



Conservation Genetics of Endangered Domestic Breeds

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Received: 22 August 2025

Revised: 28 August 2025

Accepted: 29 August 2025

Published online: 2 September 2025

Article ID: SR01020

Citation: Deka, A., Taye, R.K. & Deka, B.C. (2025). Conservation Genetics of Endangered Domestic Breeds. *Scientia Review*, 1(3), 18-21

Abstract

Conserving the genetics of endangered domestic breeds is essential to protect their unique genetic diversity heritage and ability to adapt. These breeds face growing challenges from modern farming methods crossbreeding and loss of their natural environments, all of which lead to smaller populations and less genetic variety. Understanding how to apply conservation genetics helps tackle these challenges by using tools like modern genomics to carefully manage and preserve these valuable genetic resources. Maintaining genetic diversity is key to ensuring breed survival and their ability to thrive in changing conditions. Thoughtful breeding programs aimed at preserving or rebuilding this diversity play a crucial role. Alongside genetic concerns, ethical issues and the connection between conservation efforts and sustainable farming are important factors to keep in mind.

Keywords: Conservation, Genetics, Endangered, Breeds, Inbreeding, Population

Introduction

Domestic animals like cattle sheep goats and dogs have been shaped over thousands of years through selective breeding. This process has created unique breeds perfectly adapted to specific environments and human needs. Unfortunately, many of these breeds are now at risk of disappearing. The rise of a few highly productive commercial breeds changes farming practices and along with habitat loss threatens the survival of traditional breeds. When these breeds vanish, we lose not only important cultural heritage but also the valuable genetic diversity needed to adapt to shifting environments and new diseases.

Conservation genetics combines genetics and conservation biology to study genetic variation within and between populations. It helps identify risks to genetic health and guides breeding and management strategies to protect or restore it. Although conservation often focuses on wild species endangered domestic breeds also face serious genetic challenges that require special attention. Understanding the key principles threats methods and practical examples of conservation genetics is essential for protecting and sustaining these breeds.

Importance of Genetic Diversity in Domestic Breeds

Genetic diversity is fundamental to the health and survival of any animal population. It gives these populations the ability to adapt to changing environments fight off diseases and stay reproductively strong. In domestic breeds having a wide range of genetic traits means animals can thrive even in tough or varying conditions. When genetic diversity shrinks populations become vulnerable to inbreeding depression where breeding between close relatives leads to weaker health. This can cause more illnesses lower fertility and higher death rates.

Many native or traditional breeds are disappearing because they have been replaced by a few specialized commercial breeds chosen for traits like high milk meat or wool production. Although these commercial breeds are efficient in the short term, they usually do not carry the genetic variety required for long-lasting survival. Take Nordic Spitz dogs such as the Norwegian Lundehund these breeds have very low genetic diversity and suffer from inbreeding problems. As a result, they often face serious health issues like severe gastrointestinal disorders (Kristensen *et al.*, 2015). This example highlights why preserving genetic diversity in domestic breeds is so important.

Genetic Threats to Endangered Domestic Breeds

Endangered domestic breeds face several serious genetic challenges. One major issue is inbreeding depression, which happens when close relatives mate within a small population that has limited genetic variation. This can lead to a decline in overall health and biological fitness. Another concern is genetic drift, where random changes in gene frequencies occur, especially in small groups, causing a loss of genetic diversity over time. Outbreeding depression can also be a problem; this occurs when animals from genetically distant populations are crossed, sometimes disrupting traits that are specially adapted to local environments. Additionally, unique adaptive traits that have developed over time in specific breeds may be lost through crossbreeding or genetic erosion. Effectively managing these threats calls for careful study and understanding of the genetic makeup and diversity both within a breed and between related breeds.

Managing these threats requires careful assessment of the genetic structure and diversity within breeds and between related breeds (Table 1).

Conservation Genetics Methods for Endangered Breeds

Modern conservation genetics uses molecular tools to measure genetic variation and guide effective breeding plans. One important method involves microsatellite and SNP markers, which help evaluate genetic diversity population structure and how closely related animals are within and between breeds. Genome-wide analyses take this further by offering detailed information about genes involved in adaptation the overall genetic burden and the breed's historical population changes. Breeding programs are then designed to create mating plans that reduce inbreeding maintain genetic diversity and carefully manage gene flow among animals.

One practical example is strategic conservation breeding, which focuses on preserving all the genetic diversity present in a breed through carefully controlled matings. This method views the entire breed or flock as a genetic unit rather than just selecting animals based on individual traits. Such an approach helps prevent the quick loss of genetic variation that can happen if breeding decisions focus only on appearance or specific characteristics.

Table 1: Genetic Threats and Conservation Strategies in Endangered Domestic Breeds

Genetic Threat	Description	Conservation Strategy
Inbreeding depression	Reduced fitness from related matings	Controlled breeding to reduce relatedness
Genetic drift	Random allele frequency changes	Maintain large effective population size
Outbreeding depression	Fitness loss from distant crosses	Assess compatibility before crossbreeding
Loss of adaptive traits	Disappearance of local adaptations	Preserve native breeds in original environments

Case Study: Norwegian Lundehund

The Norwegian Lundehund is a distinctive and rare Spitz breed native to the rugged coastal regions of Norway. Historically this breed played an important role in local communities primarily used for hunting puffins on steep cliffs and narrow ledges where few other dogs could follow. Its unique physical features including extra toes flexible joints and an ability to close its ears enabled it to perform this specialized task effectively over centuries.

However, the breed's population size has faced dramatic fluctuations over the past century.

Due to geographic isolation combined with two severe population bottlenecks in the early and mid-1900s the Lundehund's gene pool drastically shrank. These population declines led to high levels of inbreeding and severely reduced genetic diversity. As a consequence, many individuals suffer from serious health issues most notably a range of gastrointestinal disorders that can severely affect their quality of life and lifespan.

The limited genetic variation in the Lundehund makes the breed vulnerable to inbreeding depression decreasing fertility and increasing

susceptibility to diseases. The health problems linked to this genetic bottleneck pose a significant challenge to the breed's long-term survival requiring urgent conservation measures to prevent further decline. Current conservation efforts are focusing on genetic rescue through carefully controlled crossbreeding. Breeders and geneticists are working to introduce new genetic material from closely related Nordic Spitz breeds such as the Norwegian Buhund and Icelandic Sheepdog. The intent is to carefully increase genetic diversity without losing the defining physical and behavioural traits that make the Lundehund unique. This process requires meticulous planning to balance gene flow and breed identity. Such a strategy demonstrates the principle of genetic rescue wherein controlled introduction of new genes improves the overall health fitness and reproductive success of an endangered population without compromising its distinct identity. Early results from these efforts show promise in reducing health problems associated with inbreeding and increasing the breed's chances for a sustainable future.

The Norwegian Lundehund case highlights the delicate balance between preserving breed heritage and ensuring genetic health. It underscores the importance of combining traditional breeding wisdom with modern genetic tools to manage endangered domestic breeds effectively. With continued careful management and scientific support, the Lundehund's distinctive legacy can be protected while giving the breed renewed vitality and resilience (Kristensen *et al.*, 2015).

The Role of Genomics in Conservation

Recent advances in genomics have brought a remarkable transformation to the field of conservation genetics, offering powerful new tools to better understand and protect endangered domestic breeds. These cutting-edge technologies enable researchers and breeders to uncover unique genetic traits and identify specific genes that play a key role in helping animals adapt to their environments. This deeper genetic insight allows for more effective management of harmful genetic variants and the overall genetic load, which can significantly impact the health and viability of a breed.

One of the major benefits of genomics is its ability to support genome-informed mating plans. By utilizing detailed genetic information, breeders can develop strategies that maximize genetic diversity within a population while minimizing the risks of inbreeding. This is

crucial because inbreeding can lead to the accumulation of harmful alleles and result in reduced fitness or increased susceptibility to diseases.

Technologies such as SNP (single nucleotide polymorphism) chip platforms enable rapid and precise screening of an animal's genome to identify genes or alleles that may be detrimental. Breeders can then make informed decisions to select against these damaging alleles, thereby maintaining healthy levels of genetic variation at critical loci. This kind of genomic selection is far more accurate and comprehensive than traditional genetic markers, which often provide only limited information.

Beyond simply assessing diversity, genomic approaches also allow scientists to analyze the genetic architecture of traits related to adaptation, reproduction and disease resistance. This facilitates targeted breeding programs that not only preserve genetic variation but also improve breed resilience and long-term sustainability. Overall, the integration of genomics into conservation genetics represents a significant advance in safeguarding endangered domestic breeds. It equips breeders and conservationists with the detailed and precise genetic knowledge needed to efficiently recover at-risk populations and maintain their genetic health across generations. This level of insight was not possible with earlier methods, making genomics an essential tool for the future of breed conservation (Kristensen *et al.*, 2015).

Ethical and Practical Considerations

Conservation genetics of domestic breeds must balance genetic goals with the preservation of breed identity, phenotype and cultural significance. Crossbreeding, while beneficial for introducing genetic variation, risks altering breed characteristics. Decisions must consider both genetic health and breed conservation goals.

Moreover, conservation efforts are often resource-limited. Priorities must be set based on breed uniqueness and contribution to overall species diversity. Cryopreservation of genetic material through national gene banks is an essential strategy to safeguard genetic resources for future recovery programs.

Conclusion

Conservation genetics plays a crucial role in ensuring the survival and sustainable management of endangered domestic breeds. Keeping genetic diversity intact helps preserve the true nature of each breed while also

allowing them to adapt to future environmental changes. Combining traditional breeding practices with modern genomic technologies provides powerful tools to protect these valuable breeds. Ongoing dedication to conservation programs gene banks and ethical breeding strategies is necessary to safeguard the world's animal genetic resources, supporting food security cultural heritage and biodiversity for generations to come.

Conflict of interest

The authors declare no conflict of interest.

References

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