

# Breeding For A Future: Preserving The Miniature American Shepherd

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## The Goal

It is the duty of dedicated purebred dog enthusiasts to make conscientious decisions and take deliberate actions to responsibly care for and preserve our chosen breed. By doing so, we ensure that future generations of enthusiasts can experience the same love and enjoyment. As stewards of the Miniature American Shepherd breed, we have a unique opportunity to make a significant positive impact on the future of our breed. The commitment of our members and breeders to genetics research and their dedication to advancing our understanding of current scientific knowledge and recommended best practices have brought many to the same conclusion. By advocating for the extension of an open stud book, we choose to prioritize scientific knowledge and *proactively* address the current issues and potential challenges that may arise within our breed due to a lack of genetic diversity. By making forward-thinking decisions *now* that place emphasis on the long-term wellbeing and preservation of the Miniature American Shepherd we can ensure a thriving future.

## The Challenge

Extensive scientific evidence unequivocally supports the notion that closed stud books and excessive linebreeding/inbreeding can have severe negative repercussions on the health and overall well-being of species and their populations, and more pointedly, for our domestic dog breeds. The ramifications of reduced genetic diversity are far-reaching and encompass a wide range of issues, including the heightened prevalence of inherited disorders, compromised immune systems, reproductive complications, and behavioral challenges. The Miniature American Shepherd breed has identified notable health challenges even as we are facing the closure of our stud books. Testing has yet to begin for Neuroaxonal Dystrophy and a recently identified

form of juvenile onset cataracts.<sup>1</sup> Additionally, efforts to eliminate CDDY from breeding programs are still underway. These health issues pose a substantial burden on breeders who are diligently striving to eradicate these genes from their lines. As a result, breeders are actively seeking external sources to introduce dogs free from these genetic conditions into their programs with limited time and soon to be very limited options once the stud book is closed.

## Preservation Before Restoration

This article offers a thorough examination of significant findings obtained from studies and experiences involving various breeds, as well as populations of domestic and wild species. It delves into the advantages of open stud books and the disadvantages associated with closed stud books, providing a comprehensive overview of the subject matter. These sources highlight the long-lasting benefits of maintaining a consistent inflow of genetic material, rather than relying solely on genetic rescue attempts once issues related to limited gene pools and inbreeding have become prevalent.<sup>2</sup> By drawing insights from these outside sources, this article sheds light on valuable lessons that can be applied to the context of the Miniature American Shepherd breed, particularly in terms of expanding and maintaining a high level of genetic diversity to ensure the breed's resilience. Put succinctly, the overarching goal should be *preservation long before the need for restoration*.

## History and Tradition

Stud books within dog breeds have long been a topic of discussion among scientists, veterinarians, and dog enthusiasts, particularly in terms of preserving desirable traits, improving health, and maintaining genetic diversity. Contributions to the discussion encompasses research from a variety of fields, including population genetics, molecular ecology, molecular biology, evolutionary biology, systematics, forensics, and other related disciplines. The conversation regarding open and closed stud books has implications for the long-term health, adaptability, and preservation of dog breeds. The topic becomes more complex when considering the divisions that exist within dog breeds such as show, working, performance, and pet lines. A significant challenge faced by passionate breeders is the already limited gene pool is further artificially constrained by geography and breed politics (i.e. breed sub groups and the limited flow between groups, of genetic material) and for the Miniature American Shepherd, the additional constraint of being unable to consider merle males for merle females, which often forces breeders to make choices that may be less than ideal to achieve optimal outcomes in terms of health, temperament, and overall breed improvement. This lack of gene flow between groups can lead to significant genetic as well as phenotypic differentiation and potential loss of genetic diversity within each population subset. It is worth noting that registries, closed stud books and the political

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<sup>1</sup>[https://vet.purdue.edu/news/new-genetic-testing-available-through-addl-will-help-dog-breeders-eliminate-specific-diseases-pvr-s2023.php?fbclid=IwAR1qkrWJOXxOcJIm\\_eFcl2x98hnuZR\\_U2rhc347Kij1wenfgURX\\_U1x3RQM](https://vet.purdue.edu/news/new-genetic-testing-available-through-addl-will-help-dog-breeders-eliminate-specific-diseases-pvr-s2023.php?fbclid=IwAR1qkrWJOXxOcJIm_eFcl2x98hnuZR_U2rhc347Kij1wenfgURX_U1x3RQM)

<sup>2</sup> J.J. Windig, H.P. Doekes, (2018) Limits to genetic rescue by outcross in pedigree dogs. Journal Of Animal Breeding and Genetics

divisions within which are relatively recent developments, emerged approximately a century and a half ago as products of the contemporary dog fancy. Dogs, however, have been in existence alongside humans for up to an estimated 40,000 years<sup>3</sup> prior to the establishment of registries. Throughout this extensive period, dogs have thrived worldwide, and diverse breeds have emerged and been established among a variety of peoples and cultures without the constraints and limitations imposed by formal systems.

Our formal system, The American Kennel Club (AKC) was established in 1884 to be a centralized organization for a network of dog clubs. In 1887, the AKC took a significant step by maintaining a studbook, thanks to the generous gift of three volumes from Dr. N. Rowe. During that time, the AKC officially recognized nine breeds, including the Chesapeake Bay Retriever, Clumber Spaniel, Cocker Spaniel, Irish Setter, Gordon Setter, Sussex Spaniel, Irish Water Spaniel, and Sussex Spaniel.<sup>4</sup> Some of these original breeds as well as breeds with a more recent acceptance into the AKC, still retain the ability to register dogs from outside the AKC. For example, the Border Collie maintains open studbooks, allowing dogs to be registered with the AKC. It is important to note that the entry of these dogs into the AKC follows an established approval process, either through an approved pedigreed registry or by demonstrating the breed's established qualities at sanctioned shows, aligning with the breed's standard.<sup>5</sup>

## Preservation

Purebred enthusiasts have coined the term "preservation breeding" to describe the objective of preserving and distinguishing specific breeds and to describe the dedicated efforts of individuals and organizations who are committed to carrying forward the legacy of developed breeds. Preservation breeding in essence, focuses on maintaining and preserving the original characteristics, traits, as well as historical and cultural significance of these breeds. Preservation breeding is focused on upholding the breed standard, preserving its unique physical, behavior and temperament qualities, addressing existing health concerns, and promoting the breed's long-term viability.<sup>6</sup> The primary objective is to intentionally select breeding pairs that exhibit desirable traits, while also considering genetic diversity to prevent the accumulation of detrimental genetic variations. While proponents of closed stud books prefer a certain level of phenotypic and behavioral consistency, the negative consequences of general closed breeding practices have been consistently demonstrated in many long established breeds, prompting many breed clubs (across various domestic species) worldwide to address these effects and initiate outcross programs to rescue and preserve their breeds. A closed stud book, which would restrict the gene pool by limiting breeding to a set number of individuals, has consistently been shown to be counterproductive to the goal of preservation.

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<sup>3</sup> Botigué, L., Song, S., Scheu, A. et al. Ancient European dog genomes reveal continuity since the Early Neolithic. *Nat Commun* 8, 16082 (2017). <https://doi.org/10.1038/ncomms16082>

<sup>4</sup> [https://www.akc.org/about/history/?fbclid=IwAR0nylg7fzShpHzoxGJJaNUrOAqAAP\\_8YpgEuwtLnt76ctLR3kPo8jkBPcg](https://www.akc.org/about/history/?fbclid=IwAR0nylg7fzShpHzoxGJJaNUrOAqAAP_8YpgEuwtLnt76ctLR3kPo8jkBPcg)

<sup>5</sup> <https://americanbordercollie.org/services/rom-program/>

<sup>6</sup> What Does It Mean to Be a Preservation Breeder? - Showsight ([showsightmagazine.com](https://showsightmagazine.com))

## Registries and Record Keeping

Registries and stud books are important tools for breeders serving multiple purposes. They enable breeders to track parentage, health, and accomplishments of dogs and their ancestors. By maintaining accurate records, these tools aid in making informed breeding decisions, verifying pedigrees, monitoring breed health, preserving breed standards, and managing breed populations. Overall, registries and stud books play a valuable role in maintaining the integrity of dog breeds in our modern day. *Closed stud books, aimed at maintaining breed purity, is where the concern arises.* By restricting breeding to a select pool based on specific criteria, such as pedigree, health testing, or a narrow set of breed characteristics, closed stud books can reduce genetic diversity over time and increase the risk of inherited health issues accumulating through homozygosity.

## Genetic Diversity

Genetic diversity refers to the variety and variability of genetic characteristics both seen and unseen, within a population. It encompasses the range of alleles or gene variants that exist within a gene pool. Higher genetic diversity is essential for the long-term viability and adaptability of both wild and domestic individuals and populations. Like financial portfolio diversification, where investments are spread across different assets to reduce risk, maintaining a diverse gene pool helps mitigate the risk of inheriting detrimental traits or susceptibility to certain diseases within a population.<sup>7</sup> In the context of the Miniature American Shepherd breed, by incorporating a wide range of genetic material through judicious outcrossing and open stud books with approved registries, breeders can minimize the probability of negative genetic traits becoming prevalent<sup>8</sup> within the breed. We can aim to avoid homozygosity. This approach increases the genetic "portfolio" of the population, reducing the risk of relying on a limited set of genetic variants that may carry detrimental effects.

As a population becomes more inbred, the frequency of runs of homozygosity (ROH) in the genome increases. This poses a concern because recessive genes associated with illness or deleterious traits remain hidden until they are paired with another copy. Unlike dominant or codominant health issues that are observable and allow for affected animals to be removed from the breeding pool, identifying carriers of recessive alleles requires genetic testing. Genetic testing is crucial for detecting these hidden carriers and making informed breeding decisions to prevent the expression of detrimental traits in future generations, however, the process of identifying potential problems and pinpointing the specific problem gene can be time-consuming, often taking years. This delay poses a significant challenge because, by the time a problem gene is identified, it may have already spread extensively throughout a population with limited breeding options. We are facing this issue within the Miniature American Shepherd breed now with recently identified problematic genes such as CDDY, neuroaxonal dystrophy, and juvenile onset cataracts.

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<sup>7</sup> Figge, F. Bio-folio: applying portfolio theory to biodiversity. *Biodiversity and Conservation* **13**, 827–849 (2004). <https://doi.org/10.1023/B:BIOC.0000011729.93889.34>

<sup>8</sup> Coker, Oluwakayode. (2019). Importance of genetics in conservation of biodiversity.

## Health: Testing, Benefits and Limitations

Although health testing is a valuable tool, it alone cannot address all the issues that may affect the Miniature American Shepherd breed. While it is helpful to remove deleterious genes when identified, this may even cause significant problems if incorrectly utilized. We can look to the Portuguese Water Dog as an example. The Portuguese Water Dog's American lineage originated from a small group of less than ten individuals imported in the late 1960s and early 1970s. Initially, 16% of Portuguese Water Dogs tested positive as carriers of the autosomal recessive gene for GM1-gangliosidosis. The Algarbiorum line, which carried the defective gene, had a dominant breeding presence in the early years. Breeders then focused on the Alvalade line, which did not have the defective gene for GM-1 gangliosidosis, leading it to become the primary influence in the breed. Unfortunately, the Alvalade line carried the gene for late-onset prcd-PRA, resulting in a breed-wide carrier frequency of 35% for this disorder. This selection process nearly eliminated the Algarbiorum line from the breed.<sup>9</sup> Despite the breeders' best efforts and intentions, this regrettable circumstance occurred. Initially, removing a line that proves to be unsatisfactory from the gene pool can be relatively straightforward, but adding new lines or introducing new genetic traits from an outside source can be an arduous endeavor that often requires substantial time and effort, often spanning years or even decades, to achieve successful results.

Frequent problematic patterns noted in various dog breeds, especially those with closed stud books, are the overbreeding of a select few individuals (Popular Sire Effect<sup>10</sup>) possibly in addition to the population having been started with a limited number of individuals (Founders Effect<sup>11</sup>). These issues have been shown to ultimately lead to genetic bottlenecks of many breeds. As a result, outcrossing, which involves introducing new genetic material from outside the breed, has been recommended and, in some cases, implemented as a solution for struggling breeds. Several dog breeds have already faced the need for outcrossing to save their population and create a path to health, especially in cases like the Norwegian Lundehund<sup>12</sup> and Dalmatian.<sup>13</sup> Both of these breeds reached a critical juncture where genetic rescue became imperative to restore the breed's health. The registries lacked individuals who were unaffected by the specific ailments associated with each breed. Certain other breeds, such as the

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<sup>9</sup> Bell, J. S. (2007). Genetic Testing and Counseling: A Trojan Horse for Dog and Cat Breeds? Tufts Cummings School of Veterinary Medicine, North Grafton, MA, USA

<sup>10</sup> G. Leroy Genetic diversity, inbreeding and breeding practices in dogs: Results from pedigree analyses Vet J (2011)

<sup>11</sup> <https://www.genome.gov/genetics-glossary/Founder-Effect>

<sup>12</sup> Stronen, A. V., Salmela, E., Baldursdottir, B. K., Berg, P., Espelien, I. S., Jarvi, K., ... Pertoldi, C. (2017). Genetic rescue of an endangered domestic animal through outcrossing with closely related breeds: A case study of the Norwegian Lundehund. PLoS One, 12, e0177429.

<sup>13</sup> Powell, D. The Dalmatian/Pointer Backcross Project: Overcoming 20th Century Attitude About Crossbreeding 22\_LUA01182012Final\_Final.pdf (luadalmatians.com)

Doberman,<sup>14</sup> Boxer,<sup>15</sup> Cavalier King Charles Spaniel, and Bernese Mountain Dog are currently grappling with significant health concerns and shorter lifespans. According to a recent study, it was found that a population of 20,000 pedigree boxer dogs would have the genetic diversity equivalent to only approximately 70 individual dogs.<sup>16</sup> To add perspective, a species or population is listed as “critically endangered” or at risk for extinction when the population is <50 individuals. Despite the dire potentials, these breed communities find themselves embroiled in a contentious debate between the importance of preserving purity versus prioritizing overall health. As a result of indecision or inability for breed clubs to move forward, some breeders have initiated unauthorized outcross projects in an effort to garner support for their cause after the fact. Once the studbook is closed, should issues become prevalent and unavoidable, the effort to reopen it is significantly more challenging compared to the ongoing maintenance of an open studbook, as we have seen in these other breeds.

## Linebreeding and Inbreeding as Genetic Repetition

Linebreeding is a commonly practiced technique in breeding and is not inherently negative. However, one challenge that frequently arises is the loss of awareness of linebreeding beyond the fourth generation. As breeders make breeding decisions, they may perceive the pedigree as balanced, yet fail to recognize the extent of tight linebreeding which is occurring further back in the pedigree. Dogs from earlier generations can appear numerous times—10x, 15x, 20x—without even reaching the Foundation lines, this is often influenced by popular sires across generations and over time.

Breeders often utilize the coefficient of inbreeding (COI) as a tool to measure the level of genetic relatedness between individuals in a pedigree. It provides an estimation of the probability that both copies of a gene in an individual are identical due to recent common ancestry. However, there are some drawbacks to current COI formulas. One limitation is that COI calculations typically rely on a limited number of generations (10) in the pedigree, which may not capture the complete genetic history of an individual. Additionally, some formulas assume random mating patterns, which may not accurately reflect breeding practices in specific breeds or populations. This can result in an underestimation or overestimation of the actual level of inbreeding.

Extensive pedigree analysis would be necessary to assess the frequency of popular sires and the level of interrelatedness within the Miniature American Shepherd breed. However, even a cursory examination of some of the founding dogs reveals a notable occurrence of tight linebreeding during the breed's inception. In our breed's history, we are aware that Cordova Spike was the result of intentional linebreeding on Puppy's lines. Although we may lack information about the lines preceding Puppy, it is important


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<sup>14</sup> What's the problem? ([dobermandiversityproject.org](http://dobermandiversityproject.org))

<sup>15</sup> J.M. Flemming, K.E. Creevy, D.E.L. Promislow. Mortality in North American Dogs from 1984 to 2004: An Investigation into Age-, Size-, and Breed-Related Causes of Death. *Journal Of Internal Veterinary Medicine*, V 25 Issue 2 (2011)

<sup>16</sup> Calboli FC, Sampson J, Fretwell N, Balding DJ. Population structure and inbreeding from pedigree analysis of purebred dogs. *Genetics*. 2008 May;179(1):593-601. doi: 10.1534/genetics.107.084954. PMID: 18493074; PMCID: PMC2390636.

not to assume that they were entirely unrelated simply due to a lack of pedigree records. By examining the pedigree of Cordova Spike, we can observe the recurrence of certain names within his lineage, shedding light on the pattern of breeding and genetic repetition. Due to genetic repetition such as this, the number of individuals registered does not necessarily correlate to genetic diversity.


  
 Cordovas Spike  
 Australian Shepherd

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NSDR: (1)A1555-8130 Color: Blue Merle C/W Sex: M

Travis Stimi	Travis Buster	Unknown	Unknown
		Unknown	Unknown
	Travis Puppy	Unknown	Unknown
		Unknown	Unknown
Travis Shady	Travis Skeeter Of Agua Dulce	Travis Shep	Unknown
		Travis Boob	Travis Buster
	Travis Ms Squeek	Travis Skeeter Of Agua Dulce	Travis Shep
		Travis Puppy	Travis Boob
		Unknown	Unknown
		Unknown	Unknown

Figure 1 Pedigree for Cordovas Spike, a significant sire in the Miniature American Shepherd Breed. Names are highlighted and color coded to illustrate repetition.

Similar breeding patterns can be observed in Holstein cattle, where the effective population size of over 9 million individual cattle is remarkably reduced to fewer than 50 individuals.<sup>17</sup> Despite meticulous management, professional expertise from farmers and cattle associations, and extensive research conducted by agricultural universities, the Holstein breed has encountered unforeseen challenges. Throughout successive generations, breeders primarily emphasized breeding selections based on optimal production qualities. As a result, 99% of the 9 million Holstein cattle can trace their

<sup>17</sup> <https://undark.org/2019/06/19/cows-holstein-diversity/>

lineage back to just two foundation sires from the 1960s. This selective breeding approach has inevitably led to the loss of certain traits, as each breeding decision accentuates specific qualities while inadvertently diminishing others.<sup>18</sup> With each deliberate breeding decision, we reinforce certain traits while inadvertently diminishing others, shaping the development of our breed over successive generations.

## Closed Stud Books: A Critical Analysis

The most concerning consequence of closed stud books is the increased prevalence of inherited disorders within dog breeds and other closed populations. A reduction in genome-wide heterozygosity is linked to an elevated burden of Mendelian disease variants.<sup>19</sup> As closely related individuals are mated, the probability of inheriting harmful recessive genes significantly rises. Studies have linked inbreeding and linebreeding to a higher incidence of various conditions, including skeletal disorders, heart diseases, neurological disorders, and immune system deficiencies.<sup>20</sup> Such health issues not only compromise the well-being of individual dogs but also contribute to increased veterinary costs and diminished breed longevity. The Quarter Horse breed serves as a well-known example of the impact a popular sire, Impressive, and the associated genetic disease called Hyperkalemic Periodic Paralysis (HYPP) had on the breed over several generations and decades. Recognizing the significance of this issue, the American Quarter Horse Association now mandates genetic testing for horses with lineage tracing back to Impressive. Furthermore, horses found to be homozygous for the HYPP gene are not eligible for registration. However, despite these measures, the HYPP gene persists in approximately 4.4% of Quarter Horses due to continued breeding of horses carrying the gene. This example highlights the long-lasting consequences of breeding decisions and the importance of responsible breeding practices and genetic testing to prevent the spread of harmful genetic traits within a breed.<sup>21</sup>

Closed stud books can have a significant impact on a breed's fertility and reproductive health. Studies have found that inbred populations often exhibit reduced litter sizes,<sup>22</sup> higher rates of stillbirths,<sup>23</sup> and lower overall fertility.<sup>24</sup> In addition, inbreeding depression<sup>25</sup>, a decline in fitness and viability, can manifest as reduced

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<sup>18</sup> O'Hagan, Marie. From Two Bulls, 9 Million Dairy Cows. Undark. 2019

<sup>19</sup> Donner, J., Freyer, J., Davison, S., Anderson, H., Blades, M. *et al.* (2023) Genetic prevalence and clinical relevance of canine Mendelian disease variants in over one million dogs. *PLoS Genetics* 19(2), e1010651.

<sup>20</sup> Acevedo-Whitehouse, K., Gulland, F., Greig, D. *et al.* Disease susceptibility in California sea lions. *Nature* **422**, 35 (2003). <https://doi.org/10.1038/422035a>

<sup>21</sup> <https://www.aqha.com/hypp>

<sup>22</sup> Chu, E.T., Simpson, M.J., Diehl, K. *et al.* Inbreeding depression causes reduced fecundity in Golden Retrievers. *Mamm Genome* **30**, 166–172 (2019). <https://doi.org/10.1007/s00335-019-09805-4>

<sup>23</sup> Derksen, Bruce. Inbreeding remains a challenge for Holsteins. *Producer*. (2021)

<sup>24</sup> J Schrack, G Dolf, I M Reichler, C Schelling. (2017) Factors influencing litter size and puppy losses in the Entlebucher Mountain dog. *Theriogenology* Jun;95:163-170

<sup>25</sup> Charlesworth, D., Willis, J. The genetics of inbreeding depression. *Nat Rev Genet* **10**, 783–796 (2009). <https://doi.org/10.1038/nrg2664>



sperm quality and impaired reproductive performance in males.<sup>26</sup> Such reproductive challenges can further exacerbate the decline in genetic diversity and increase the risk of inherited disorders within a breed. The impact of this increased inbreeding coefficient is evident in the pregnancy rates of Holstein cattle which have experienced a significant decrease in fertility over time. Currently, the "inbreeding coefficient" for Holsteins stands at approximately 8 percent. This means that an average calf inherits identical copies of 8 percent of its genes from both its mother and father. To provide context, this figure is in comparison to a baseline from 1960, and it continues to rise by approximately 0.3 or 0.4 percent each year. In the 1960s, pregnancy rates ranged between 35 to 40 percent. However, by the year 2000, these rates had declined to approximately 24 percent.<sup>27</sup>

## Conclusion

Extensive scientific evidence unequivocally supports the notion that closed stud books and excessive linebreeding/inbreeding can have severe negative repercussions on the health and overall well-being of dog breeds. The ramifications of reduced genetic diversity are far-reaching and encompass a wide range of issues, including the heightened prevalence of inherited disorders, compromised immune systems, reproductive complications, and behavioral challenges. There has been significant evidence to support maintaining high genetic diversity and moving away from traditionally closed studbooks through the experiences documented from other breeds and species, as well as the outcomes of studies and published scientific articles to effectively preserve the history and heritage of our beloved dog breeds. Our intention is not to discredit the value of purebred dogs or endorse extensive crossbreeding. Rather, we emphasize the importance of preserving open avenues for lines and branches within our breed as a means to safeguard the long-term well-being of our purebred dogs.

## Our Hope

The Miniature American Shepherd breed has identified notable health challenges even as we are facing the closure of our stud books. Testing has yet to begin for Neuroaxonal Dystrophy and a recently identified form of juvenile onset cataracts.<sup>28</sup> Additionally, efforts to eliminate CDDY from breeding programs are still underway. These health issues pose a substantial burden on breeders who are diligently striving to eradicate these genes from their lines. As a result, breeders are actively seeking external sources to introduce dogs free from these genetic conditions into their programs with limited time and soon to be very limited options once the stud book is closed.

There is hope the Miniature American Shepherd can avoid the pitfalls other breeds have encountered by utilizing an open approach to breeding, which allows for outcrossing and the introduction of new genetic material long before a need for breed

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<sup>26</sup> C. Asa, P. Miller, M. Agnew, J. A. R. Rebolledo, S. L. Lindsey, M. Callahan, K. Bauman. et al. (2007) Relationship of inbreeding with sperm quality and reproductive success in Mexican gray wolves. *Animal Conservation*. <https://doi.org/10.1111/j.1469-1795.2007.00116.x>

<sup>27</sup> O'Hagan, Marie. *From Two Bulls, 9 Million Dairy Cows*. Undark. 2019

<sup>28</sup>[https://vet.purdue.edu/news/new-genetic-testing-available-through-addl-will-help-dog-breeders-eliminate-specific-diseases-pvr-s2023.php?fbclid=IwAR1qkrWJOXxOclIm\\_eFcl2x98hnuZR\\_U2rhc347Kij1wenfgURX\\_U1x3RQM](https://vet.purdue.edu/news/new-genetic-testing-available-through-addl-will-help-dog-breeders-eliminate-specific-diseases-pvr-s2023.php?fbclid=IwAR1qkrWJOXxOclIm_eFcl2x98hnuZR_U2rhc347Kij1wenfgURX_U1x3RQM)

restoration efforts. Breed restoration can be challenging and unsustainable with just a single or a few initial outcrosses.<sup>29</sup> It is advantageous to maintain genetic diversity to improve the breed over time. Regular or continuous outcrossing is necessary to have a significant impact on inbreeding and allele frequencies. While initial offspring may have low inbreeding coefficients of 0, inbreeding levels and rates can quickly rebound to previous levels without ongoing outcrossing.<sup>2</sup>

As conscientious breeders of the Miniature American Shepherd recognizing the importance of genetic diversity, we can make deliberate efforts to mitigate the issues we are facing by allowing continued controlled outcrossing with our foundation registries and breeds to include the Australian shepherd and the Australian shepherd size variations. The goal is to promote genetic diversity and mitigate risks, while still preserving our breed standard. Striking a balance between AKC breed purity and genetic diversity is crucial for ensuring the long-term health and sustainability of the Miniature American Shepherd breed. By embracing an open stud book, we can better safeguard the future of this breed by *proactively* contributing to the long-term sustainability and welfare of our cherished Miniature American Shepherd.

*The Miniature American Shepherd breed was created with open stud books, has thrived for decades with open stud books, and can very well and easily be maintained with open stud book.*

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<sup>29</sup> Hedrick, P.W., Peterson, R.O., Vucetich, L.M. et al. Genetic rescue in Isle Royale wolves: genetic analysis and the collapse of the population. *Conserv Genet* 15, 1111–1121 (2014). <https://doi.org/10.1007/s10592-014-0604-1>