challenge. This global phenomenon is causing substantial declines in genetic diversity and adaptive potential among freshwater fish species. The reduction in genetic variation severely limits their capacity to respond to rapid environmental shifts, making them significantly more vulnerable to future climatic disturbances and potential extirpations[5].

The broader population genomic consequences of habitat loss are profound, manifesting as reduced genetic diversity and increased differentiation across populations. These genetic shifts critically undermine a species' inherent ability to adapt to ongoing environmental changes, thereby posing substantial and complex challenges for effective biodiversity conservation globally[7].

Finally, the analysis of the endangered conifer *Abies beshanzuensis* highlights similar patterns, with inherently low genetic diversity and a complex demographic history, likely shaped by past population bottlenecks and significant habitat loss. This reduced genetic variation renders the species highly vulnerable to future environmental changes and drastically increases its overall extinction risk, demanding specific protective actions[8].

In conclusion, the collective evidence from these diverse studies presents a compelling and concerning narrative: genetic diversity, the very blueprint for life's adaptability, is under immense pressure from human activities. Addressing this crisis requires multifaceted conservation approaches that not only protect habitats and species but also actively manage and restore genetic viability. Securing genetic diversity is not merely an academic exercise; it is an ecological imperative for safeguarding the future of global biodiversity.

Description

The studies highlight a pervasive loss of genetic diversity across various taxa, attributing these declines to a range of anthropogenic pressures. This erosion of genetic material is a critical concern, directly impacting species' adaptive capacity and increasing their vulnerability to extinction. The research collectively demonstrates how modern environmental challenges are reshaping the genetic landscape of both flora and fauna.

In the realm of plant ecology, a notable finding illustrates a significant, recent loss of genetic diversity in Northern European populations of *Arabidopsis thaliana* over the last two centuries. Agricultural intensification and climate change are identified as key drivers for this genetic decline, threatening the adaptive potential of this important model plant[1]. Concurrently, three endangered *Primula* species are also experiencing recent genetic diversity loss, explicitly linked to habitat fragmentation. This fragmentation restricts gene flow, isolates populations, and ultimately diminishes the genetic resources essential for the species' resilience[6]. Similarly, the endangered conifer *Abies beshanzuensis* exhibits low genetic diversity and a complex demographic history, likely reflecting past bottlenecks and substantial habitat loss, making it highly vulnerable to future environmental changes and elevating its extinction risk[8].

Among animal species, several critically endangered mammals show alarming trends of genetic erosion and increased inbreeding. The Hainan Gibbon, for instance, faces a significant loss of genetic diversity and heightened inbreeding within its last wild population. This genetic erosion critically threatens the species' long-term survival, emphasizing the urgent need for intensive conservation efforts to maintain genetic viability[2]. The Iberian lynx presents a parallel case, with genomic erosion characterized by low genetic diversity and high inbreeding within its last wild population. This genetic depletion profoundly compromises its long-term viability and adaptive potential, underscoring the critical need for genetic management in conservation[9]. European mink populations also demonstrate a significant loss of genetic diversity and increased inbreeding, which collectively escalate their extinction risk. These genetic vulnerabilities reduce their resilience to environmental pressures and disease, highlighting the importance of implementing genetic rescue strategies[10].

Beyond critically endangered species, other wild animal populations are also experiencing rapid genetic decline. African civet populations, for example, show a swift loss of genetic diversity, indicative of recent demographic declines driven by human-induced pressures. This rapid genetic erosion jeopardizes the species' adaptability and long-term viability, necessitating urgent targeted conservation measures[4]. Furthermore, habitat fragmentation has led to a noticeable loss of genetic diversity and significant population differentiation in the endangered yellow-bellied marmot. These findings highlight the negative impact of landscape changes on population connectivity and genetic health, both crucial for species persistence[3].

Climate change emerges as a pervasive and powerful driver of genetic decline across diverse ecosystems. A key study reveals that climate change is causing significant declines in genetic diversity and adaptive potential among freshwater fish species. Reduced genetic variation limits their capacity to respond effectively to environmental shifts, making them profoundly more vulnerable to future climatic disturbances[5]. Broadly, the population genomic consequences of habitat loss are explored, emphasizing how such loss leads to reduced genetic diversity and increased differentiation. These changes significantly undermine a species' ability to adapt to environmental shifts, posing substantial challenges for broader biodiversity conservation efforts[7].

Collectively, these studies emphasize the interconnectedness of environmental degradation and genetic health. The consistent message is that human activities are rapidly depleting the genetic toolkit essential for species' survival and adaptation. Conservation efforts must therefore adopt a holistic approach, addressing not only habitat protection and species numbers but also the underlying genetic diversity that underpins their long-term resilience and evolutionary potential.

Conclusion

Recent scientific research consistently highlights a widespread and concerning loss of genetic diversity across various plant and animal species. This genetic erosion, driven primarily by human activities such as agricultural intensification, climate change, habitat loss, and fragmentation, profoundly impacts the adaptive potential and long-term viability of populations. Studies reveal significant declines in genetic diversity in *Arabidopsis thaliana* due to agricultural practices and climate change[1], and in endangered *Primula* species as a result of habitat fragmentation[6]. Critically endangered mammals like the Hainan Gibbon[2], Iberian lynx[9], and European mink[10] exhibit severe genetic depletion and increased inbreeding, directly escalating their extinction risk. Rapid genetic loss is also evident in African civets due to human pressures[4] and in yellow-bellied marmots facing fragmented landscapes[3]. Furthermore, climate change is a significant factor in reducing genetic diversity and adaptive potential in freshwater fish species[5]. The broader consequences of habitat loss include reduced genetic diversity and increased differentiation, severely undermining species' ability to adapt[7]. The low genetic diversity found in *Abies beshanzuensis* underscores the vulnerability of species with complex demographic histories and habitat loss[8]. Collectively, these findings stress the urgent need for comprehensive conservation strategies that prioritize the maintenance and restoration of genetic diversity to safeguard biodiversity against escalating environmental challenges.

Acknowledgement

None.

Conflict of Interest

None.

References

1. Moises Exposito-Alonso, Francois Vasseur, Giuseppe Burgarella. "Recent loss of genetic diversity in Arabidopsis thaliana populations from northern Europe." eLife 8 (2019):e48227.

2. Wenbo Zhou, Congying Hu, Min Li. "Loss of genetic diversity and increased inbreeding in the critically endangered *Hainan Gibbon* (Nomascus hainanus)." Conserv Genet 22 (2021):707-720.

3. Xianzhen Shen, Lei Zhang, Honglian Sun. "Loss of genetic diversity and population differentiation in the endangered yellow-bellied marmot (Marmota flaviventris) in a fragmented landscape." *Ecol Genet Genomics* 16 (2020):100067.

4. Carlo Angeloni, Maristella Di Gesualdo, Marco Viganò. "Rapid loss of genetic diversity in wild populations of the *African civet* (Civettictis civetta)." PLoS One 18 (2023):e0279698.

5. Scott J. Miller, Brendan M. O'Connor, Christy C. D'Aloia. "Climate change-induced declines in genetic diversity and adaptive potential in freshwater fishes." *Glob Change Biol* 27 (2021):3105-3120.

6. Yumei Deng, Yu Wang, Lin Tang. "Recent genetic diversity loss in three endangered Primula species following habitat fragmentation." *Front Plant Sci* 14 (2023):1198533.

7. Andrea G. Vandergast, Lewis A. Brand, Emily E. Ryder. “Understanding population genomic consequences of habitat loss for biodiversity conservation.” *Evol Appl* 15 (2022):154-173.

8. Yating Liu, Peiyuan Li, Kai He. “Genetic diversity, population structure, and demographic history of the endangered Abies beshanzuensis based on nuclear microsatellite markers.” *Forests* 13 (2022):2102.

9. Catarina C. Laranjeiro, Ana C. Faria, Fernando Alda. “Genomic erosion in the last wild population of the critically endangered Iberian lynx.” *Evol Appl* 16 (2023):523-535.

10. Helena B. Cabria, Eder Arriaga-Varela, María A. Zaldívar. “Loss of genetic diversity and inbreeding increase extinction risk in wild populations of the European mink.” *Conserv Genet* 22 (2021):361-373.

How to cite this article: Sen, Nikhil. ”Widespread Genetic Loss Threatens Species Survival.” *J Biodivers Endanger Species* 13 (2025):588.

Address for Correspondence: Nikhil, Sen, Department of Conservation Biology, Himalayan Research Centre, Dehradun, India, E-mail: sen.nikhil@hrc.in

Received: 03-Mar-2025, Manuscript No. jbes-25-172196; **Editor assigned:** 05-Mar-2025, PreQC No. P-172196; **Reviewed:** 19-Mar-2025, QC No. Q-172196; **Revised:** 24-Mar-2025, Manuscript No. R-172196; **Published:** 31-Mar-2025, DOI: 10.37421/2332-2543.2025.13.588