



Lathund regarding project for increased genetic variation



Hälleforshund is a numerically small Swedish breed that is primarily used for moose hunting. The breed originates from a litter of moose dogs that were born in the 1930s in the vicinity of Hällefors mill and was recognized as its own breed as recently as 2000. Within the breed, enrollment (dispensation registration) of breed-typical individuals is applied to ensure a long-term sustainable breeding with regard to genetic variation. Photo: Ulrica Nykvist.

Produced by SKK's breeding committee

2022-10-27

Table of Contents

Background	3
Mapping the current situation.....	3
Define the objective.....	4
Forms for the project	4
Exemption registration/enrollment	4
From race to variant of race	5
Intersection.....	6
Open studbook	7
Planning projects for cross-breeding.....	7
Crossbreeding or open studbook?.....	7
Identify suitable breeds	8
Requirements for breeding animals	8
How many cross pairings should be done?.....	9
Evaluation of the offspring.....	9
Planning and continuity for a successful project.....	9
Guidelines for the application for intersection projects	11



Gotlandsstövaren is our numerically smallest Swedish breed and has needed genetic addition from other dust breeds for increased genetic variation. Photo: Member photographer.

Background

Within some breeds, where a lack of genetic variation and/or widespread health problems make it difficult or impossible to achieve the desired breeding goals, the addition of genetic variation may be necessary for long-term sustainable breeding work. The great similarity in our dogs' genetic mass shows that methods to increase the genetic variation within our breeds is something we need to use to an increased extent in order to achieve a sustainable degree of genetic variation for the continued breeding work within some breeds. This is a conclusion also several breed clubs have landed in and more and more are coming to the SKK's breeding committee requests for help and support with the planning and implementation of intersection projects.

There are various approaches to, under controlled and well-planned forms, increasing genetic variation in a breed; such as dispensation registration, amalgamation of closely related breeds, crossbreeding and open stud book. Which approach is best depends on the breed's situation and conditions.

In this guide, a brief description of various possibilities for increasing the genetic variation in a breed is given and suggestions for implementation plans are given.

The SKK's Registration Rules (page 13) state the following: *"Breeding work is a creative and constructive activity that aims to maintain or develop the dog's characteristics. Within both numerically small and large breeds, breeding can lead to the loss of characteristics important to the breed or to the widespread spread of unwanted characteristics. The breeding work must then focus on a reconstruction of the breed. Crossbreeding with another breed is a method of reconstruction that can be used to increase the hereditary variation in the event of inbreeding depression or in the event of loss of important functions for the breed."*

Crossbreeding is not a new invention, but has been used to varying extents as a breeding method throughout the history of our breeds. In SKK's Dog Book from 1957, for example, the following can be read: *"The knowledgeable breeder, who is about to seek to improve an essential detail of his breed and finds that suitable material is lacking within the breed, should not hesitate to get what he needs from outside the breed"*.

In Sweden, crossbreeding has recently been carried out within, for example, our Swedish duster breeds and with clumber spaniels. Several other examples can be found in our Nordic neighboring countries. Crossbreeding with backcrossing to the original breed occurs regularly in many other domestic animals (such as pigs, cattle and horses) and is an accepted method of improving health and function.

Mapping the current situation **The**

first step is to make a mapping of the current situation in the breed with regard to genetic variation, general health status and possible signs of inbreeding depression.

Closed stud books mean breeding in a closed population, which over time invariably leads to increased inbreeding and reduced genetic variation. Please try, as far as possible, to investigate if there are health problems that are prevalent in the breed and if these could be linked to inbreeding/lack of genetic variation. It can be, for example, immune-mediated/autoimmune diseases or impaired fertility and reproductive capacity.

Inbreeding depression is a collective term for negative effects of inbreeding that mainly affect traits associated with reproduction and survival, so-called fitness traits.

Inbreeding depression can, for example, manifest itself as impaired fertility in the parent animal and impaired vitality and/or growth in the puppies. A tangible and measurable effect can be reduced litter size. See also the book Hundavel p. 130-131.

Determine and document which problems need to be solved and which features need to be improved.

Information from SKK Breeding Data, statistics from insurance companies (e.g. Agria Breed Profiles) and health questionnaires sent to owners of the breed can be used as a basis for a mapping.

Contact details for SKK's dog owner register for questionnaire surveys can be ordered via medlem@skk.se.

Information from genetic analyzes carried out at various laboratories may also be of interest (e.g. genetic inbreeding rates for individual dogs and/or mating combinations and molecular genetic analyzes of genetic variation/kinship within the breed).

In connection with the survey, it is advisable to also review and evaluate whether existing breeding strategies in the breed may need to be revised in order to maintain or increase genetic variation.

Sometimes there are opportunities for a more efficient use of genetic variation WITHIN the breed. Are there strict requirements and thresholds for breeding animals that result in many dogs being excluded from breeding? For example, there may be requirements for show merits, HD X-rays, etc. for registration and/or puppy referral, which means that a large proportion of the breed is excluded from breeding. It is appropriate to evaluate whether all requirements are justified and possible with regard to the breed's numerical and health status. What does the population of the breed look like outside of Sweden? Can the exchange of breeding animals between countries increase to obtain a larger breeding base?

Define the objective **The next step is to define the objective with the project.**

The objective can, in addition to increased genetic variation, for example be improved fertility, reduced occurrence of specific diseases, improvement of certain characteristics or reintroduction of characteristics that have been lost in the breed.

Also define which existing features are important to preserve.

For a broad anchoring of the project, it is recommended to try to get a large percentage of breeders and club members involved in this step, so that as many people as possible can agree on the breed's important characteristics.

Forms for the project **In what way can and should the project be best conducted?**

There are various approaches to introducing genetic variation into a breed, such as dispensation registration, merging of closely related breeds, crossbreeding and open studbook. These are briefly explained below. Which approach is best suited can vary between breeds depending on the situation and conditions.

Dispensation registration/enrollment In some cases there are unregistered individuals of a breed who can add valuable genetic information. For example, there may be dogs with incomplete pedigrees that do not meet SKK's requirements for registration in the regular stud book (SE register). These individuals can be registered after a special dispensation and represent a valuable addition to the breed. Currently, these individuals are registered in the SE register with incomplete

lineage. From 2024 onwards, it is hoped that exemption-registered dogs will instead be entered into SKK's X-register, then with more complete pedigree information.

The purpose of exemption registration, traditionally also called enrolment, is primarily to add presumably valuable breeding animals to the breed. According to SKK's registration rules, for a dog to be considered for exemption registration, it must "meet customary requirements for breeding such as being healthy with a good mentality and exterior, and genetically thought to be able to add the characteristics that the breed needs".

The application for exemption registration is submitted to the SKK's breeding committee, which assigns the relevant special club for an opinion. Decisions on exemption registration are made by SKK. The information that needs to be included in the application may vary depending on the purpose of the exemption registration. Dispensation can be given, for example, to enable the building up of breeds, in breeds where the breeding base has become too narrow or where important characteristics such as health or function need to be improved (see also SKK's Registration Rules).

In some breeds, exemption registration/enrollment has been used more frequently to reduce the risk of lack of genetic variation. An example is our Swedish Hälleforshund, where sampling of breed-typical individuals is applied to ensure long-term sustainable breeding with consideration of genetic variation. Even the Swedish white moose dog previously applied the recruitment of breed-typical white moose dogs. It is sometimes referred to as these breeds having an "open studbook", but the term in this case means enrollment/dispensation registration and not an open studbook in the sense intended in this Lathund (see further under the heading Open studbook further down).

From breed to variant of breed Another

option to broaden the breeding base could be to open up mating between closely related breeds by redefining the breeds as variants of the same breed, instead of separate breeds. There are several examples where different sizes and hair layers are defined as variants of the same breed, for example dachshund, poodle and Belgian shepherd.

By defining closely related populations as variants of a breed, instead of strictly separate breeds, it becomes possible for whoever wishes to use genetically valuable individuals from a closely related population in breeding. This without requiring any exemptions or special administrative measures.

This type of action is easier for our Swedish breeds and nationally recognized breeds than FCI-recognized ditto where an international consensus is needed. For our Swedish races, which are often made up of numerically small populations, we have the opportunity to control ourselves how strict we want and think we can afford to be with the concept of race.

Even for variants of a breed, there is often the possibility of maintaining separate breed standards and competing for separate certificates at shows. For FCI-recognized breeds, some variants of a breed are in the same standard (with the same FCI breed number) and in others they are separated by different FCI breed numbers. How the CACIB is awarded at international shows is governed by the FCI's categorization. Awarding of national certificates to different varieties of a breed is governed by the national kennel club. Here too different are applied routines in different races.

It is clear in the lineage of an individual, and in the case of a mating combination, which variant the individuals in question belong to. In this way, pairings between the different variants become transparent and well documented. Using individuals from different breed variants in your breeding work is of course highly voluntary.

Crossbreeding Crossbreeding, or crossbreeding, means the introduction of genetic variation and/or the improvement of characteristics through mating with another breed. The offspring in the first generation (F1) will receive half of their genetic mass from the original breed and half from the other breed (crossbreed). In future generations, backcrossing is then normally done to the original breed (F2, F3, etc.). For each generation, the genetic contribution of the crossbreed is halved. Generation 4 (F4) dogs will have 6.25% of their genetic mass from the breed used for the cross.

To achieve a long-term effect of inbreeding, it is not enough to carry out a few single cross-matings. As described above, the genetic contribution brought about by cross-mating will relatively quickly decrease over time with each passing generation. For a long-term effect on the population at large, repeated cross-mating needs to be carried out.

The application to carry out a crossbreeding project is submitted to SKK's breeding committee. In SKK's Registration Rules it is stated that the application to carry out a cross breeding "can be submitted by breeders, breed and special clubs. The application is made to SKK's Breeding Committee and must be submitted in good time, preferably no later than six months before the intended mating. Permission for cross-mating is granted after consultation with the breed and special club. Approval is not given retrospectively to a crossing made without a permit." For a long-term and successful crossing project, it is desirable that the breed club stands behind and develops a plan for the project, rather than it being carried out as single crossings initiated by individuals.

Offspring after approved cross-mating are registered in SKK's X-register. X-registered individual can be used in breeding provided that it meets the registration requirements for the breed in question (breed of origin). Offspring from X-registered dogs are registered in the X-register. After three generations of backcrossing to the original breed, the individuals will again be registered in the regular stud book (SE register), this in accordance with FCI guidelines.

X-registered dogs can participate and qualify in SKK's exhibition, test and competition activities on the same premises as the breed in question. However, a dog that does not have a complete pedigree in three lines cannot be awarded any of the international certificates (exhibition, test, competition) and consequently cannot obtain any of the FCI international champion titles. An X-registered dog can also have health results and results from mental description (MH and BPH) registered in the SKK's database in the same way as other dogs of the breed. This possibility is important so that the crossbred animals can be evaluated to guide the continued breeding work.



The dog in the picture, Spindel's Crossline, is the grandson of a clumber spaniel and a hunting cocker spaniel. Crossbreeding of cocker spaniels was done to add genetic variation to the numerically very limited breed of clumber spaniel. Photo: Annika Åkerman.

Open pedigree

Another way to add genetic variation through mating with another breed can be to, under controlled conditions, open the pedigree to one, or more, breeds.

Examples of breeds that apply an open pedigree are the miniature American Shepherd, which has an open pedigree against the Australian Shepherd, the miniature bull terrier, which has an open pedigree against the bull terrier, and the American Hairless Terrier, which has an open pedigree against the rat terrier. The exchange in an open stud book is usually unidirectional, i.e. breed A may be mated with breed B and the offspring are registered as breed A but not as breed B. According to this principle, for example, the offspring after a mating between miniature American shepherd and Australian shepherd will always be registered as miniature american shepherd and the offspring after a mating between american hairless terrier and rat terrier are registered as american hairless terrier.

Offspring after cross-mating in breeds with an open studbook are currently registered in the regular studbook. When SKK's X-register is updated, hopefully from 2024, offspring after cross-mating in breeds with an open stud book will be registered in the X-register. After three generations, the individuals will again be registered in the regular stud book (SE register), this in accordance with FCI guidelines. Offspring after cross-mating can be used in breeding, provided they meet the registration requirements for the breed in question.

In the event that mating between two breeds is sanctioned by the FCI, i.e. the breeds are included on the FCI's list of breeds that may be mated with each other, the offspring will be registered in the regular stud book (SE register). This is the case for matings between, for example, bull terrier/miniature bull terrier, griffon belge/griffon bruxellois/petit brabancon and Greenland dog/canadian eskimo dog.

Open studbooks can be an administratively simpler and more efficient way of adding genetic variation to the breed compared to crossbreeding. Provided that both breeding animals meet set requirements and recommendations, no application needs to be made before each individual mating. The procedure also gives greater freedom to the individual breeder to choose the appropriate mating combination.

In order to ensure that the additions made from another (or several other) breeds add good qualities to the breed, it is possible to place high demands on the individuals used. See further under the heading "Requirements for breeding animals" below.

Planning crossbreeding projects If you come to the conclusion that mating with another breed (crossbreeding or open pedigree) is the best method of adding genetic variation to the breed, there are several things to think about and decide on.

Crossbreeding or open pedigree?

As mentioned above, open studbook against one or more breeds can represent an administratively simpler and potentially more efficient way of adding genetic variation to the breed than crossbreeding.

Open studbook becomes less burdensome for everyone involved and gives greater freedom to both breeders and male dog owners. However, some clubs feel that it feels more controlled and perhaps less controversial to initially apply single crosses, and evaluate these, before considering possibly opening the studbook to one, or more, breed(s). Feel free to discuss the pros and cons of the various options within the breed club, with the special club concerned, the breeder of the breed and, if desired, also with the SKK office and breeding committee.

Identifying suitable breeds A

central question in a crossbreeding project is which breed(s) are suitable in terms of health status, behaviour, appearance and relatedness/genetic distance?

The project's objectives can provide guidance regarding the current breed/breeds. For example, if the goal is to only add genetic variation, one should look for a breed that is not too closely related, with few health problems. The breed(s) you choose should not have the same hereditary health problems/deficiencies as your own breed, but preferably the same or similar background/function.

Note that appearance/exterior traits are generally easier to restore after a cross than, for example, behavior/function, which has a lower heritability. In the selection of breed(s), the focus should therefore be on health, behavior and function rather than on appearance/exterior details.

If the crossbreeds differ greatly in size, matings should be made so that the female is of the larger breed and the male of the smaller breed. Regardless, the offspring are registered in the X register under the breed code the project refers to (the breed of origin).

Feel free to include breeders, male dog owners and puppy buyers in the discussions for a broad grounding in this central issue. Also the breed clubs and breeders/male dog owners of intended crossbreeds can add valuable information.

If the main purpose of the crossbreeding project is to add genetic variation, it may be of value, if possible, to map the relatedness/genetic distance between the own breed and other potential crossbred breeds/populations. SKK's breeding and health department can help with research contacts for this.

Requirements for

breeding animals What requirements must be placed on the breeding animals of the own breed or the crossbreed? This may apply, for example, to health, behaviour, function, age and evaluation of previous offspring.

In general, it is wise to place high demands on the individuals of another breed that are to be crossed into one's own breed. Here there are usually many potential breeding animals to choose from and you can "afford" to be picky.

- Choose individuals that have previously bred and are well evaluated.
- Feel free to choose slightly older breeding animals so that their previously produced offspring have also had time evaluated.
- Ensure that the dogs are clinically healthy and have had all the required tests and recommended within the current breed.
- Ensure that the dogs have the appropriate mental/functional characteristics.
- In addition to the above, you can consider also carrying out a DNA test in the form of a "panel test" regarding a large number of mutations. Although these tests are not normally recommended, in a crossbreeding project it can be a safety measure to reduce the risk of introducing unwanted disease predispositions into one's own breed.

The dogs of the own breed that will be included in the project should not be too closely related to each other. These individuals may also have had previous litter(s) and should of course meet the requirements that are normally placed on breeding animals of the breed.

How many crosses should be made?

As mentioned earlier, interbreeding with another breed is not a "quick fix". For a long-term effect on the population at large, repeated cross-mating needs to be carried out. An intersection project is a long-term project!

As it can be time-consuming for the people working on the project to plan, administer and inform about the project and about planned matings, it may be wise to plan and carry out one crossing at a time, but ensure the long-term continuity of the project over time. This includes, in addition to the fact that several crosses need to be made, to ensure that the offspring from the cross are evaluated and in turn proceed in breeding (provided they are deemed suitable). When the F1 generation has been evaluated and suitable individuals have continued in breeding, it is time to evaluate the F2 etc.

There is no exact answer to how many intersections need to be made for the project to have the desired effect. It depends on several factors such as the breed number, the purpose of the project and to what extent the crossbred animals produced in each generation are further used in breeding.

Evaluation of the offspring

Evaluation of the offspring from cross-mating is an important part of a cross-breeding project. Unless these individuals, from F1, F2, F3, etc., are evaluated and used in breeding, the project will have no effect.

An important task for the club will be to draw up guidelines for which requirements and recommendations should apply so that the offspring will continue to be current in the project. For example, there may be requirements for certain health examinations, function tests and/or mental descriptions.

A condition here is not to place unreasonably high demands on these crossbred animals for breeding. In general, higher demands should not be placed on these individuals than other dogs in the breed. Their most important contribution to the population is the new genetic variation they possess. A common pitfall in crossbreeding projects is that very few dogs from the F1, F2 and F3 generations go on to breed, whereby the effect of the crossbreeding becomes very small or non-existent.

The exterior of especially the first generation of crossbreeds (F1) will deviate from what is desirable. However, this is usually easy to deal with in later generations, thanks to the high heritability of exterior traits. Set no, or very limited, requirements on the appearance of dogs in the F1 generation, preferably also in the F2 generation.

Please determine already at the start of the project how the evaluation of the offspring will take place. What examinations should be done, should questionnaires be sent out for follow-up, if so at what ages? Be clear to both breeders, male dog owners and puppy buyers what is expected with regard to examinations and other follow-ups. It is of course also important that the offspring within the project are not castrated before evaluation and that they are made available for breeding if this becomes relevant.

Planning and continuity for a successful project **A**

crossbreeding project is a long-term project that requires planning, cooperation, perseverance and, not least, committed breeders who are willing to carry out the crossbreeding and puppy buyers who are prepared to take care of and evaluate the offspring.

For a successful project, good collaboration between breeders, male dog owners and breed clubs for the breeds in question is important. A common pitfall is that the genetic contribution to the breed that

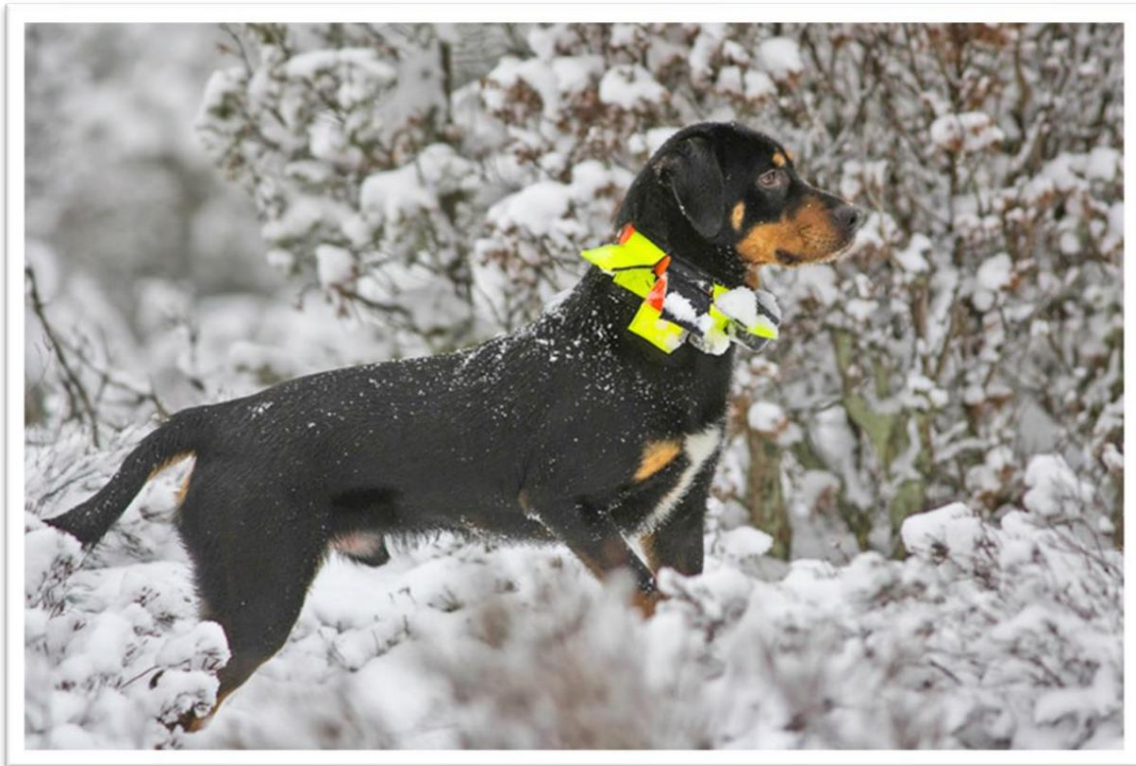
totality in the end becomes small, as only a single crossing is made, the offspring are not followed up sufficiently and, above all, are not further used in breeding to any greater extent.

In addition to the above, information and communication are an important part of the project. Understanding and anchoring the project are important pieces of the puzzle. A dialogue should be held not only in Sweden but preferably also internationally, not least with the breed's homeland. The key words should therefore be cooperation, communication, evaluation and perseverance!

On the next page there are guidelines for what an application for an intersection project should, in broad terms, contain.

Guidelines for applications for crossbreeding projects The application to carry out a crossbreeding project (such as crossbreeding or by opening the stud book) is made to the SKK's breeding committee, via the breed's special club. The application should contain the following parts:

- A survey of the current situation in the breed (mainly regarding genetic variation, general health status and possible signs of inbreeding depression). RAS may form the basis of this description.
- The objective of the intersection project.
- Describe how the project will be conducted, e.g. in the form of intersection, exemption registration, open pedigree or a combination of different measures.
- Selected breed/breeds for the project and justification for this/these.
- Describe the requirements to be placed on current breeding animals in the project, both individuals of your own the breed and the crossbreed(s).
- Describe how the offspring from crosses must be followed up and what requirements must be met that these should be able to continue breeding.
- Feel free to include a short description of how the project is to be communicated with and anchored with breeders, male dog owners and other members.
- Include an overview schedule for the project's implementation and follow-up.
- Statements from the special club must be included in the application.



Our Swedish Småland stövare is a numerically small breed within which crosses with other stövar breeds have been made for increased genetic variation and improvement of health characteristics. Photo: Member photographer.