NordGen

THE FIRST STATUS REPORT ON THE CONSERVATION OF FARM ANIMAL GENETIC RESOURCES (ANGR) IN THE NORDICS

40 years of Nordic collaboration in the conservation of Animal Genetic Resources

Content

FOREWORD

As the modern world evolves at a rapid pace, the importance of safeguarding and understanding the values of farm animal genetic resources becomes even more crucial. Native farm animal breeds have been an essential part of life in the Nordics, reflecting centuries of adaptation to this environment and specific human demands. These breeds have historically been important for human survival in northern conditions, and today their special characteristics are of great value for sustainable food production and other ecosystem services, helping to meet future unpredictable challenges.

Safeguarding conserved breeds goes beyond agricultural interests. The breeds have a unique genetic diversity (i.e., within and between breeds) and important ecosystem effects (e.g., by contributing to the overall biodiversity of the ecosystem), which is why it is an important commitment to preserve their biological diversity. Conserved breeds may often possess special characteristics that make them well-suited to local conditions, such as cold tolerance, disease resistance, and the ability to be productive and fertile on marginal lands. These traits make them valuable when facing climate change and the needs for sustainable agricultural practices.

At the Nordic Genetic Resource Center (NordGen), our mission is to contribute to the safeguarding of the Nordic genetic resources and facilitate their sustainable use for agriculture, horticulture and forestry for both current and future generations. We aim to provide up-to-date knowledge and genetic materials to facilitate sustainable food and feed production and other biobased solutions in the changing climate of the Nordic region.

This report presents the status of all Nordic native breeds and offers the first comprehensive overview of the 40-year journey in official Nordic collaboration for conservation Nordic farm animal genetic resources (AnGR). It examines the diversity, distribution, and conservation status of these farm animal breeds. By presenting the current methods used for conservation, it also highlights internal and external pressures in the Nordic region.

Conservation efforts over the past 40 years have been fruitful; thus, the report also showcases successful conservation efforts by various stakeholders. The differences in conservation strategies among Nordic countries are also reported, particularly the criteria for classifying breeds as protected.

We trust that this report addresses various needs for information and enhances understanding of the continuous necessity to protect native breeds and the critical importance of data collection in these efforts. Let this report inspire readers to recognize and promote the conservation of the national heritage of the Nordic countries.

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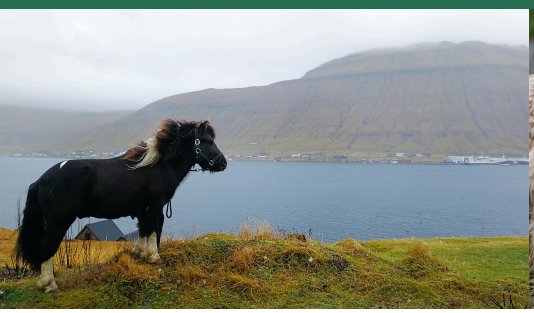
NordGen Farm Animals

October 10, 2024
Ås, Norway

CHAPTER 1

BACKGROUND



Left: Faroese horse **I** Middle: Danish Whiteheaded Marsh sheep **I** Right: Danish Blackspotted pig

The Nordic countries – Denmark (including Greenland), Finland (including Åland), Iceland, Norway, Sweden and the Faroe Islands – house a variety of farm animal breeds and subspecies native to the North. Throughout history, these traditional breeds have played a significant role in agriculture, companionship and warfare until commercial breeds were introduced (e.g. White *et al.*, 2024; Bläuer, 2015). These animals exhibit a rich historical heritage in the Nordic countries, and the earliest evidence of livestock in the area is from about 6000 years ago (Bläuer, 2015). Studies suggest that for example dogs were part of human communities as early as 9000 years ago (Hufthammer 2007; Fischer *et al.* 2007), but more surveys on early stages of domestic animals in Nordics are needed.

The importance of safeguarding the native breeds in the Nordic region was recognized long ago, and 40 years of collaboration has led to increased population sizes of various native breeds, an increased number of characterisation studies, and growing public awareness and interest in preserving these breeds. The Nordic native breeds are an important part of our history, and owners of Nordic animal genetic resources (AnGR) take great pride in their animals and their cultural importance. Therefore, the Nordic native breeds and subspecies today are important reservoirs for the overall animal genetic diversity.

The official Nordic collaboration to safeguard these animal breeds started in 1984 which has contributed to the survival to many of the breeds. Despite various success stories in conservation, most populations of the native breeds in the North face the threat of extinction and are vulnerable to both external and internal pressures. These include emerging diseases (e.g., the bird flu in Finland, the African swine fever outbreak in wild boars in Sweden, and scrapies influencing sheep

industry in Iceland), natural disasters (e.g., Iceland has recently been threatened by earthquakes and volcanic eruptions), and risks related to loss of genetic variation.

Animal production systems are constantly changing, and Europe, including the Nordic countries, are relying heavily on only a few production breeds. The trend of using fewer production breeds contributes to loss of genetic diversity within food production systems (FAO, 2007). Strengthening the conservation of Nordic AnGR is vital for both the survival of the breeds and subspecies, and for future ecological sustainability.

In this report we aim to present the status of all the Nordic native breeds and highlight their importance and positive uses in production. We also aim to discuss current methods for conservation, and to identify internal and external pressures. Conservation efforts during the last 40 years have not been in vain, and therefore we will also present positive stories that have resulted from the important work that has been carried out by various important stakeholders.

CHAPTER 2

POSITIVE USES OF THE NATIVE BREEDS

Left: Animal assisted activities | Middle: Eastern Finncattle | Right: Icelandic landrace chicken

The Nordic native production and companion animal breeds have a long co-existence with humans. Subsequently, they are all also an invaluable part of the social-economic history in the Nordic countries. Long periods of adaption in the North have made the native breeds well adapted to seasonal changes of the weather which has provided them with several favourable characteristics that are important when facing future challenges. Studies have identified several genomic regions under selection that may have contributed, for example, to the adaptation of the native cattle breeds to the northern and subarctic environments, including genes involved in disease resistance, sensory perception, cold adaptation and growth (Ghoreishifar *et al*, 2020; Weldenegodguad *et al*., 2019).

Alongside their adaption to the Nordic climates, their historical significance, and their traditional roles in food supply and security, native breeds may also have important contribution to landscape management, trademark food production (e.g. ice cream production from Northern Finncattle milk), education, tourism, and animal-assisted therapy (Tudor *et al*, 2023; Karja and Lilja 2007; Finnish Food Authority, n.d.). Reinventing uses of the native breeds and sharing their positive attributes could help broaden the opportunities for local economy and increase the interest in keeping the breeds.

The unique characteristics of the Nordic native breeds offer possibility to boost the local economy in various ways. Advertising local food resources e.g., special quality meat and cheese could increase public interest in the products and possibly increase tourism. Utilising the native breeds in education, competitions or for

animal-assisted therapy could also provide another source of income. In addition, with new technical aids such as virtual fencing, grazing animals such as sheep and goats can be rented out to maintain cultural biotopes, which could boost farmer economy while sustaining biodiversity.

2.1 Social acceptance

The gentle temperament of many of the native breeds make them easy to handle and therefore useful for education and animal assisted therapy (Karja and Lilja, 2007). Native horse breeds are useful to use in riding schools and possibly in higher education in terms of animal care, health and veterinary sciences. Further, they are often described as highly suitable for children (Soini and Lilja, 2014). A study from Finland has highlighted that equine activities reduce the incidence of social exclusion, and this can also be argued for in different dog breeds. Joining activities such as agility or obedience training allows the public (and their dogs) to learn new things and to be social. Studies have shown that owning companion animals can help boost our mental and physical health (for example Levine *et al.*, 2013, Martins *et al.,* 2023; Wells, 2009; Beets *et al.*, 2012; Ravenscroft *et al*, 2021). Owning or taking care of animals that require physical activity motivates keepers to get up and out, it also teaches children responsibility. Characteristics such as gentle temperament and being easy to handle are highly desired in families with small children and participants in sports – this makes some of the native breeds especially suitable.

2.2 Healthy and robust animals that can help maintain cultural biotopes and local biodiversity

Adaption to local pathogens

Resilient animal populations and their ability to sustain biodiversity of both flora and fauna, are crucial features for the Nordic native breeds. Native local breeds are known to be versatile and more resilient against pathogens. This could relate to the resource allocation theory – i.e., high yielding animals have been bred to allocate more resources to production, thus perhaps having less resources for other processes in the organism such as immunological processes (e.g. Rauw *et al.* 1998). Furthermore, generations of natural selection have provided the native breeds with resilience against local pathogens, which can reduce the need for veterinary intervention and culling related to epidemics. For example, the Icelandic sheep breed is known for its resistance to scrapie, a fatal, degenerative disease comparable to mad cow disease in cattle and Creutzfeldt-Jakob disease in humans (Igel *et al.*, 2023).

The role of grazing animals in biodiversity and ecosystem sustainability

Various grazing animal species (cattle, sheep, goats and horses) can be used for grazing areas that are no longer useful in current farming systems. By utilising this opportunity, farmers can save money on feed while preventing plant overgrowth and thus contribute to maintaining ecological biodiversity (e.g. Jeffreys, 1999). Several studies have highlighted the differences in grazing patterns between native and commercial farm animal breeds: For instance, evidence suggests that commercial breeds such as the Norwegian Red and Holstein prefer more energy-dense pastures, whereas native cattle breeds exhibit more varied grazing patterns (Sæther *et al*, 2006). Additionally, native breeds like the Swedish Mountain cattle (Fjällko) have been observed to walk 25% longer distances than Holstein cows (Hessle *et al.*, 2014). Recently several cities and NGOs in Finland have launched public projects utilizing farm animals in management of invasive plant species. Moreover, some urban areas including seaside meadows have been maintained with grazing for some time now (HEL-RESU, 2024; Suomen ympäristökeskus, 2022; Niemelä, 2012; Haapaniemi *et al.*, 2012; Lassheikki, 2021; Pennanen, 2021). Grazing not only controls invasive species, but balanced grazing can also promote overall biodiversity (United Nations, 2015; Hirvonen *et al.*, 2021). Especially in areas where those plants have spread widely, grazing native breeds can prevent their spread and even destroy already existing vegetation.

Balanced and varied grazing is important for the sustainability of ecosystems: Grazing animals are essential for maintaining biodiversity by directly influencing the composition of plant communities on grassland and the growth of green biomass (Fraser, Vallin and Roberts, 2022). Innovations such as virtual fences allow cows, sheep and goats to graze in otherwise unapproachable areas, and subsequently prevent plant overgrowth, as well as control weeds and invasive species. By utilizing different grazing areas according to their preference, the grazing animals also create favourable conditions for the formation of habitats for various animals including endangered birds, small mammals, and invertebrates (Bele *et al.,* 2018). This means that, when they are managed properly, these animals not only contribute to maintenance of biodiversity, but also enhance soil health both chemically and mechanically (Hall, 2018). Improved soil health will in turn increase sequestration of greenhouse gases and positively influence water infiltration and filtration – promoting improved water quality and reducing the risk of flooding and soil erosion (Hall, 2018). Importantly, grazing also enhances the health and wellbeing of ruminant and equine farm animal species themselves because it is an important part of their natural behaviour.

2.3 Commercial values of unique characteristics related to production

Milk components

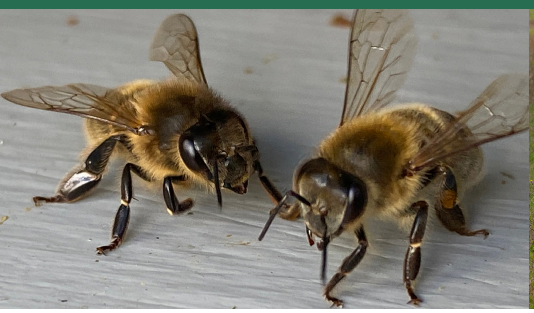
Growing interest in the native dairy cattle breeds have led to new characterisation studies, and in turn, these research findings have further boosted the breeds' popularity. In 2021, Sunds *et al.* studied and compared milk oligosaccharides yielded in milk from native dairy cattle from Norway, Sweden, Denmark, Iceland, Lithuania and Finland with commercial breeds, and identified eight unique monosaccharide compositions and various isomers. They further found that dairy breeds native to Finland, Iceland and Norway produce milk with high contents of oligosaccharides that can help fight against gut-bacterial infections, which can be especially useful when creating formula for infants. In addition, ongoing Norwegian research related to milk immunological components has recently revealed promising preliminary results in milk of two native cattle breeds (Devold and Olsaker, 2023). The influence of these immune cells for the consumers have yet to be determined. Another recent study has also found that the variation of αs1-and αs2-casein, β-casein A1 and κ-casein B is larger in the native breeds than in the commercial Norwegian Red, and further that the milk from these old breeds have better renneting properties (Inglingstad *et al.*, 2024). Therefore, keeping the old native Norwegian breeds in dairy production could be of great importance for future cheese production. This also promotes the possibility of a more diverse production system where the native dairy breeds can be utilised for cheese-production, which can also create new possibilities for local economy through niche cheese-products.

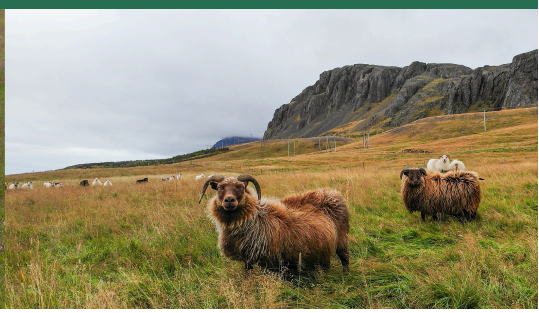
Meat components

Besides exhibiting desirable characteristics in dairy products, native cattle breeds also have a desirable carcass composition. For example, a recent study suggest that Norwegian native cattle breeds have higher iron content in their carcass, and that most of them have better quality meat than the commercial Norwegian Red cattle (Sambugaro *et al.*, 2024). These characteristics can be commercialised and create an improved market for sustainable production of meat from native breeds.

CHAPTER 3

CONSERVATION





Left: Nordic Brown bee **I** Middle: Jutland cattle **I** Right: Icelandic sheep

Organised conservation efforts for animal genetic resources have been present in the Nordics since the 1980s. Different areas of responsibilities are divided between various stakeholders, including governmental sectors, advisory organisations, agricultural and genetic research institutes, and breeding organisations and associations. It is a commonality between all the countries that the governmental sector and agricultural/genetic research institutes carry an advisory or coordination role concerning conservation, while the breeding organisations carry out the practical breeding and record keeping. Farmers play a key role in conservation as they are the ones who use their resources to maintain the breeds – without the participation and enthusiasm from them, *in situ* conservation would not be possible.

Each country has different policies for which breeds are included in their national conservation work (Table 1). The conservation strategies and subsidy policies are outlined and overseen by different authorities. There are two main methods for conservation – *in situ* (live conservation in place of origin) and *ex situ* (conservation in the form of either live gene banks or cryoconservation). The methods have both advantages and limitations (thoroughly described by FAO), but these can be overcome when applied in a complementary manner. In the past, the Nordic countries focused mainly on maintaining live populations, but increasing pressures related to poorer population status and lower genetic variation, climate change and a range of anthropogenic factors (see section 3.1 and 3.2) have led to the implementation of cryoconservation efforts as recommended by FAO (Boes *et al.*, 2023).

Table 1: Conservation strategies and subsidy policies for each of the Nordic countries

Country	Conservation strategy or action plan	Activities applies to	Subsidy policy	Authorities involved in policies
Denmark	Strategi for Bevaringsudvalgets arbejde med husdyrgenetiske ressourcer – Vision, Mission og Mål 2016-2020.	Old Danish Animal Genetic Resources	Grants to preserve old Danish plant and animal genetic resources.	The Ministry of Food, Agriculture and Fisheries
The Faroe Islands	Action plan for Faroese horse	The Faroese horse	Some subsidies to keep the Faroese horse	Búnaðarstovan - The Agricultural Agency of the Faroe Islands
Finland	Suomen maa-, metsä- ja kalatalouden kansallinen geenivaraohjelma. (2018-12-18).	Purebred native animals such as Finncattle breeds, Finngoat, Finnsheep, Åland sheep and Kainuun grey sheep, Finnhorse and Finnish landrace chicken.	Breeding and maintaining purebred animals of the native breeds. Contracts are issued on a one-year basis.	Ministry of Agriculture and Forestry of Finland, the Finnish Food Authority. Centre for Economic Development, Transport and the Environment (ELY). Natural Resources Institute Finland
Iceland	The conservation plan for the Icelandic goat (2012). The national action plan for conservation of genetic resources in Icelandic nature and agriculture (2024-2028).	Icelandic goats, leader sheep, the Icelandic sheepdog, and Icelandic poultry	Icelandic goat (for winterfed animals)	The Ministry of Food, Agriculture and Fisheries, the Genetic Resource Council.
Norway	Handlingsplan for bevaringsverdige husdyrraser i Norge 2021-2025, Nasjonal tiltaksplan for bevaring og bærekraftig bruk av genetiske ressurser for mat og landbruk 2023.	Only breeds that are categorised as native and endangered are included in the conservation program.	Subsidies for endangered native breeds of cattle, sheep, goats and horses. Living poultry gene bank. Conservation herds for goose.	Norsk genressurssenter, Landbruksdirektoratet
Sweden	Bevara, nyttja och utveckla – handlingsplan för uthållig förvaltning av svenska husdjursraser 2023-2027.	The action plan applies to all species and breeds within the Swedish conservation responsibility (i.e., breeds that are listed in the action plan - breeds that fulfil the 7 criteria set up in the Action plan.	Subsidies available for cattle, pig, goat, sheep, horse, bee, rabbit and poultry breeds that are considered within the Swedish conservation responsibility.	Jordbruksverket

3.1 External pressures influencing live populations

Economy

The economy of the keepers of the Nordic native farm animals, including native breeds, influences the ability to both care for and manage the populations in the best way possible. Consequently, finances play a large role in the carrying capacity of farms. The economic value of a breed usually takes priority over other values such as sustainability and culture. Therefore, keeping native breeds is often not profitable because cultural values are rarely recognised by markets despite the many benefits they offer to both the community and ecosystems. Conservation of native breeds therefore largely depends on voluntary work and special interest in a specific breed. A survey of Finnish farmers indicate that finances play a crucial role in the feasibility of keeping native breeds (Ovaska *et al.*, 2021). While subsidies are provided for keeping native breeds in most of the Nordic countries, there have been listed challenges to these systems. For example, in Finland, farmers stress excessive bureaucracy, scarcity of subsidies and laborious requirements (e.g., having to report information to several registers).

Changing climate – changing transmission patterns of diseases and influencing natural disasters

Climate change, influencing feed availability, transmission patterns of diseases and migration patterns, is predicted to have more extreme effects in northern latitudes (European Commission, n.d; IPCC, 2021). This will likely affect the carrying capacity of the environment and increased pressures from both competition for feed resources and more unpredictable infectious diseases threatening the populations of the Nordic production animals. Changing climates influence the migratory patterns of vectors such as slugs, insects and wild birds, which influences the infectious disease transmission patterns. Global warming can increase the rate of development of important arthropods that act as vectors and alter their migration patterns. Events of important diseases becoming more prominent during longer periods of heat has for example been shown in Europe in 2018, when the incidence rate of West Nile virus increased in the Mediterranean, and the disease was identified in Germany for the first time (Frank *et al.*, 2022). Further, more humid climates create desirable habitats for slugs, which act as intermediate hosts for problematic parasites (CDC, 2019; Konecny, 2022). Several of these pathogens can be transmitted across species and are sometimes zoonotic; their impact can be detrimental to production animals, companion animals and humans.

Natural disasters

Natural disasters – floods, wildfires, volcanic eruptions, earthquakes, etc. – threaten biodiversity especially by influencing the habitats of animals. Continuous severe disasters in the same place, can cause irreversible damage, and thus render a previous habitat inadequate. The Nordic regions also face the threat of natural disasters and extreme weather events such as storms, floods, droughts, and fires. The native breeds of Iceland are especially vulnerable due to volcanic eruptions and earthquakes.

Public unrest and warfare

Wars have had devastating effects on local livestock. During WWII, for example, many livestock were lost. In Finland, this accelerated the extinction of the Finnish landrace pig breed considerably. Even today, public unrest and warfare can severely threaten the conservation of native breeds. Conflicts can lead to depletion of resources, erosion of infrastructure and distribution of conservation practices, worsening challenges these breeds already face.

3.2 Loss of genetic variation influencing live populations

Genetic variation is necessary for populations to cope and adapt to the continuously evolving pressures of their environment. Subsequently loss of genetic variation driven by factors such as high selection intensity, inbreeding, and consumer preference results in reduced resilience, decreasing their ability to respond to changing climates, emerging diseases, and shifts in consumer demands. In addition to genetic drift and inbreeding depression, population management can have shortcomings in initial genetic characterization and lack of consistent follow-up of genetic structure. An essential way to mitigate the risk of inbreeding depression is the application of breeding strategies that include the maintenance of genetic variation within the populations.

Managing the various Nordic AnGR populations in a sustainable way is vital to ensure their long-term conservation. For a conservation strategy to be appropriate for a given breed, it is essential to evaluate the breed's genetic diversity. Different parameters can be used to describe genetic diversity or genetic variation, including marker-based and pedigree-based methods. Inbreeding rate and effective population size (N_e) are considered the most suitable. There are different ways of calculating these parameters, which influences the threshold of what is acceptable or not. However, there is a consensus that the inbreeding rate per generation should be below 1%, and that the N_e should be at least 50-100 for the population to be sustainable and above 500 for future evolutionary potential. If the N_e is below 50, the risk of reduction in genetic variation and inbreeding depression

increases. This increases the risk of infertility and poorer overall health and performance reducing their resilience.

Inbreeding will occur and rise in closed populations where related animals are mated. The rate of inbreeding per generation (i.e., how quickly the inbreeding increases) influences the population fitness, which is why the establishment of informative and adequate management strategies that consider genetic variation is essential for ensuring sustainable populations. Improvement in management strategies and tools for controlling inbreeding such as optimum contribution selection (OCS) and the EVA program have largely contributed to reductions in the generational inbreeding rates for various populations (including the Jutland horse, the Jutland cattle and the Faroese horse).

Most of the Nordic breeds have a small population size and or have gone through historical bottlenecks which has led to higher rates of inbreeding. In some Nordic populations the inbreeding rate has been successfully managed, and there is minimal increase per generation. A few examples are the Norwegian Dole horse, the Fjord horse and the Nordland/Lyngen horse (Norsk Hestesenter, 2022).

CHAPTER 4

THE STATUS OF THE NORDIC NATIVE BREEDS

Left: Puffin dog I Middle: Finnish Landrace chicken I Right: Danish Landrace goat

4.1 Materials and methods

Status of the populations

The Domestic Animal Diversity Information System (DAD-IS), hosted by the Food and Agriculture Organization of the United Nations (FAO) was investigated to determine the current status of the Nordic breeds. The data was extracted from DAD-IS 04.06.2024. We extracted population data from 2004 to 2024 and the current risk status for local breeds in Denmark, Sweden, Norway, Finland, Iceland and the Faroe Islands. For breeds that were not available or that lacked updated information in DAD-IS, we collected external information about their population size where it was available from sources such as breeding organisations, national reports, online databases and scientific articles.

Information concerning cryoconservation for each of the countries was extracted from DAD-IS 19.06.2024. The extracted data included reported numbers from the 2007 to 2024 at the latest. The total number of samples were interpreted to be the last reported number into DAD-IS.

Available genetic parameters

Available reports for both inbreeding parameters and effective population sizes were used as the primary source of information. For breeds where no updated reports were available, a thorough investigation of the web using both breed-wise (1) and species-wise (2) searches in both English and Nordic languages was conducted:

1. **Breed-wise:** Breed name + inbreeding; breed name + effective population size.
2. **Species-wise:** Native species + inbreeding; native species + effective population size.

Evaluation of the data

Most of the breeds (82%) had at least one entry of population size in DAD-IS, and information regarding the current population was collected for another 11% of the breeds using additional sources (Figure 1). 77% of the breeds had updated population data from the last three years (2021 or newer), while 16% had either no data or data older than 10 years (Figure 2). When looking at the distribution of data based on species (Figure 3), all the sheep, cattle, horse and goat breeds are represented in DAD-IS, while 52% of the dog breeds have recorded information. Contrastingly, all the dog breeds have available population data online in other sources. For instance, the number of puppies registered each year are reported by either breed associations or the national kennel clubs. Cats are not considered as production animals by the FAO, and do not have any entries into DAD-IS. For the poultry, pigeon and rabbit breeds, 80-90% of the breeds are represented in DAD-IS, however, the information from these species is often scattered or not recently updated (Supplementary 1, Table A-G). Some of the transboundary breeds might have been represented in DAD-IS in one country and not the other it belongs to and so the data had to be complemented using external sources.

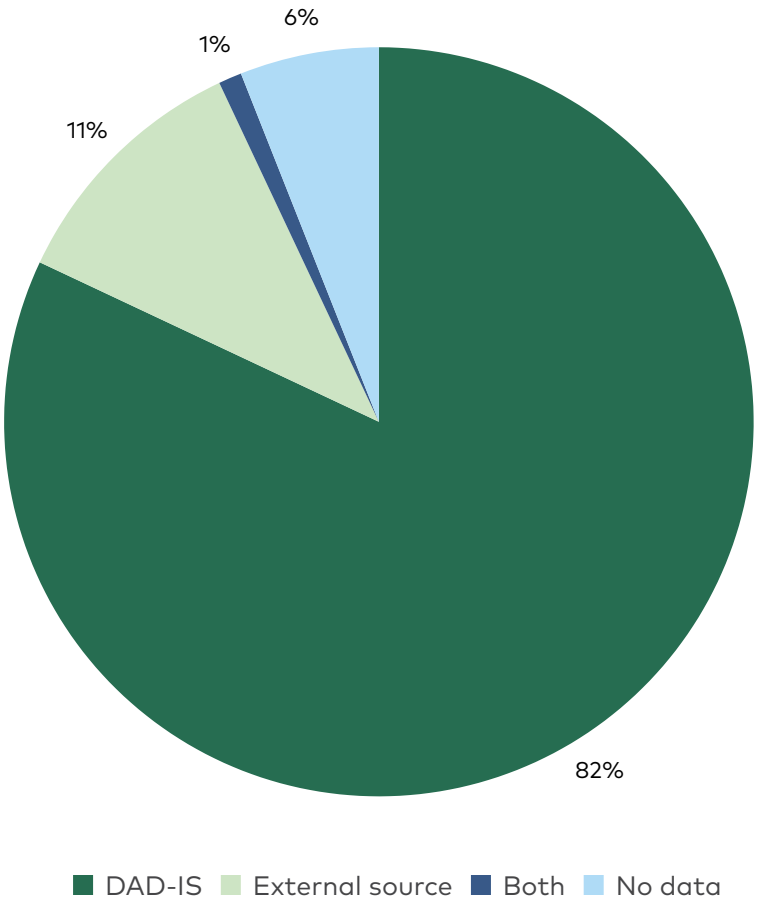


Figure 1: The percentages of breeds with population data divided according to source material (i.e., DAD-IS, external source, both, no data).

'Both' indicates breeds where there are not sufficient data in DAD-IS and it has been complemented with information from an external source and 'no data' indicates that no information was available through either DAD-IS or other sources.

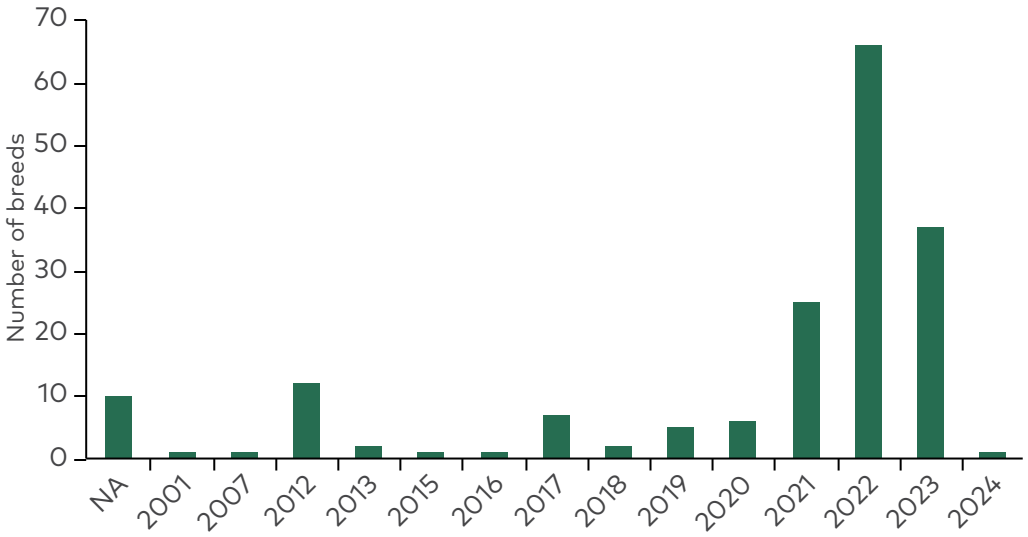


Figure 2: Distribution of which year the last updated population data were found for each breed.

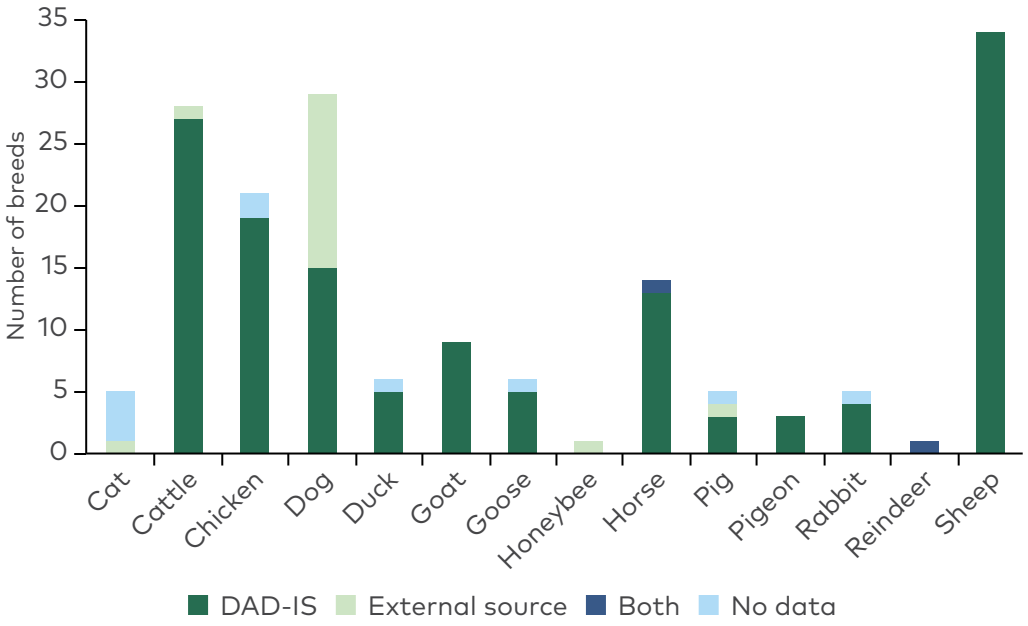


Figure 3: Data sources by species.

4.2 The Nordic native breeds – overall status

There are 167 native breeds in the Nordic region. The majority of them are native to Sweden (67) followed by Norway (43), Denmark (25), Finland (16), Iceland (7) and the Faroe Islands (4), while five breeds/subspecies are considered transboundary in the Nordic region. Sheep, dogs, cattle and chickens have the largest proportions of breeds (34, 29, 28 and 21 breeds, respectively) (Table 2, Figures 4 and 5).

Table 2: Number of breeds per species and country.

Species	Denmark	Faroe Islands	Finland	Iceland	Norway	Sweden	Transboun	Total
Cat			1		2	2		**5**
Cattle	6		4	1	7	9	1*	**28**
Chicken	1		1	1	5	13		**21**
Dog	4		5	1	7	10	2	**29**
Duck	1	1				4		**6**
Goat	1		1	1	2	4		**9**
Goose	1	1			2	2		**6**
Honey-bee							1	**1**
Horse	3	1	1	1	4	4		**14**
Pig	2				1	2		**5**
Pigeon	3							**3**
Rabbit	1				1	3		**5**
Reindeer							1	**1**
Sheep	2	1	3	2	12	14		**34**
Total	**25**	**4**	**16**	**7**	**43**	**67**	**5**	**167**

* In this table, transboundary breeds are counted only once across all countries (and not within the countries) to avoid double counting. For number of breeds per country including transboundary breeds, see section 4.4. The exception is VikingRed as it is based upon three different native breeds (i.e., the Swedish Red, Danish Red and Finnish Ayrshire; see section 4.4).

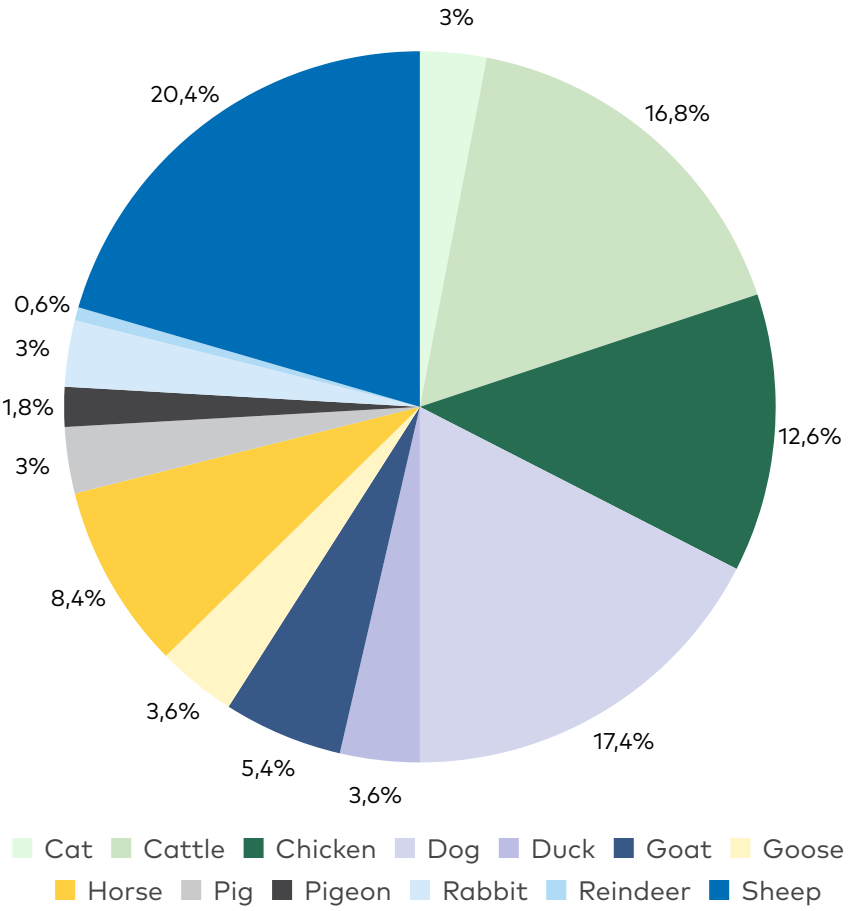


Figure 4: The distribution of breeds within each species in the Nordics. Total number of breeds: 167.

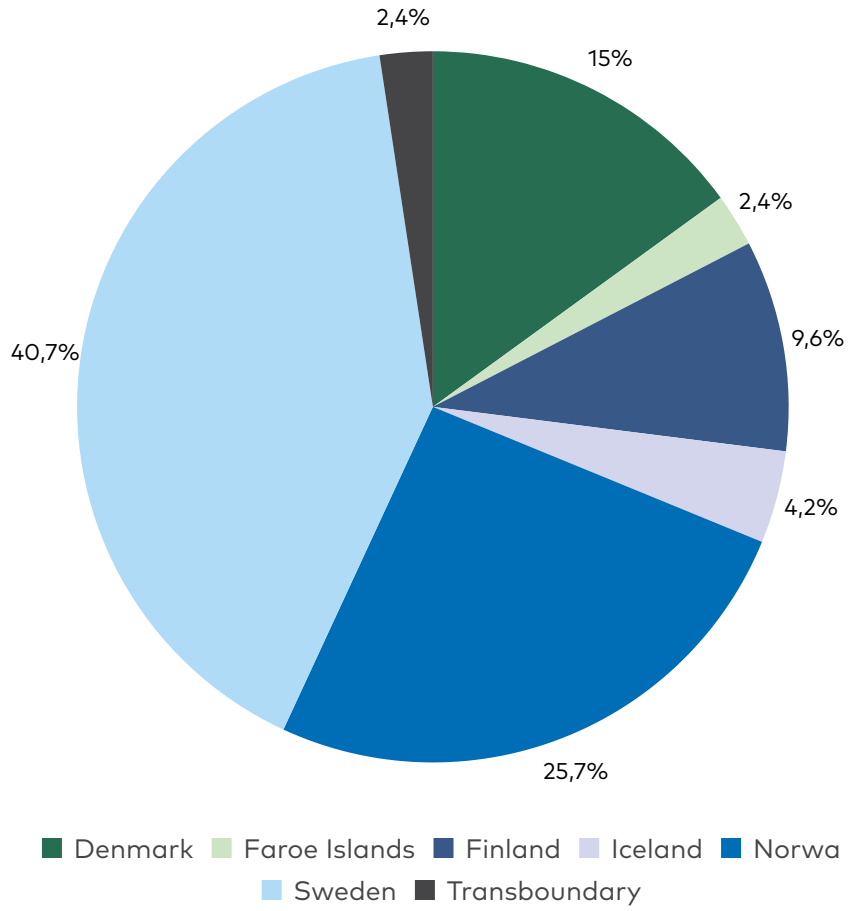


Figure 5: The distribution of breeds within the Nordic countries. Total number of breeds: 167.

FAO uses the number of breeding females and males as the criteria for deriving the risk status of a breed (Figure 6). The risk statuses of the breeds for this report (except for the brown bee) were based on DAD-IS, where the definition of number of females differs according to country (i.e., some use the total number of females, while others use number of females of reproductive age, or the number of females that had offspring). While there is a large variety of native breeds within the Nordic region, most of them are at risk. According to the DAD-IS only 23 breeds can be categorized as "not at risk" of extinction. The remaining 144 breeds are either categorized as "vulnerable", "endangered", "critically endangered" or "undetermined" (9, 84, 35 and 16, respectively; Figure 7A).

Repro-ductive capacity	Males (n)	≤100	101-300	301-1000	1001-2000	2001-3000	3001-6000	>6000
High*	≤5	C	C	C	C	C	C	C
	6-20	C	E	E	E	E	E	E
	21-35	C	E	E	V	V	V	V
	>35	C	E	E	V	N	N	N
Low**	≤5	C	C	C	C	C	C	C
	6-20	C	C	E	E	E	E	E
	21-35	C	C	E	E	E	V	V
	>35	C	C	E	E	E	V	N

Figure 6: Parameters for assigning risk categories according to FAO-guidelines (FAO, 2013).

- Red: critical (C)
- Orange: endangered (E)
- Yellow: vulnerable (V)
- Green: not at risk (N)

* High reproductive capacity species = pigs, rabbits, dogs and poultry species
** Low reproductive capacity species = horses, donkeys, cattle, yaks, buffaloes, deer, sheep, goas and camelids

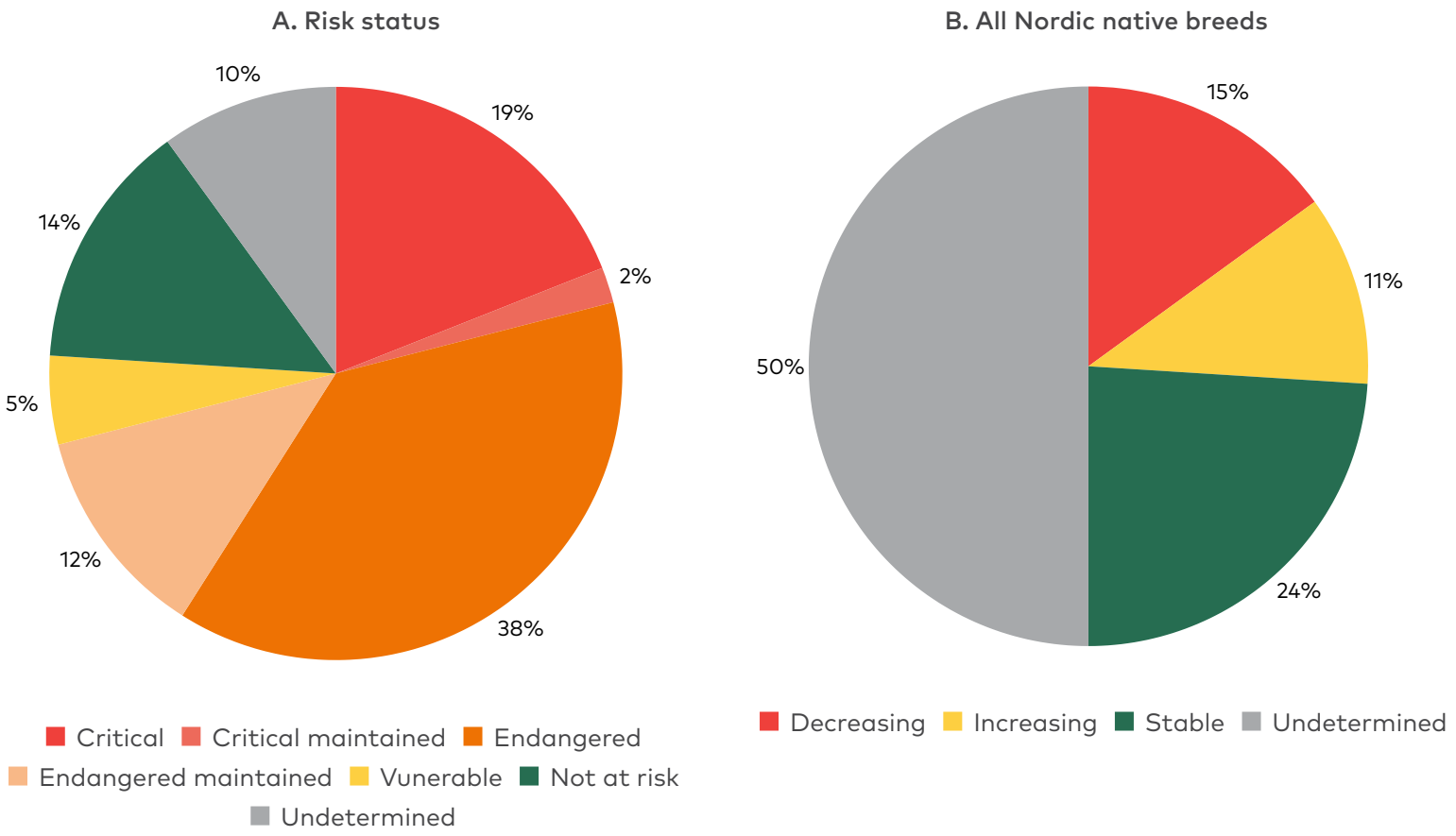


Figure 7: Risk status and developmental trends of the Nordic native breeds.
The figure illustrates the risk status (A) and the developmental trends (B) of all the 167 Nordic native breeds. Maintained indicates that the breeds are part of a conservation programme.

The population developmental trends of the different breeds are variable between and within species and different countries. Based on the data available from DAD-IS the population trends of the native breeds were determined as "increasing", "decreasing", "stable", and "undetermined" (insufficient information). 50% of the breeds did not have information on trend registered in DAD-IS (Figure 7B). While 11% and 24% of the breeds are either increasing or stable, 15% of the breeds have a declining population trend.

4.3 Country-wise risk status of the Nordic native breeds

Denmark – native breeds, subspecies and their risk status

Denmark houses 27 breeds, including the transboundary breeds Nordic Brown bee, Danish-Swedish Farmdog and Danish Red dairy cattle with their contribution to the VikingRed cattle breeding program (Table 2). The majority of the breeds are either endangered or critically endangered by extinction, highlighting the necessity for continued conservation of the Danish native breeds (Figure 8). Only the Danish population of VikingRed is considered not at risk in Denmark (Figure 8).

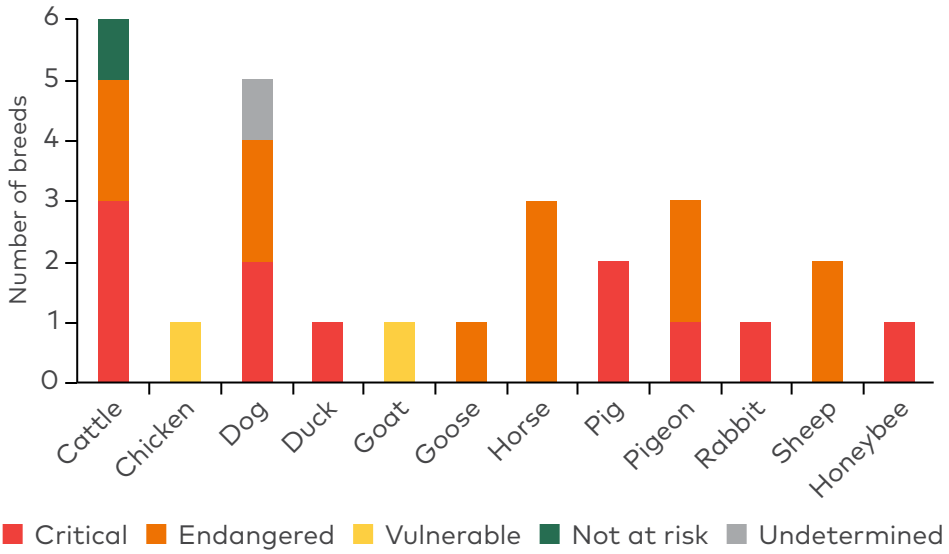


Figure 8: Number of breeds per species and their risk status for Denmark.
Total number of Danish breeds, including transboundary breeds: 27.

Greenland

The livestock in Greenland are mainly based on mixes of imported breeds. For example, the Greenlandic sheep is considered a descendant of the Icelandic sheep (Bojesen and Olsen, 2019). The exception is the Greenland Dog that is considered its own breed. Although not part of the Danish conservation program, the Greenland Dog is included in the statistics for Denmark, as the breed is under the Danish Kennel club's responsibility according to the Nordic Kennel Union. The Greenland dog does not have data registered in DAD-IS, however, Statbank Greenland[1] has statistics on the total number of sled dogs in Greenland, which is the number used in this report. Although this number is well above what is considered "not at risk" (13 123 sled dogs in 2022), we cannot validate how many of these sled dogs belong to the Greenland Dog breed, and thus the breed has been categorised with an "undetermined" risk status. The numbers are also declining each year which indicates that there could be a risk to the breed in the future (Supplementary 2, Table 1).

1. https://bank.stat.gl/pxweb/en/Greenland/

The Faroe Islands – native breeds and their risk status

The Faroe Islands house four native breeds. Like Denmark, only one of the breeds (Faroese sheep) is not at risk of extinction. Further, one breed (the Faroese horse) is critically endangered, and the remaining two (the Faroese duck and Faroese goose) breeds have an undetermined status (Figure 9). However, it is likely that the status of the poultry breeds is critical as well, and the fact that they do not have records of the populations is a risk factor in itself. The Faroese horse is vulnerable to both loss of genetic variation and external pressures, as its live population consists only of 82 individuals. Measures are currently being taken to conserve this breed: an action plan has been published, semen for cryoconservation have been collected and a new project for transferring embryos across borders have been initiated in the attempt to maintain and hopefully to increase both the breeding population size as well as its genetic diversity.

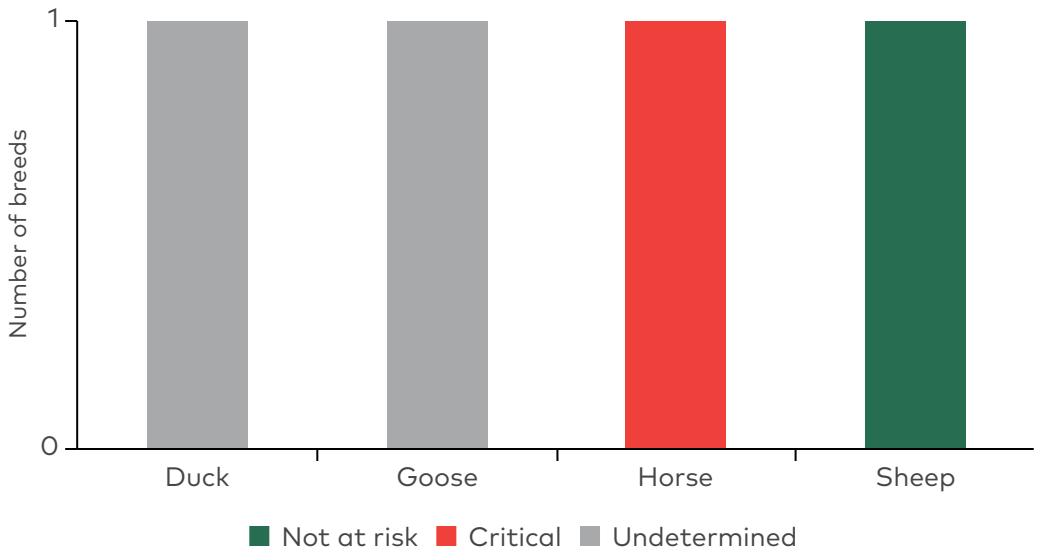


Figure 9: Number of breeds per species and their risk status for Faroe Islands.
Number of breeds: 4.

Finland – native breeds, subspecies and their risk status

Finland hosts 18 breeds, including the transboundary breeds the Nordic Brown bee, the Fennoscandian reindeer, and the Finnish Ayrshire with their contribution to the VikingRed breeding program (Figure 10). Of native breeds only two populations are not at risk (the Finnish landrace chicken and Finnsheep; Figure 10). All of the cattle breeds are endangered, but they are also maintained in conservation programs according to the data provided in DAD-IS. The Finnish sheep breeds appear to be doing the best, with two breeds that are vulnerable and one that is not at risk. Most of the remaining breeds (the Finnhorse with its four lineages, Finngoat, and four of the native dog breeds) are considered endangered in terms of the annual number of breeding females, while the Finnish landrace cat has an undetermined status since it is not included in the Finnish conservation program and has no official registration system.

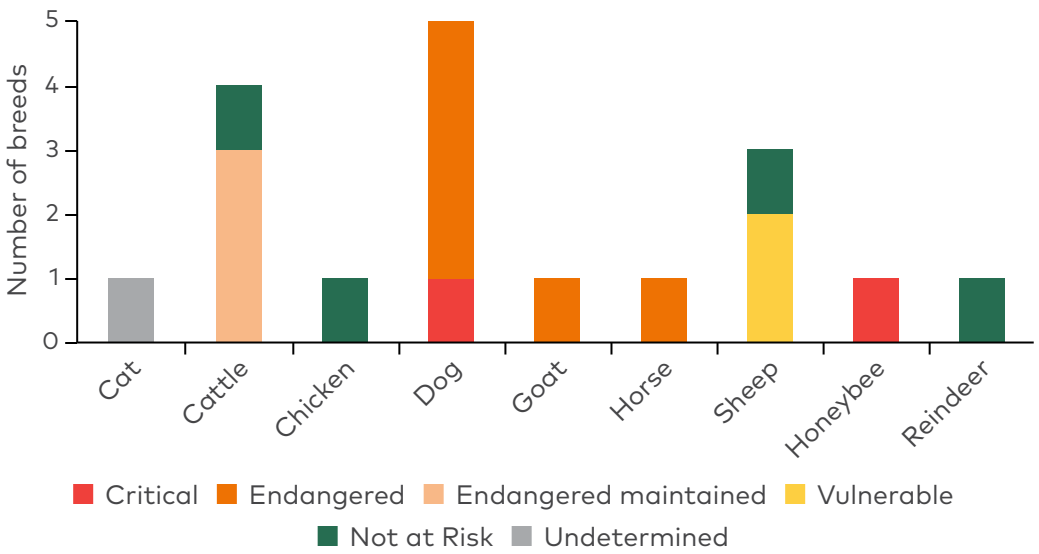


Figure 10: Number of breeds per species and their risk status for Finland.
Total number of breeds, including transboundary breeds: 18.

Iceland – native breeds and their risk status

There are seven breeds that are native to Iceland. The cattle, sheep and horse breeds are not considered at risk (Figure 11), but it is important to monitor these breeds with regards to future increase in inbreeding. The Icelandic goat breed is considered endangered, and a conservation plan was issued in 2012 by the Genetic Resource Council. Since 1965, goat breeders have received subsidies for winterfed goats. In the early 20th century, the Icelandic sheep dog breed underwent a drastic bottleneck and the need to save the breed was urgent. In 1974-76, collection of dogs and native chickens was made all over the country to save the remaining animals. Today they are bred within the Icelandic Dog Association and the Icelandic Chicken Owner and Breeder Association and included in the national conservation programme. The leader sheep was considered a subpopulation of the Icelandic sheep until 2017 when it was given the status as a breed on its own. Today the leader sheep are considered at risk. Iceland is the only country in the Nordics where the native breeds are the primary breeds used in agriculture due to strict rules that prevent import of animals.

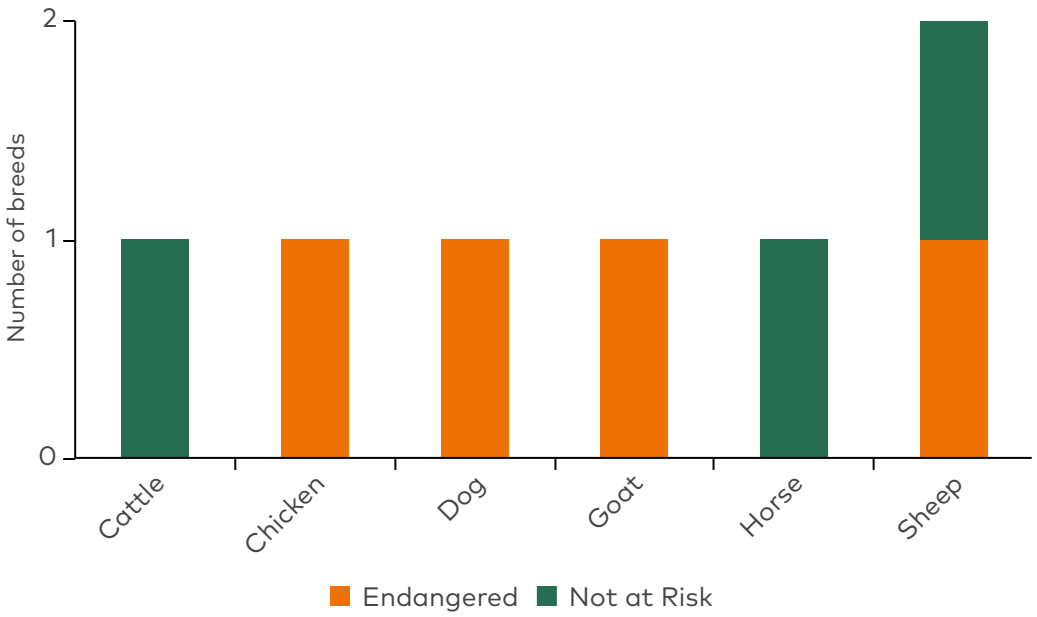


Figure 11: Number of breeds per species and their risk status for Iceland.
Total number of breeds: 7.

Norway – native breeds, subspecies and their risk status

Norway has the second largest proportion of breeds and subspecies in the Nordic region (43 breeds and populations of the transboundary Nordic Brown Bee and Fennoscandian reindeer); see Supplementary 1: Breed status Table E. Norwegian national breeds population size and conservation status. The breeds that are not considered at risk are all used in commercial production systems, and most of these populations are either sheep, pigs or goats (Figure 12). The largest percentage of the breeds are categorised as endangered. The critically endangered breeds are the Trønder-rabbit and most of the Norwegian dog breeds. The status of the goose and cat breeds in Norway are currently undetermined. Cat breeds are not part of the conservation program in Norway.

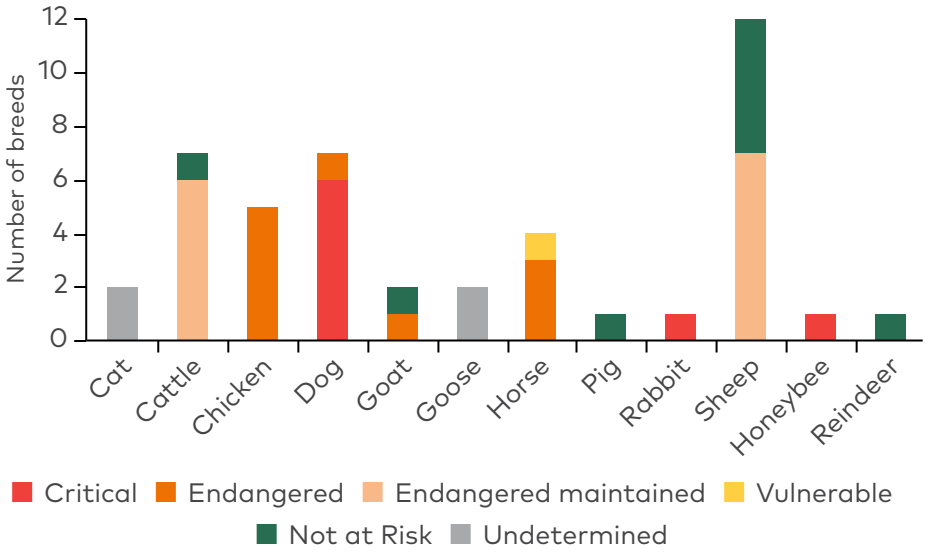


Figure 12: Number of breeds per species and their risk status for Norway.
Total number of breeds, including transboundary breeds: 45.

Sweden – native breeds, subspecies and their risk status

Sweden houses the largest portion of breeds (70 breeds including the transboundary breeds) (Table 2). Of these breeds, five are considered not at risk (three national breeds and two transboundary breeds, respectively (Figure 13). Another seven have an undetermined status (the Swedish dwarf chicken, the Fifty-five Flowery chicken, the Swedish landrace cat, the Europé cat, the Hällefors dog, the Swedish white Elkdog and the Swedish fur rabbit), and four are considered vulnerable (the Swedish mountain cattle (i.e., Svensk Fjällras), the North-Swedish horse, the Åsbo chicken and the Värmland sheep). The remaining breeds are considered as endangered and critically endangered (37 and 14, respectively). Cattle and dogs are the species with the highest proportion of breeds that are critically endangered. Sweden is the only country to include a breed of fish in their conservation program. However, this report only includes terrestrial animals, and it is thus not included in these statistics.

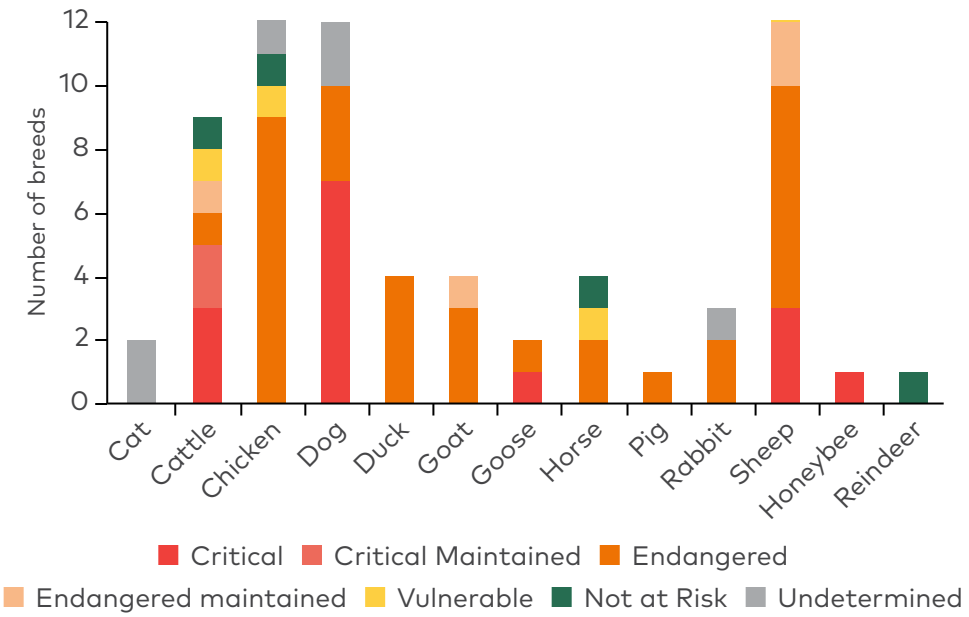


Figure 13: Number of breeds per species and their risk status for Sweden.
Total number of breeds including transboundary breeds: 70.

4.4 Nordic transboundary breeds

Introduction

Many of the Nordic farm animal breeds were developed from animal populations which migrated along with the people in the Nordics, and they have a common ancestry across the Nordic countries. However, as modern breeding emerged with the establishment of herd books within regions and countries, most of the populations today have diverged into specific breeds that have not interbred since the late 1800s or early 1900s. However, some subspecies or breeds are still not separated into individual national breeds but have populations that can be considered one across the Nordic borders. They can thus not be assigned to just one Nordic country. These transboundary breeds are the Nordic Brown Bee, the Fennoscandian Reindeer, the Danish-Swedish farmdog, and the VikingRed. The VikingRed is a transboundary commercial breeding programme based on the three Nordic Red breeds, Danish Red Dairy cattle, Swedish Red and White cattle, and Finnish Ayrshire.

There are also some breeds that are considered their own breed in their own country, but still interbreed across borders or have a history of doing so. This is for example the Norwegian and Swedish Coldblooded Trotter horse, who has a breed cooperation across borders. The Norwegian coloursided Tronder and Nordland cattle (STN), The Swedish Mountain Cattle and the Northern Finncattle are also examples of breeds that have exchanged animals across the borders, and sometimes still do. However, as they are also considered separate breeds, with a population belonging within their respective countries, these breeds will not be presented in this section. Breeds with one country of origin that have populations in several countries (typical for horses, dogs and cats) are also not presented in this section. Following is a presentation of the breeds or subspecies that we were not able to assign to one single country or are otherwise considered transboundary.

The Nordic Brown bee

Honeybees are producers of honey, beeswax and propolis. As pollinators, they are an essential part of the ecosystem, and their decline is predicted to have detrimental effects. Maintaining the genetic variation of honeybees is therefore crucial for future sustainability.

There are four main subspecies of honeybees in the Nordics: Carniolan, Italian, Brown and Buckfast bees. The Brown bee (*Apis mellifera mellifera*, also known as the European Dark or Black bee) is considered as the original honeybee subspecies in the Nordics. The subspecies migrated from the Southwest of the Alps towards the north after the ice age and reached southern Scandinavia approximately 10 000 years ago (NordGen, N.D.).

The Brown bee has evolved and adapted to different climatic conditions in Europe, including the Nordics (see for examples Schauman *et al.*, 2024), which has led to large variations in both characteristics and brood rhythm. It is described to have longer hair and a larger body size than other bee types. The bee subspecies is also known to behaviourally adapt to their environment, and to venture out even if it is cold or wet, which make them suitable for the Nordic countries.

Risk status and conservation

Intensive agricultural areas, together with habitat loss and climate change, have contributed to the decline of important pollinators, including the brown bee. Competition from other subspecies with a higher honey yield is also a threat to the brown bee. At present the Brown bee is at high risk of extinction, despite having dominated vast parts of Europe until the 1900s. Important conservation efforts for the Brown bee have been initiated both internationally (i.e., the International Association for the Protection of the European Dark bee (SICAMM)), in the Nordics (i.e., the Nordic Brown Bee Network) and within countries through e.g. Brown bee beekeeper's associations. Country-experts in the Nordic Brown Bee Network created an action plan for the Nordic Brown bee, which was updated in 2019[2].

The breeding pattern of honeybees is very different from mammalian species. The queen will fly up to 10 km from the beehive and mate with as many drones as she can in this area. This makes it challenging to keep the bees a pure subspecies. Thus, it is necessary to create areas where the only bees allowed to be kept are of the

2. Second Plan of Action for the Conservation of the Nordic Brown Bee. (2019). Retrieved from https://urn.kb.se/resolve?urn=urn:nbn:se:norden:org:diva-5627

same subspecies to avoid intermixing. It is also important to have mating stations for queens that can be kept pure. This is often done on islands, as the queens usually do not cross bodies of water.

There are colonies of purebred brown bees in Sweden, Denmark, Finland and Norway (Table 3). Local beekeepers in these countries that are interested in conservation of this subspecies are crucial for the Brown bee. The future of the Brown bee depends on cooperation, consistent characterization of bee populations to exchange breeding material when necessary, and the development, improvement and sharing of management techniques (Second Plan of Action for the Conservation of the Nordic Brown Bee, 2019).

Table 3: The risk status and population statistics of the Nordic Brown bee in Denmark, Finland, Norway and Sweden.

Native name	English/other name	Country	Year (data)	Population size	Mated queens	Conservation Status
Brun Læsøbi	Nordic Brown Bee	Denmark	2022	200	NA	Critical
Brunbie	Nordic Brown Bee	Norway	2022	4000*	100**	Critical
Tumma mehiläinen	Nordic Brown Bee	Finland	2022	300	NA	Critical
Nordiskt bi	Nordic Brown Bee	Sweden	2022	2000-3000	800-1000***	Critical

* 1000-1100 of the 4000 colonies are kept in the legal conservation area in Flekkefjord, Sokndal and Lund.
** About 100 queens from 5 to 9 different breeding lines are mated yearly, and the official gene bank maintains four of them (Lauri Ruottinen, personal communication).
*** Mating station on an Island in Lake Vänern.
Data Source: NordGen Brown Bee Network

The Fennoscandian reindeer

1/3 of the world's reindeer populations currently reside in the north of Norway, Sweden and Finland (approximately 200 000 domestic individuals in each country). These animals are described as highly robust to both the cold and vegetation in these areas, which is not surprising as they have been adapting to these climates for millennia.

Before they were tamed, wild reindeer were hunted. After being domesticated by the Sami people, they were used for transportation and to attract wild reindeer herds. Their use gradually shifted towards reindeer pastoralism and production of meat (Bjørklund, 2013). The reindeer migrate across borders depending on where they can find winter and summer pasture. However, migration was reduced after the closure of the borders in the North in the mid to late 1800s.

At present, reindeer husbandry is threatened by climate change, and while the reindeer in the Nordics are not considered as at risk of extinction, the future adaption and selection of reindeer depend largely on the pre-existing genetic diversity of the animals. This highlights the importance of estimating important genetic parameters to broaden the understanding of their genetic variation and possibly enhance the future viability of reindeer husbandry.

Risk status and statistics

Reindeer husbandry is not considered as at risk in the Nordics (Table 4), which is why little to no conservation efforts are in place for this species. However, interest in improved understanding of the reindeer have prompted several studies considering both their origin, historical migration and genetic development. Furthermore, the species is included in the conservation program in both Sweden and Finland, with some samples from the Finnish reindeer already stored in a gene bank.

Table 4: The risk status and population number of the Fennoscandian reindeer in Finland, Norway and Sweden.

Native name	English/other name	Country	Year (data)	Population size	Conservation Status	Source
Reinsdyr	Domestic Reindeer	Norway	2022	217 000	Not at risk	Both[1]
Poro	Domestic Reindeer	Finland	2021	195 000	Not at risk	DAD-IS
Tamren	Domestic Reindeer	Sweden	2019	241 000	Not at risk	External[2]

1 Ressursregnskap for reindriftsnæringen 2023
2 Rennäringens tillstånd 2020

The Nordic Red breeds

The Nordic Red cattle breeds, now referred to as VikingRed and Norwegian Red cattle, are robust and high yielding dairy cattle. VikingRed was created in 2008 as a breeding program to promote the genetic development of the red breeds in Denmark, Sweden and Finland[3].

The genetic composition of modern Nordic Red dairy breeds includes contributions from Scottish Ayrshire cattle from the 1800s and early 1900s, as well as local cattle breeds native to the Nordic countries. Additionally, these breeds have shared some key sires during the 20th century and early 2000s. Despite these shared genetics, the breeds have developed independently. Besides being robust and high yielding, these dairy cattle have other valuable attributes. For example, their breeding strategy has included a focus on health and fertility since the 1970s, which gives them an edge over other breeds. Further, the natural health and longevity of the Nordic Red cattle also make them popular in crossbreeding.

Risk status and statistics

The maintenance of the Nordic Red breeds belongs to two breeding companies: VikingGenetics (VikingRed) and Geno (Norwegian Red), which are responsible for determining the breed's breeding goals. There are about 175 000 Norwegian Red cattle in milk recording systems (Table 5), and the population of Danish Red Dairy cattle, Swedish Red and White and Finnish Ayrshire is all together ~350 000 animals. However, not all cattle of these breeds belong to the VikingRed breeding program; there are about 125 000 cows total in the Viking Red population (Table 5). The Nordic Red breeds served as the primary dairy breeds in the Nordic countries for a long time. However, Holstein cattle has taken over more and more, especially in Sweden, Finland and Denmark. Although the populations are not currently in danger of extinction, their numbers have declined over the past 50 years due to increased competition with the Holstein, in addition to improved yield through breeding.

3. https://www.vikinggenetics.com/

Table 5: The risk status and population size of the Nordic Red breeds; VikingRed and Norwegian Red.

Native name	English/other name	Country	Year (data)**	Population size	Conservation status	Source
Rød Dansk Malkerace	Viking Red (Danish Red)	Denmark	2017	23 000 (74 344)*	Not at risk	Both[1]
Suomalainen Ayrshire	Viking Red (Finnish Ayrshire)	Finland	2023	57 000 (60 000-100 000)*	Not at risk	Both[1]
Svensk röd och vit boskap (SRB)	Viking Red (Swedish Red)	Sweden	2022	55 000 (217 869)*	Not at risk	Both[1]
Norsk rødt fe	Norwegian Red	Norway	2022	175 975	Not at risk	DAD-IS

[1] NAV – Nordisk Avlsværdi Vurdering
* The VikingRed population according to numbers from NAV is outside parenthesis, and the total number of the local Red cattle inside parenthesis (according to DAD-IS).
** Year reflects the year data was from in DAD-IS.

Danish-Swedish farmdog

The Danish-Swedish farmdog probably originates from pincher and fox terrier type dogs, and is an avid rat hunter, guard- and companion dog. This type of dog was very common on farms in southern Sweden and Denmark. However, due to industrialisation, the breed was becoming rarer in the mid 1900s and was in danger of extinction.

Photo: Kari Helene Ågård

In 1985, the Danish and Swedish kennel club collaborated to preserve the breed, and it was acknowledged as its own breed in 1987. Both Denmark and Sweden are the acknowledged home countries of this breed, and thus it is listed in our transboundary breed list.

Risk status and statistics

The Danish- Swedish farmdog is considered endangered (Table 6), but in the last decade it has become a very popular family and sporting dog in many countries, so the total number of dogs of this breed worldwide is probably much higher.

Table 6: The risk status and population size of the Danish Swedish Farmdog.

Breed/ Most common name	English/ other name	Country	Year (data)	Population size	Conser-vation status	Source
Dansk-svensk gårdhund	Danish Swedish Farmdog	Denmark	2023	293-390	Endan-gered	DAD-IS
Dansk-svensk gårdshund	Danish Swedish Farmdog	Sweden	2012	6272	Endan-gered	External[1]

[1] Jansson et al. 2018

4.5 Nordic dogs and cats

Like the Nordic production animals, the Nordic dogs and cats have an important historical value. For example, cats have been illustrated in Norse mythology, and both cats and dogs have been used as pest control. Furthermore, companion animals play an important social value: Several studies (Wells, 2009; Beets et al., 2012; Ravenscroft et al, 2021) have determined that owning and taking care of a pet can improve both physical and mental health. In addition to their cultural significance and social importance, many native companion animals may have favourable characteristics not sufficiently characterized yet. Efforts for conserving companion animals (e.g., cats and dogs) differ between the Nordic countries, because there are different requirements for which breeds to include in the official conservation programmes.

Dogs

Most of the dog breeds native to the Nordic countries are Spitz type dogs with a long, thick coat suitable for rough winters. The Nordic Spitz dogs had various uses; for example, they were reindeer herders, bird-, moose- and bear hunters, as well as all-round farm dogs. They were also used for pest control and companionship.

Finnish Lappdog

There is also a significant number of Nordic Hound dogs used for hunting for example hare. All the Nordic native dog breeds are part of their own breeding association with the national kennel clubs as an umbrella, providing information and advice for the choice of breeds to potential owners. Depending on the country of residence, the breed organisations gather important information regarding the populations, such as number of breeding animals and genetic parameters. Many of the Nordic dog breeds have a long history of having been used for hunting, guarding and pest control. As the need for these uses have declined today, so have the population sizes of the Nordic dogs, and most of them are either endangered or critically endangered.

Cats

Cats have been a traditional part of Nordic farms and homes for centuries with an important role as pest control and companion animal. Most cats are not part of a breed or breeding scheme, but present more like a landrace – these are usually referred to as "farm cats" or "house cats".

Norwegian Forrest cat. Photo: Frøydis Husøy

The Swedish Landrace cat[4] and the Finnish Landrace cat (often referred to the as the Finnish national cat; Hassinen, 2016) are two examples of Nordic cat breeds that can be put into this category. There are also two pedigree cat breeds, the European Shorthair (also known as Europé[5]) and the Norwegian Forest cat[6],[7] which are considered native to the region. Pedigree cat breeds are registered in a breed registration, their pedigrees are recorded, and their breeding is organised by breeders and breed associations[5,6,7].

Cats are only included in the official conservation program in Sweden, and it is mandatory to register all cats with the Swedish Board of Agriculture. It is not, however, mandatory to register which breed these cats belong to. Therefore, the population number of the Swedish landrace cat is currently undetermined. However, Lantrasföreningen Bondkatten describes its status as critically endangered and recommends establishing *ex situ* protection[4]. Finland is making an effort to implement a registration system similar to Sweden's for all cats in the next few years.

In Norway, measures to protect the Norwegian Forest cat began in the middle of the 20th century: It was feared that the breed would become extinct, which lead to the establishment of the Norwegian Forest Cat Breeding Association (Norsk Skogkattring[6]). Today the association hosts a website with important information and history about the Norwegian Forest cat. Further, the national cat association 'Norske Rasekattklubbers Riksforbund'[7] hosts a database with the number of registered pedigree breed cats in Norway, including the Norwegian Forest cat.

4. https://bondkatten.se/index.php/bondkatten/
5. http://europeringen.se/
6. http://www.norskskogkattring.no/Norsk_Skogkatt/Norsk_Skogkatt_Norsk_Skogkattring.shtml
7. https://katt.nrr.no/Katter/kissat.aspx

4.6 Extinct Nordic breeds

There are some Nordic breeds that have already gone extinct or were merged with other breeds. Most of them are not conserved in a gene bank and their genetics have therefore been lost. The extinct breeds that are conserved in a gene bank is the Swedish landrace pig, the Norwegian (Norsvin) Yorkshire and the Faroese Cattle (only mixed breed conserved).

Following are the known extinct breeds that are not conserved: In Sweden, there are four extinct cattle breeds; Rödbrokig Swedish cattle, Heregård cattle, Skåne cattle and Småland cattle. These breeds eventually merged and became part of the Swedish Red population. Sweden also has two extinct horse breeds: Färsingehäst and Ölandshäst. In Finland, the landrace pig with its three distinct populations (i.e., länsisuomalainen luppakorva, savo-karjalainen pirtasika and pohjoissuomalainen sika) became extinct in 1960s. In Norway, the Finnmark cattle was eradicated during WWII. If there were any remaining cattle of the breed, they were merged with Nordland cattle that later merged with Røros cattle and became what is known today as the Coloursided Tronder and Nordland Cattle (STN). There were many local cattle breeds in Norway at the end of the 1800s, however most of them merged into what is today known as Norwegian Red (NRF). Some of those breeds were Målselv cattle, Rød trønder cattle and Lyngdal cattle. Norway did for a short time have breeding lines of broiler chicken that are now extinct. Other extinct breeds are the Lofoten horse, Tauter sheep and the Norwegian White Landrace rabbit/Kvit smålenskanin. In Denmark, Økvæg, Angler and Ballum cattle merged with Danish Red cattle. There might be more types and breeds that have existed in the Nordic countries that are missing from this list as many of the breeds went extinct around the late 1800s to early 1900s and were never thoroughly recorded.

4.7 The current status of estimating and recording inbreeding and effective population sizes in the Nordics

Through searching available literature, information regarding inbreeding was found for 91 of the 167 breeds, while N_e estimates were found for 79 of the breeds (Figure 14A and B). Of the available estimates for inbreeding, genomics has been used for most of the breeds (43), pedigree methods were used for 33 of the breeds and 15 breeds had available information from both genomic and pedigree calculations. Available estimates for inbreeding, and the list of breeds with available estimates for N_e are presented in Supplementary 3: Genetic parameters tables 1-2; since there are different ways of calculating the inbreeding coefficient and N_e, the comparison of any values is not feasible. A list of breeds and the corresponding literature with inbreeding and N_e can be found in Supplementary 3, Tables 1 and 2. Disclaimer: this was based on a limited literature review and some studies could have been missed.

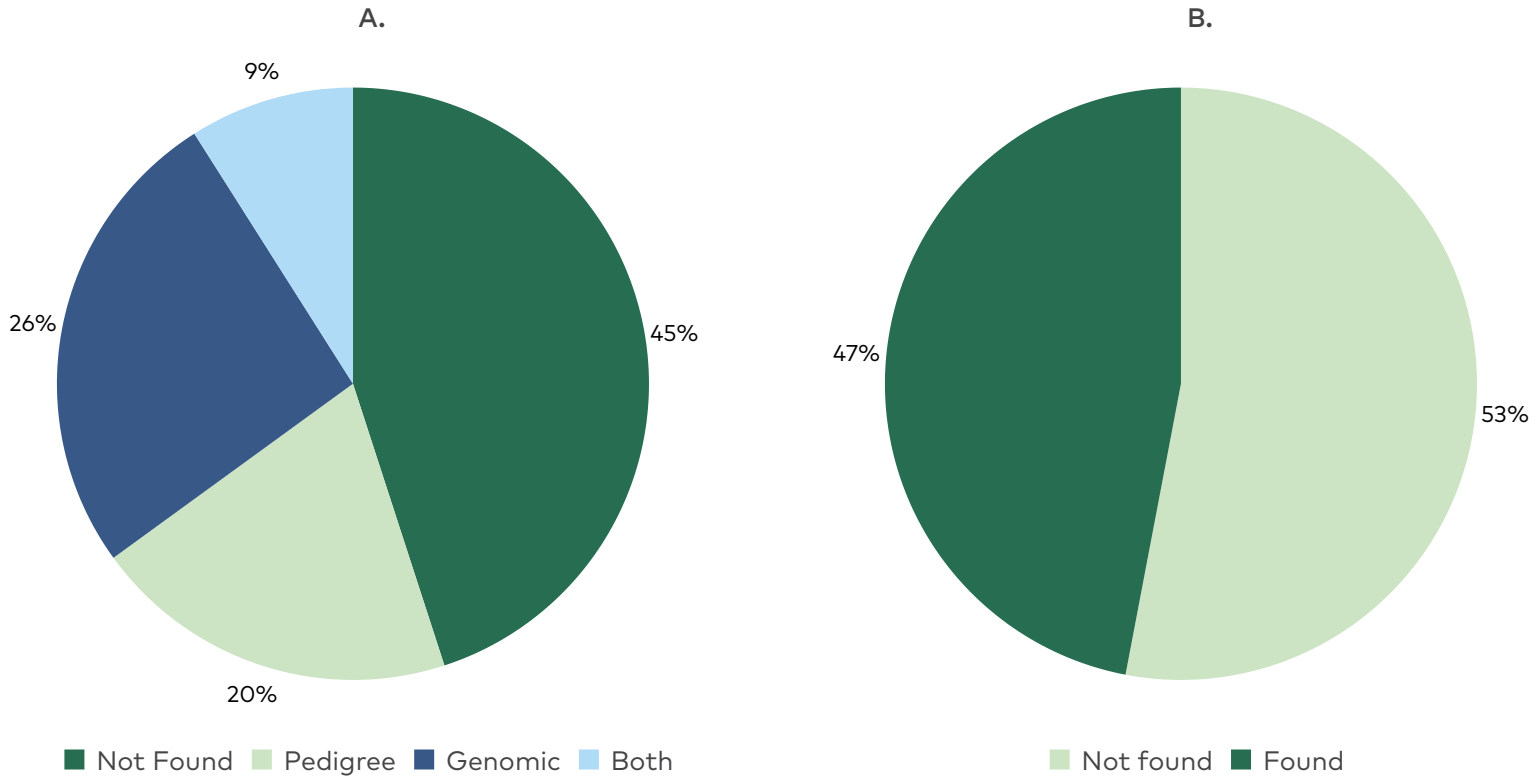


Figure 14: Proportion of breeds with Inbreeding (A) and effective population (B) estimates for Nordic native AnGR.

4.8 The status of cryoconservation in the North according to DAD-IS

According to FAO, it is recommended to implement cryoconservation measures for breeds that are endangered and critically endangered. This will safeguard the remaining genetic diversity in the populations (Table 7). Since most of the Nordic breeds are either endangered or critically endangered, establishment of complementary cryoconservation is needed following FAO recommendations.

Table 7: Recommendations of when to implement cryoconservation as an additional safeguard according to FAO (FAO, 2013).

Relative importance of population management objectives according to risk status				
Risk category	Enlarging the population	Managing diversity	Selection for productivity	Cryoconservation
Critical	+++	++	-	+++
Endangered	++	+++		++
Vulnerable	+	+	+++	
Not at risk		+	+++	

Nordic efforts for cryoconservation began in the 1980s (Maijala, 2011). According to DAD-IS, Norway has the largest number of stored samples (762 162), followed by Finland (217 649) and Sweden (76 273; Table 8). However, in terms of different samples (i.e., embryo, somatic cells, oocytes, semen etc.) Finland has the largest distribution and is the only country that has registered in DAD-IS that they have stored DNA and embryos in addition to semen for their production animals (Table 8). According to DAD-IS there is stored material from 78 of the total number of Nordic breeds (both native and Nordic-transboundary). According to FAO's definition for risk status, 119 of the breeds are considered either endangered or critically endangered. 60 of these breeds have cryopreserved material stored in gene banks, while the remaining 59 do not. It is important to consider that the data reported by DAD-IS does not always reflect the actual situation within the country, as reporting is not mandatory.

Table 8: Disposition of material that are preserved in each country (DAD-IS, 2024).

Country	Stored semen samples	Stored DNA samples	Stored embryos	Stored SC samples	Stored oocytes
Denmark*	NA	0	0	0	0
Faroe Islands**	NA	NA	NA	NA	NA
Finland	217 649	569	232	550	0
Iceland	15 625	0	0	0	0
Norway	762 162	0	0	0	0
Sweden	76 133	0	0	0	0

* It has been registered into DAD-IS that there are samples that are cryoconserved from various breeds in Denmark, however, the number of samples has not listed (only the number of donors)
** There are stored samples of Faroese horse and of the extinct Faroese cattle, but these are not listed in DAD-IS.

The number of cryoconserved samples from Nordic native breeds (collective under species) that have been registered in DAD-IS is shown below (Table 9) and shows that efforts have been largest in cattle and sheep.

Table 9: The distribution of stored samples between species (DAD-IS, 2024).

Species	Stored semen samples	Stored DNA samples	Stored embryos	Stored SC samples	Stored oocytes
Bees	0	0	0	0	0
Cats	0	0	0	0	0
Cattle*£	972,907	190	119	0	0
Chicken	0	0	0	0	0
Deer	200	100	1	550	0
Dogs	1,634	0	0	0	0
Ducks	0	0	0	0	0
Goats*	21,499	30	4	0	0
Geese	0	0	0	0	0
Horse*	1,558	34	0	0	0
Pig*£	0	0	0	0	0
Pigeon	0	0	0	0	0
Rabbit	0	0	0	0	0
Sheep	75,291	215	108	0	0

* The number of stored samples is underestimated for these species as the registered cryopreserved breeds from Denmark only includes the number of donors and not the number of samples in DAD-IS.

£ There are samples that are cryoconserved from the Swedish Landrace pig, the Norsvin Yorkshire, and the Faroese cattle, but these breeds are extinct. This report focuses mainly on the breeds that still have live populations.

Sufficiency of samples and donors

Cryopreserved semen has been the main stored material (Table 9). According to DAD-IS, the number of donors per breed varies largely. The number of breeding animals that is needed to maintain a healthy population without risk of inbreeding depression is above 50. In an evaluation of gene banking status conducted by the Centre for Genetic Resources Netherlands (CGN) of Wageningen University & Research the sufficiency of the stored material was determined according to three categories: safe (a sustainable population can be reconstituted, inbreeding rate: <0.25% per generation), compromised (higher rates of inbreeding will be present, 0.67% per generation, and little to no selection should be conducted), and at risk (will lead to an inbreeding rate of 1% per generation). For the banked breeds to be considered safe, there should be at least 50 male donors. The number of doses necessary is species-specific and sometimes varies between breeds (e.g., commercial vs native poultry breeds).

According to DAD-IS, the number of breeds with more than 50 semen donors with enough doses in the Nordics at the beginning of 2024 was 19 (Figure 15; Table 10). Most of these breeds are Norwegian native cattle and sheep breeds. Most of the breeds have stored samples from less than 50 donors – i.e., they do not yet have enough donors stored for the breed to be considered safe according to the criteria presented by Wageningen. Furthermore, samples that include female genetic information (e.g., embryos, oocytes, DNA or somatic cells) are mostly missing. For some species (e.g., avian species) cryopreservation protocols for reproductive tissues still need further optimisation.

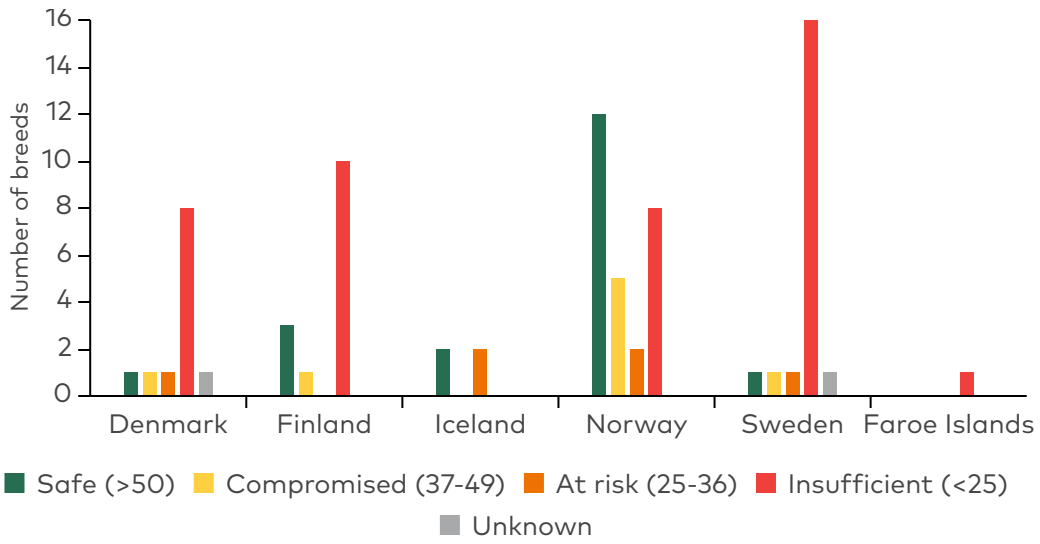


Figure 15: The number of donors of cryoconserved semen for AnGR in the Nordic countries according to DAD-IS and the Faroese horse association (2024).
Total number of breeds with samples: 78.

Table 10: The number of Nordic breeds within each risk category for cryoconservation (safe, compromised, at risk, insufficient, unknown).
The risk categories are based on the number of donors per breed, and the data was extracted from DAD-IS (2024).

Country	**Safe** (>50 donors)	**Compromised** (37-49 donors)	**At risk** (25-36 donors)	**Insufficient** (<25 donors)	**Unknown**
Denmark	1	1	1	8	1
Faroe Islands	0	0	0	1	0
Finland	3	1	0	10	0
Iceland	2	0	2	0	0
Norway	12	5	2	8	0
Sweden	1	1	1	16	1
Total number of breeds	**19**	**8**	**6**	**43**	**2**

It is important to emphasise that there is no standard way of reporting required by DAD-IS, subsequently it is difficult to know whether the reported number per year reflects the total number of conserved samples or the total samples collected for the reported year. This highlights the necessity for either being able to enter some description for how the data should be interpreted or to promote a standardised way for the data to be entered. This is not only relevant for the entries of cryopreserved material, but also in terms of population number, and number of breeding males and females in the populations. The data for cryoconservation presented in this report is based on the last entries reported from the countries. Some of the countries have had no new entries since 2020. Whether this reflects that no new material has been preserved since then, or if it is because there has been lack of available information, is unknown. Nevertheless, gathering and reporting the correct information for these efforts is important for evaluating the status of cryoconservation in the Nordics, and further to evaluate the risk status of different breeds in a larger perspective, and in terms of future population sustainability.

Cryoconservation status based on national evaluations in DAD-IS

There is an option to define whether the status of cryoconservation of a breed is sufficient or not in DAD-IS. This is something that is defined by each country on their own (i.e., not as above by following our definition) and could vary from country to country. According to these statistics, 41% of cattle breeds, 41% of sheep and 22% of goat breeds have enough samples in frozen gene banks while for other species there is either no information, no material or not sufficient material (Figure 16).

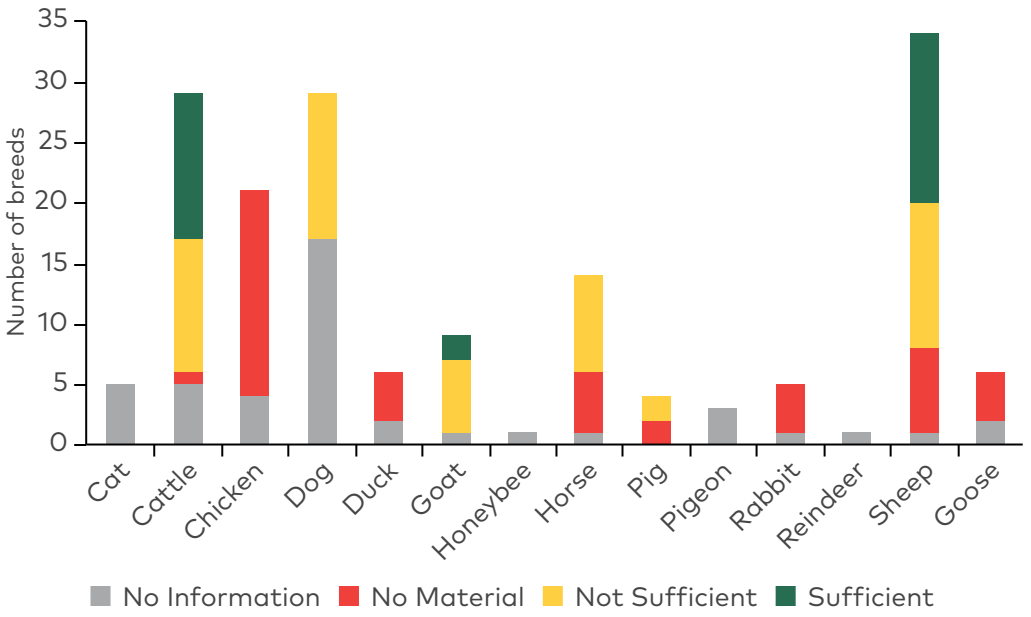


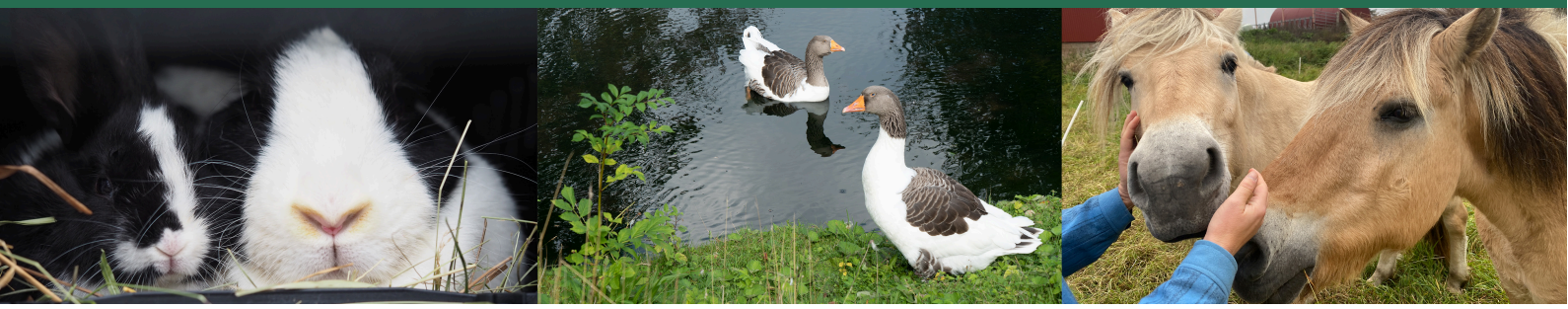
Figure 16: Status of cryoconservation according to input to DAD-IS.
Total number of breeds: 167.

Sanitary status

Lack of systematic breeding and conservation efforts could lead to incomplete identification of donors (Boes *et al.*, 2023). Utilising the samples without sufficient background information about the sanitary status, pedigree or genotype information, risks introducing infectious diseases and unwanted genetic mutation into the population. Thus, collectively organised efforts concerning phenotypic and genomic characterisation of breeds in the frozen gene bank would ensure better management of the genetic diversity of the breeds in the future. Furthermore, infrastructure allowing diagnostics of the sanitary status of the potential donor animals is also important.

CHAPTER 5

IMPORTANT STORIES OF CONSERVATION



Left: Mellerud rabbit | Middle: Scanian geese | Right: Norwegian Fjord horse

5.1 Denmark

The Jutland horse

The Jutland horse is considered as Denmark's national draft horse, and it has a studbook that dates back to 1881. The breed was used as a draft horse in farming, but like many other Nordic native horse breeds, the population declined significantly after the Second World War.

Consequently, the number of breeding mares is currently at 100, with only a few foals being born annually. Increasing or maintaining the number of breeding animals is therefore difficult. The use of few stallions led to inbreeding problems in the population in the 1980s, and since then the Jutland horse breeding association has been working toward increasing the number of horses. During a project between 2017 and 2019, the use of optimum contribution selection (OCS) to control for inbreeding was tested in the Jutland horse population. It was found that the use of OCS can significantly slow down the rate of inbreeding per generation.

Read more at: H. M. Nielsen & M. Kargo (2020) An endangered horse breed can be conserved by using optimum contribution selection and preselection of stallions,

Acta Agriculturae Scandinavica, Section A — Animal Science, 69:1-2, 127-130,
DOI: 10.1080/09064702.2020.1728370

Danish Shorthorn

Studies considering the genetic diversity and relationship of different old Danish breeds found that the Danish Shorthorn has an alarmingly high genomic inbreeding value (33%) (Szekeres *et al.*, 2016).

This means that the Danish Shorthorn has a small population that exhibits low genetic diversity, and continued breeding within the enclosed small population without control-measures or introduction of new genetic material will increase the accumulated inbreeding, and therefore increase the consequences of inbreeding (e.g., reduced disease resistance and reduced fertility). Subsequently, a project to map the genome of the Danish Shorthorn population was carried out between 2019 and 2020. The goal of the project was to determine both the genetic variation and relationship between the Danish Shorthorn and other shorthorn populations with the focus on possible gene renewal into the Danish Shorthorn population to improve the future sustainability of the breed. The authors found that selection and import of 2 Northern Dairy Shorthorn bulls from the UK and the use of OCS can be used in future breeding to improve the population size of the Danish Shorthorn in the future.

- Project description
- End report Anna A. Schönherz, 2021, Dansk Korthornsavl i Fremtiden – Genomisk Kortlægning af Korthornpopulationer.

5.2 Finland

In 2024, Finland is celebrating its 40-year anniversary for the implementation of national conservation strategies and activities for the animal genetic resources. Over the years, conservation activities have evolved from a framework established by authorities and the efforts of a few enthusiasts into a coordinated and research-oriented conservation approach. For example, Finland adopted a unique and innovative approach for safeguarding by gathering rare breeds on governmental prison farms. The groundbreaking initiative not only contributed to the conservation of endangered livestock but also provided purposeful work for inmates, which created a mutually beneficial relationship between the conservation efforts and the prison system. In 1984, the first cows, bulls and calves of Eastern Finncattle and Northern Finncattle arrived at two different prisons, Sukeva and Pelso prison farms, respectively. The conservation and breeding flock of Finnsheep and endangered Kainuu Grey sheep was established on the Pelso Prison farm. Northern Finncattle, Finnsheep and Kainuu Grey sheep gene bank herds were maintained for almost 40 years until the Prison and Probation Service of Finland (Rikosseuraamuslaitos) ceased this activity for live animal gene banking in 2022. Currently, these conservation herds are located on the educational farms of three vocational colleges: AhlmanEdu Vocational college in Tampere (Western Finncattle), Kainuu Vocational college (Eastern Finncattle) and Vocational College Lappia (Northern Finncattle. Finnsheep and Kainuu Greysheep). Moreover, the conservation of the Finnish Landrace chicken was initiated in 1998. The Finnish National Program considers common farm animal species as well as the honeybee (i.e., Nordic Brown bee), domestic reindeer and the native dog breeds.

Throughout their history, both the Eastern and Northern Finncattle breeds have experienced several critical turning points that have shaped their journeys. The large-scale evacuation of more than 20,000 northern Finncattle to Northern Sweden during the Lapland war in 1944-1945 saved the breed temporarily. Post-war agricultural intensification pressured farmers to replace local breeds with more efficient dairy breeds, shrinking the population to less than 30 individuals by the 1980s. A few dedicated pioneers began efforts to save the breed, and the newly established official conservation program coordination took over conservation. This effort has been successful, resulting in a stable population of approximately 850 breeding females today. Lately, the breed has gained significant visibility and recognition through several multidisciplinary research projects.

A similar event occurred with Eastern Finncattle, involving evacuation from the lost Karelia during World War II and subsequent efforts by a few pioneers to initiate conservation in the 1970s and 1980s. The breed's exceptional suitability for grazing has boosted its popularity in recent decades, and its population is now approaching 2 000 individuals.

Eastern Finncattle

Research activities have played a crucial role in the implementation of genetic resources program since the beginning. Finland was a pioneer in population genetics research and in enhancing genome level information. An open-minded approach has enabled the use of cutting-edge technologies. For example, in 1992, an Eastern Finncattle bull calf was born using artificial reproductive technologies (*in vitro* embryo production) in laboratory successfully. In recent decades, genetic resources have been recovered to the gene bank by producing embryos from post-mortem materials, allowing emergency harvesting of reproductive material. Additionally, cooperation with legislative authorities has been effective, exemplified by adjustments of legislations given by the Ministry of Agriculture and Forestry to allow the collection of sperm from the epididymides for both gene banking and breeding purposes. In the near future, preservation of skin tissue samples for animal genetic resources conservation will be implemented.

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5.3 Iceland

Origin

The Icelandic farm animals have a unique position among Nordic farm animals. For each species of animals there is only one breed except for sheep and leader sheep. Animal breeding is based on breeds that have been isolated for over 1100 years, since the settlement period AD 874 – 930 and can be considered as a living gene bank for old Nordic farm animal breeds. Some import of live animals for breeding purposes occurred in earlier times but it is known that their influence on local breeds were minimal.

Conservation

The import of live animals is tightly regulated due to the risk of diseases; therefore, the breeds have remained genetically closed. Conservation of farm animals in Iceland began in the early 1960s when there was a need to pay attention to the endangered goat breed. In 1965 The Icelandic Farmers Association was obligated to work on the conservation of goats and leader sheep by the Act on livestock breeding. The first genetic resource council for AnGR was established in 1984 and celebrates 40 years of conservation work in 2024. From 2009 the Genetic Resource Council has issued a National Strategy Plan for Animal Genetic Resources which is updated every five years. Iceland has participated actively in the Nordic co-operation first from 1984; Nordic Gene Bank for Farm Animals (NGH), and from 2007; Nordic Genetic Resource Center (NordGen).

Goat breed

Photo: Birna Kristín Baldursdóttir

The Icelandic goat breed has been endangered for a long time and has suffered at least two serious bottle-necks when the number of animals went under 100. Conservation of the breed began 60 years ago when pedigree and phenotypical information on the breed was collected, and subsidies were granted for winterfed goats.

A conservation plan was issued in 2012 with great emphasis on increasing the number of animals, production development, registry, and use of AI bucks to reduce inbreeding. Today the breed has achieved success and is becoming increasingly popular among breeders. The number of animals has increased from 875 (2012) to 1875 (2022). Inbreeding is high and the effective population size (N_e) was estimated under 10 animals (Baldursdottir *et.al.*, 2012). Recent (unpublished) research shows that conservation work has been successful, indicating that the effective population size is increasing and inbreeding level is decreasing.

Leader sheep

Photo: Birna Kristín Baldursdóttir

The Icelandic leader sheep have been known to exist in Iceland since the settlement. The leader sheep was considered a subpopulation within the sheep population until 2017 when it was defined as a separate breed.

The leader sheep is an example of subpopulation of sheep breed that has been successfully conserved. In the middle of the 20th century the population experienced a major bottleneck due to a disease eradication programme.

Leader sheep are graceful and prominent in the flock with alertness in the eyes, normally going first out of the sheep house, looking around in all directions, watching if there are any dangers in sight and walking in front of the flock when driven to or from pasture. There are many stories about leader sheep and their ability to sense bad weather and how they lead the flock home before a storm.

Inbreeding has been successfully controlled during the last few decades and leader sheep rams are kept in AI stations. The number of pure-bred animals is under 1000 and the total number including crossbreds is around 3500. The breed is defined as endangered.

Landrace chicken

The so-called settlement chickens are descendants of a group of chickens collected in Iceland by Dr. Stefán Adalsteinsson during 1974-1975. The group was collected in an attempt to try to save the remains of the chicken breed believed to have been brought to Iceland with the settlers 1100 years ago. The estimated number of birds today is 2000-2500. The effective population size (N_e) has been estimated to 36 (Gudmundsdottir, 2011).

Photo: Birna Kristín Baldursdóttir

Icelandic sheepdog

The Icelandic sheepdog is believed to be among the animals that were brought to Iceland with early settlers during the settlement period. The population underwent a drastic bottleneck in the early 20th century and the current population descends from only a few individuals.

Photo: Mervi Honkatukia

The number of founders estimated from pedigree was 44 (Olafsdottir & Kristjansson, 2008). Today there are between one and two thousand dogs registered in Iceland and over 11 000 registered in other countries.

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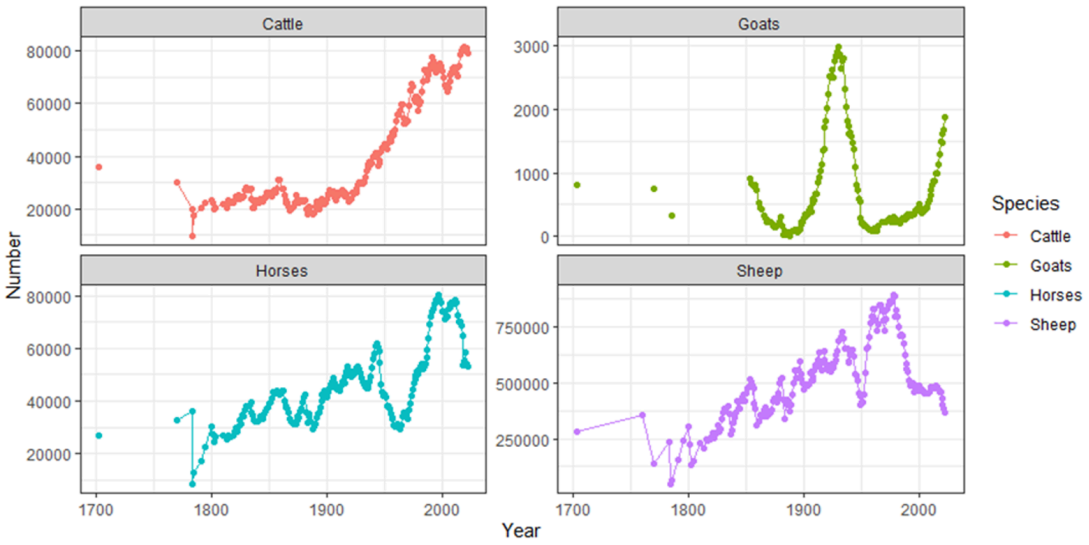

Figure 17: Number of animals 1703–2022.
Source: Hagskinna 1997 and Statistic Iceland, 2022.

5.4 The Faroe Islands

The Faroese horse

The Faroese horse is a small horse native to the Faroe Islands. A recent study shows that the breed is closely related to the Icelandic horse, Shetland pony and the North Atlantic breeds.

Photo: Maria Kjetså

The population of the Faroese horse has decreased significantly due to the use of larger horses for heavy agricultural equipment and the export of Faroese horses to the British coal mines in the 1900s. In the early 1900s, the breed suffered a severe bottleneck, and the breed almost went extinct as there were less than 10 horses left alive in the 1960s. Some enthusiasts found the remaining horses of the breed and started a rescue operation. However, due to the limited horses left, all living horses today are descendant of only five horses, and some of them were also related. The breed association for Faroese Horse was established in 1978, and the population size of the Faroese horse has slowly increased since. In 2021, the highest number of living horses, 94 individuals, were noted. However, in 2022, there was a population decline of 8.5% because 10 horses were lost and there were only two new foals born. A further decline was seen in 2023, when seven horses were lost due to age and illness, while three foals were born. By the end of 2023, there were 82 live horses in the population (Figure 17).

In March 2024, the first ever action plan considering the Faroese horse was released. The action plan outlines the different actions that are advised to be taken to further improve the status of the breed. The execution of the action plan has already begun, and the use of artificial reproductive technologies for gene banking is ongoing (e.g., systematic semen collection and embryo transfer). The slow increase in population number of the Faroese horse since the 1960s, the increased awareness and characterization of the breed and the successful use of control tools such as optimum contribution selection (OCS) marks a slow success story of conservation on the Faroe Islands.

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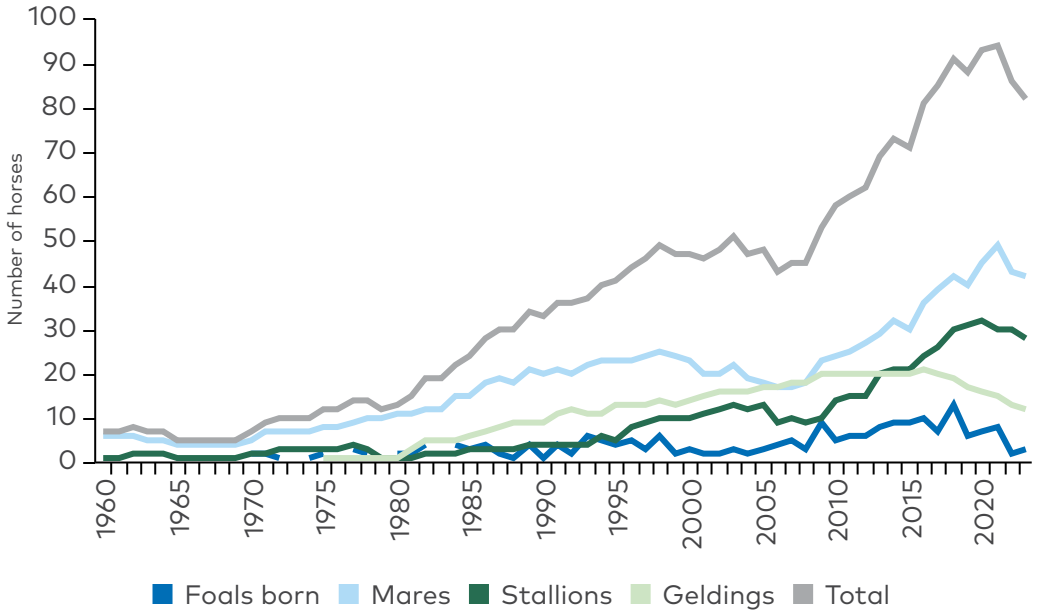

Figure 18: The Faroese horse population.

5.5. Norway

The Norwegian Genetic Resource Centre, part of the Norwegian Institute of Bioeconomy Research (NIBIO), is a competence centre for the conservation and sustainable management of genetic resources for food and agriculture and provides technical assistance to all actors in the national conservation work.

Telemark catle

The centre monitors the status and development trends of the national genetic resources for food and agriculture in Norway and reports the status of these nationally and internationally. It also acts as an advisory body to the Norwegian Ministry of Food and Agriculture.

In 1990, a survey revealed that four of Norway's six endangered cattle breeds had fewer than 50 breeding cows, with none recorded in a proper pedigree database. The situation was critical, requiring urgent action. Thanks to the systematic conservation measures for over more than three decades, none of the native endangered breeds of cattle, horse, sheep and goat were any longer classified as critical endangered in year 2023 (i.e., all the breeds have more than 300 recorded breeding females in their population). The success of the conservation work on these breeds is roughly explained by the following key factors:

Pedigree databases

- Tracking kinship is crucial in breeding, especially in small populations, to minimize inbreeding and to monitor population trends.
- Appropriate pedigree databases for the native endangered breeds have thus been developed or strengthened for the livestock species of cattle, sheep, goat and horse.
- Registration is voluntary and free of charge but necessary for receiving subsidies.
- The pedigree databases function as herd books for the endangered breeds.
- Population trends are reported annually at both national and international levels.

Breeding associations and breed societies
Breeding associations and breed societies are essential networks for the farmers having three main tasks: facilitating the exchange of breeding material, promoting sustainable breeding practices and sharing traditional knowledge about suitable production systems.

Systematic expanding of the semen collection
Access to frozen semen is essential for breeding and gene banking. Since the late 1970s, and especially since the early 2000s, semen has been collected regularly from all the native breeds of cattle, sheep and goat. The semen is available for purchase by breeders. In addition, some doses of all donors have been put in a gene bank for long time storage.

Sustainable breeding in small populations
Communicating the special challenges in sustainable breeding in small populations has been a key task in the Norwegian work on conservation of native endangered livestock breeds.

Easy and free access to breeding advice
Since the early 1990s, farmers with endangered native breeds of livestock have had free access to advice on sustainable breeding in small populations from Norwegian Genetic Resource Centre. To assess the impact of breeding efforts between 1990 and 2020, effective population sizes (N_e) were estimated for the six endangered native cattle breeds every ten years in this period. The results show that the breeding work has been sustainable, with N_e increasing or remaining above 100.

New uses
Finding new areas of use has been important for all the livestock species with native endangered breeds. The horses are no longer working animals; they are used in sports. The goat and sheep breeds are successful as landscape managers and in 2010 a local spinning mill started spinning knitting wool from the challenging wool from the endangered native sheep breeds. This has turned out to be a success and in 2023 the mill produced yarn from a total of six tonnes of wool, only from native sheep breeds. The native endangered cattle breeds are now mainly used for meat production. The increase of breeding females in the decade from 2014 to 2023 has been from 2852 breeding cows to 5509 (assembled figures for all the six breeds). This increase of 93% in population status is due to the increased number of suckler cows, see Figure 19.

Production subsidies
A crucial factor in conservation success was the introduction of the production subsidies for the endangered native cattle breeds in 2000. This subsidy scheme was expanded in 2016 to also cover the endangered native breeds of sheep, goat and horses. While it is more a recognition of farmers' conservation efforts than a significant income source, this support is highly valued by the farmers.

Future challenges

While Norwegian farming sees fewer farms with livestock, this hasn't yet impacted the growing populations of the endangered livestock breeds. However, this positive trend could eventually be threatened without supportive agricultural policies.

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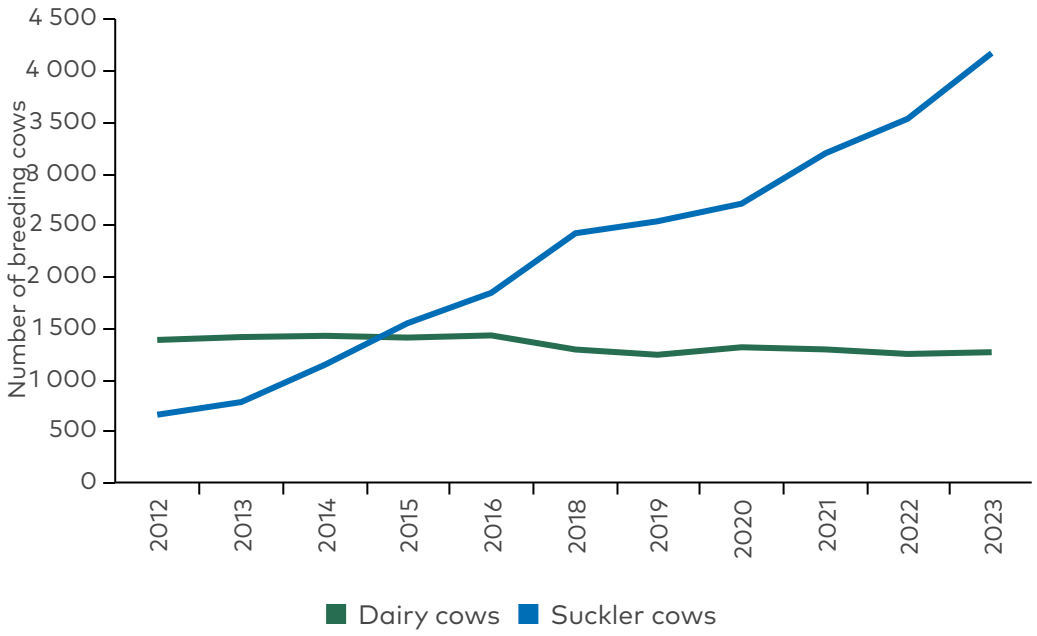

Figure 19: The number of breeding cows in 2014-2023, assembled figures for all the six native endangered cattle breeds in Norway, by cows in different production systems; suckler cows for meat production and dairy cows for dairy production.
Source: Norwegian Genetic Resource Centre.

5.6 Sweden

Sweden has been active in conservation since the 197os, and even private companies began storing semen from bulls used for artificial insemination in the 1950s. Importantly, the international nature conservation conference, hosted in Stockholm in 1972, marked the beginning of efforts for preserving domestic AnGR.

Klövsjö sheep

At this conference, it was decided that each country should be responsible for their animal genetic resources and to pay special attention to breeds with small population sizes. During a conference for the Nordic countries in the following year it was decided that each of the Nordic countries have the responsibility to conserve their own AnGR, and Nordic collaboration through a working group in the Nordic Council of Ministers was suggested. For Sweden, the investigation of Sweden's national AnGR initiated by the Swedish government, marked the beginning of long-term conservation efforts. These efforts led to the important report: "Bevarandet av genresurser hos husdjur".

Although they have the widest array of native breeds to manage, they have arranged studies that comprise estimating important genetic parameters for over half of the breeds. Positively, only 7% of the breeds fall under the category of unknown, which is a large accomplishment considering the number of native breeds residing in Sweden. Furthermore, the use of master students to analyse data has significantly increased the information regarding genetic parameters of the Swedish native breeds. Almost all of the breeds have calculated inbreeding coefficients, and the N_e of a little over 75% of breeds have been estimated. Genetic characterisation studies and the continued monitoring of important genetic parameters such as inbreeding and N_e is essential for the evaluation of genetic variation and health of the population and are important for the determination of adequate breeding strategies. Subsequently, the active participation of students in these types of projects is an important asset to the field of animal genetic resources and can escalate the efforts to fill the existing gaps.

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CHAPTER 6

DISCUSSION AND CONCLUSIONS

Left: Danish-Swedish Farmdog **I** Middle: Faroese sheep **I** Right: Gotlandsruss

The Nordic countries have officially cooperated on the conservation of farm animals' genetic diversity for 40 years, although individual national efforts began much earlier. The Nordic countries have mainly focused on maintaining live populations, while cryoconservation efforts have also been implemented in most Nordic countries to some degree. *In situ* conservation allows breeds to be visible and adapt to prevailing conditions rather than being merely in the depths of the gene bank. Over time, *in situ* conservation measures in the Nordic countries have become more professional and effective, though some populations have faced difficulties.

Most Nordic farm animal breeds have a small population size, where only 23 breeds can be classified as "not at risk". Of the breeds, 144 are vulnerable, endangered, critically endangered or undetermined. Therefore, regular data collection and monitoring is crucial. One important tool that holds great potential for reporting and analysis of data is DAD-IS, hosted by the FAO. FAO has been collecting global data for animal genetic resources since 1982. The DAD-IS database was established in 1996. The database is regularly used to prepare various comprehensive global reports that provide valuable insights supporting internation policymaking and resource allocation beyond the scope of FAO.

Over the years, the use of DAD-IS in the Nordic countries has improved considerably. Of the Nordic breeds, 82% had at least one data entry, and 77% had updated population data from 2021 or later, indicating the importance of reporting and monitoring is getting widely recognized by the Nordic countries. Only 16% of

the breeds either had no data or data older than 10 years. The DAD-IS database contains comprehensive information on all the Nordic breeds of sheep, cattle, horses, and goats, as well as up to 90% of poultry, pigeons, and rabbits. However, information concerning the poultry, pigeons, and rabbit breeds are scattered. Furthermore, only 52% of dogbreed is reported to have an increasing population trend in DAD-IS, but the numbers show a clear decline in numbers over the last 10 years (Supplementary 2). A clear definition to determine a population's trend could be positive to assess the true risk of a population and to put conservation measures in place to counteract a negative trend.

A population's viability can also be assessed using parameters such as inbreeding rate and effective population size. These methods can be based on marker-based or pedigree-based methods. In this study we gathered inbreeding value for 91 of the Nordic breeds, while N_e estimates were found for 79 breeds from the literature or various breed association's internet sites. Of the available estimates for inbreeding, genomics has been used for most of the breeds (43), pedigree methods were used for 33 of the breeds and 15 breeds had available information from both calculations. Based on the data analysis, relatively high inbreeding rates were detected in the Norsk Jærhøns (native Norwegian chicken breed), Íslenska geitin (Icelandic goat breed), Lundehund (Norwegian Puffin dog), and Fjordhest (Norwegian Fjordhorse) breeds. The inbreeding rate per generation (i.e. how fast inbreeding increases) affects the health of the population, which is why the development of informed and sufficient management strategies that take genetic variation into account is important to ensure sustainable populations.

The data entered into DAD-IS is defined by the national coordinator of each country. This has led to the use of different definitions for e.g., population size or number of breeding females between countries. I.e., some define the population as the number of females while other define it as the total number of animals. In some instances, changing definitions or information sources within a country have led to odd fluctuations of numbers within breeds over different years. It must be remembered that the quality of the data depends on the content providers and is not controlled by FAO. However, the introduction of common and specific definitions could improve quality and consistency.

The Global Action Plan for Animal Genetic Resources (FAO, 2007) emphasizes that both *in situ* and *ex situ* conservation measures should be implemented to ensure the future security of animal genetic resources. The Nordic countries have been at the forefront of this effort, since they introduced cryoconservation even before that - in the 1980s (Maijala, 2011). According to DAD-IS, Norway has the largest number of stored samples, followed by Finland and Sweden. From Denmark and the Faroe Island, no information was available in DAD-IS. However, in terms of different samples (embryo, somatic cells, oocytes, semen etc.) Finland has the largest distribution and is the only country that has stored DNA and embryos in addition to

semen for their production animals. According to our analysis there is stored material from 78 Nordic breeds (both native and Nordic-transboundary). According to the FAO definition for risk status, 107 of the breeds are considered either endangered or critically endangered. 60 of these breeds have cryopreserved material stored in gene banks, while the remaining 47 do not.

Our investigation of DAD-IS data (extracted at the beginning of 2024) shows that most investments in cryoconservation have been made in cattle and sheep breeds. Based on the information nothing has been frozen from bees, cats, chickens, ducks, geese, pigeons or rabbits. Furthermore, the data also showed only 19 breeds with more than 50 semen donors with sufficient doses. In many breeds, semen samples have been collected from too few donors to ensure future genetic diversity. In addition, there is a significant lack of female genetic material (e.g., embryos, eggs, DNA, or somatic cells).

It is important to emphasize that, based on DAD-IS data, it is impossible to determine whether the numbers represent the total stored samples or only those collected in the reporting year, which makes it difficult to determine if the last entered data is in fact the total accumulated number of samples, or if all the entries should be added together. In addition, not all cryoconserved material is reported in DAD-IS.

While the data reported in DAD-IS has room for improvement, the data that is collected can give us a lot of important insights into the status of the Nordic breeds. It shows that there is a large diversity of breeds in the Nordic countries, with 167 different breeds in total over 14 species, where 82% of the breeds have at least one data entry in DAD-IS. The data is mostly complete for the traditional farm animal species: Cattle, sheep, and goats. The Nordic countries have a system for collecting population data for many breeds and species, and there are measures taken for both *in situ* and *ex situ* conservation. Important stories depicting successful strategies for conservation in each of the countries are presented in section 5. These stories directly illustrate how impactful conservation efforts have been during the last 40 years.

Key findings

- The Nordic countries have been working to secure their animal genetic resources for at least 40 years, both individually and collaboratively. As a result, 167 native breeds still exist in the Nordic countries. These breeds are important for the biodiversity of domestic animals both in the Nordic region and globally.
- Conservation work continues to be important as 35 of these 167 breeds are classified as at critical risk of extinction and only 23 breeds are not at risk of extinction.
- Currently, 35% of the breeds show an increasing or stable trend, 15% are decreasing, and for 50% of the Nordic breeds, the population trend was not determined.
- Conservation efforts in the Nordic countries have developed positively over the decades, with an increasing emphasis on utilizing both in situ and ex situ conservation strategies as they complement each other.
- These efforts have led to the successful maintenance and improved status of many breeds found in the region (e.g., the Lundehund, Icelandic goat, and many different Nordic cattle breeds).
- Recognition of the value of the Nordic breeds have led to increased interest in keeping the breeds.
- Characterisation studies have provided important information and revealed future possibilities of creating local niche products and activities.
- Continuous monitoring of population statistics such as the number of breeding animals and number of offspring born annually remain important to determine the development of the breeds. The parameter of number of breeding females have been and continues to be an important indicator for risk status in conservation.
- The systematic follow-up routines initiated in Norway (i.e., the cow register, key figures from the Norwegian Genetic Resource Centre) during the past decade have proven a solid foundation for more professional maintenance of native breeds, serving as a best practice in the sector.
- Practical tools for improved breeding selection and inbreeding control such as EVA have been important for monitoring and improving genetic variation within populations.
- Monitoring and updating estimations of population inbreeding and genetic variation is essential for understanding the genetic soundness of the population and important for evaluating breeding strategies.
- The DAD-IS database, hosted by the FAO, holds great potential for reporting data concerning breeds globally. While there is room for

improvement in data management practices from the countries, the use of the database has become significantly more efficient in recent years. Today, DAD-IS contains information about 82% of the Nordic breeds, and 77% of the breeds have updated population data from 2021 or later.

- Not all reporting criteria in DAD-IS are currently defined and can therefore vary depending on the person entering the data. This influences the comprehensiveness and further the comparability of data between countries and even within and between breeds. Uniform and transparent reporting criteria across countries would enhance regional evaluations.
- There are benefits to be gained by supplementing the missing information, as the necessary conservation measures related to the breeds are unlikely to be successful without the relevant reporting. Information gaps may distort general overviews and can influence decision-making.
- FAO recommends that endangered breeds should be prioritized in gene banking activities. Continuous improvements with techniques and infrastructure for collecting and freezing reproductive tissue such as semen and epididymal sperm has made cryopreservation cheaper and more feasible for several breeds. Other methods such as collecting and storing tissue samples also provide useful alternatives for breeds where the infrastructure for reproductive tissue has not yet been optimised.
- Of the endangered and critically endangered breeds, up to 57 % have cryoconserved material in a gene bank. Efforts for cryoconservation in the Nordics have mainly focused on cattle and sheep breeds.
- Of the cryoconserved samples reported to DAD-IS, 99,87% are male reproductive material (semen/sperm).
- Cryopreserved samples have been collected from too few donors in many breeds to ensure future genetic diversity. 19 of the breeds in the gene banks have enough donors and doses, i.e., 11.5% of the Nordic breeds are safe.
- Future challenges include many factors, such as climate change and social interest (e.g., consumer preferences), that can influence the possibility for small scale farming opportunities. Loss of genetic variation is also an important challenge because most of the Nordic breeds have small population sizes.

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SUPPLEMENTARY INFORMATION

1: BREED STATUS

Supplementary Table A. Danish national breeds population size and conservation status.

Breed/Most common name	English/other name	Specie	Year (data)	Population size	Breeding males	Breeding females	Conservation Status	Source
Rød Dansk Malkerace	Danish Red Dairy Cattle	Cattle	2017	74 344			Not at risk	DAD-IS
Agersøkvæg	Agerso Cattle	Cattle	2023	152	17	125	Critical	DAD-IS
Jysk Kvæg	Jutland Cattle	Cattle	2023	1095	139	750	Endangered	DAD-IS
Dansk Malkekorthorn	Danish Shorthorn	Cattle	2023	790	98	441	Endangered	DAD-IS
Rød Dansk Malkerace anno 1970 (RDM-1970)	Danish Red Dairy Cattle anno 1970	Cattle	2023	408	28	265	Critical	DAD-IS
Sortbroget Dansk Malkerace anno 1965 (SDM-1965)	Danish Black Spotted Dairy Cattle anno 1965	Cattle	2023	339	21	217	Critical	DAD-IS
Danske Landhøns	Danish Landrace Chicken	Chicken	2017	2100			Vulnerable	DAD-IS
Broholmeren	Danish Mastiff	Dog	2023	87			Endangered	DAD-IS
Dansk Spids	Danish Spitz	Dog	2023	550-600	59	61	Critical	DAD-IS
Gammel Dansk Hønsehund	Old Danish Pointer	Dog	2023	102-200			Endangered	DAD-IS

Sort hvidbrystet dansk and	Danish Landrace Duck	Duck	2017	50			Critical	DAD-IS
Dansk Landraceged	Danish Landrace Goat	Goat	2022	1465	316	1060	Vulnerable	DAD-IS
Grå og Gråbrogede Danske Gæs	Danish Landrace Goose	Goose	2017	125			Endangered	DAD-IS
Den Jydske Hest	Jutland Horse	Horse	2023	1462	615	758	Endangered	DAD-IS
Frederiksborgheste	Frederiksborg horse	Horse	2023	1542	574	763	Endangered	DAD-IS
Knabstrupper	Knabstrupper horse	Horse	2023	1736	629	969	Endangered	DAD-IS
DL-1970	Danish Landrace Pig anno 1970	Pig	2023	28-43	5	10	Critical	DAD-IS
Sortbroget Landracesvin	Danish Black Spotted Pig	Pig	2023	174-278	22	82	Critical	DAD-IS
Parykduen	Paryk dove	Pigeon	2017	200			Endangered	DAD-IS
Svaberduen	Svaberg dove	Pigeon	2016	280	70	70	Critical	DAD-IS
Tumlingeduen	Tumlinge dove	Pigeon	2017	750			Endangered	DAD-IS
Hvid Dansk Landkanin	Danish White Landrace rabbit	Rabbit	2023	450-600	25	75	Critical	DAD-IS
Dansk Landfår	Danish Landrace Sheep	Sheep	2023	1326	370	916	Endangered	DAD-IS
Hvithovedet Marskfår	Marsh sheep	Sheep	2022	802	173	620	Endangered	DAD-IS
Grønlandshund	Greenland dog	Dog	2022	13 123			Undefined	External[1]

[1] Source: Total number of sled dogs in Greenland (i.e. not just pure bred Greenlandic dogs), Statbank Greenland (bank.stat.gl)

Supplementary Table B. Finnish national breeds population size and conservation status.

Breed/Most common name	English/other name	Specie	Year (data)	Population size	Breeding males	Breeding females	Conservation Status	Source
Finnish Ayrshire	Finnish Ayrshire	Cattle	2023	60 000-100 000		75000	Not at risk	DAD-IS
Itäsuomenkarja	Eastern Finncattle	Cattle	2023	1800-3500	70	2000	Endangered maintained	DAD-IS
Länsisuomenkarja	Western Finncattle	Cattle	2023	1000-1200		1100	Endangered maintained	DAD-IS
Pohjoissuomenkarja	Northern Finncattle	Cattle	2023	800-900		850	Endangered maintained	DAD-IS
Maatiaiskana	Finnish Landrace Chicken	Chicken	2023	5000-6000	900	5000	Not at risk	DAD-IS
Karjalankarhukoira	Karelian Beardog	Dog	2019	4000-8000	90	110	Endangered	DAD-IS
Lapinporokoira	Lapponian reindeer herder	Dog	2019	1500-2000	40	60	Critical	DAD-IS
Suomenajokoira	Finnish Hound	Dog	2019	14 000-23 000	200	340	Endangered	DAD-IS
Suomenlapinkoira	Finnish Lapponian Dog	Dog	2020	8000-1100	150	210	Endangered	DAD-IS
Suomenpystykoria	Finnish Spitz	Dog	2019	4000-8000	130	200	Endangered	DAD-IS
Suomenvuohi	Finngoat	Goat	2023	3000-4000	70	3000	Endangered	DAD-IS
Suomenhevonen	Finnhorse	Horse	2024	19 000-20 000	219	1549	Endangered	DAD-IS

Ahvenanmaanlammas	Aland sheep	Sheep	2023	4500-4750	610	4100	Vulnerable	DAD-IS
Kainuunharmas	Kainu sheep	Sheep	2023	4000-5500	610	4600	Vulnerable	DAD-IS
Suomenlammas	Finnsheep	Sheep	2023	40 000-45 000	4200	38000	Not at risk	DAD-IS
Finnish landrace cat	Finnish landrace cat	Cat					Undefined	No data

Supplementary Table C. Faroese national breeds population size and conservation status.

Breed/Most common name	English/other name	Specie	Year (data)	Population size	Breeding males	Breeding females	Population trend	Source
Færøsk hest	Faroese horse	Horse	2023	82	28	31	Decreasing	Both[1]
Færøsk får	Faroese sheep	Sheep	2017	75 000			Undefined	DAD-IS
Føroysk dunna (Færøsk and)	Faroese Duck	Duck					Undefined	No data
Føroysk gás (Færøsk gås)	Faroese Goose	Goose					Undefined	No data

[1] Source: Total population size. Føroya Fongur (Faroese Horse Associasion Database)

Supplementary Table D. Icelandic national breeds population size and conservation status.

Breed/Most common name	English/other name	Specie	Year (data)	Population size	Breeding males	Breeding females	Conservation Status	Source
Icelandic cattle	Icelandic cattle	Cattle	2022	79 306		25842	Not at risk	DAD-IS
Islanski hænsnastofninn	Icelandic landrace chicken	Chicken	2018	3000-3500	300	3200	Endangered*	DAD-IS
Icelandic goat	Icelandic goat	Goat	2022	1875			Endangered maintained	DAD-IS
Islenski Hesturinn	Icelandic horse	Horse	2022	53 015		4147	Not at risk*	DAD-IS
Icelandic Leadersheep	Icelandic Leadersheep	Sheep	2022	1200-1500			Endangered maintained	DAD-IS
Icelandic Sheep	Icelandic Sheep	Sheep	2022	365 290		287000	Not at risk	DAD-IS
Íslenski hundurinn	Icelandic sheepdog	Dog	2023	162			Endangered*	External[1]

[1] Source: Puppies registered in Iceland in 2023 (Icelandic sheep database: islenskurhundur.com)
* Risk categories marked with asterisk was not correct in DAD-IS and was updated based on information from the National Coordinator on Animal Genetic Resources in Iceland.

Supplementary Table E. Norwegian national breeds population size and conservation status.
This list divereges slightly from the official Norwegian list of native livestock breeds. The divergence is mainly explained by more poultry breeds and no cat breeds in the official list. The official list of livestock breeds native to Norway is published in the annual report Nøkkeltall fra Norsk genressurssenter

Breed/Most common name	English/other name	Specie	Year (data)	Population size	Breeding males	Breeding females	Conservation Status	Source
Norsk Rødt Fe (NRF)	Norwegian red cattle	Cattle	2022	175 975		175975	Not at risk	DAD-IS
Doelafe	Dola cattle	Cattle	2022	405	55	350	Endangered maintained	DAD-IS
Østlandsk rødkolle	Eastern red polled cattle	Cattle	2022	612	38	574	Endangered maintained	DAD-IS
Sidet trønderfe og nordlandsfe	Coloursided tronder and nordland cattle	Cattle	2022	2352	178	2174	Endangered maintained	DAD-IS
Telemarkfe	Telemark cattle	Cattle	2022	582	76	506	Endangered maintained	DAD-IS
Vestlandsk fjordfe	Western fjord cattle	Cattle	2022	1419	127	1292	Endangered maintained	DAD-IS
Vestlandsk raudkolle	Western red polled cattle	Cattle	2022	354	47	307	Endangered maintained	DAD-IS
Norbrid 1	White Leghorn 1	Chicken	2021	289	38	251	Endangered	DAD-IS
Norbrid 4	White Leghorn 4	Chicken	2021	222	34	188	Endangered	DAD-IS
Norbrid 7	Brown Egg Layer 7	Chicken	2021	266	42	224	Endangered	DAD-IS
Norbrid 8	Brown Egg Layer 8	Chicken	2021	288	43	245	Endangered	DAD-IS

Norsk Jærhøne	Norwegian jaerhon	Chicken	2022	323	52	271	Endangered	DAD-IS
Dunker	Norwegian hound / Dunker	Dog	2022	17		17	Critical	DAD-IS
Haldenstøver	Halden hound	Dog	2022	4		4	Critical	DAD-IS
Hygenhund	Hygen hound	Dog	2022	5		5	Critical	DAD-IS
Lundehund	Norwegian lundehund	Dog	2022	43		43	Critical	DAD-IS
Norsk buhund	Norwegian buhund	Dog	2022	42		42	Critical	DAD-IS
Norsk elghund grå	Norwegian grey elkhound	Dog	2022	176		176	Not at risk	DAD-IS
Norsk elghund sort	Norwegian black elkhound	Dog	2022	71		71	Critical	DAD-IS
Kystgeit	Norwegian coastal goat	Goat	2022	704		704	Endangered	DAD-IS
Norsk melkegeit	Norwegian dairy goat	Goat	2022	35 472		35472	Not at risk	DAD-IS
Norsk hvit gås	Norwegian white goose	Goose	2013	130		130	Critical maintained	DAD-IS
Smaalensgås	Smaalens goose	Goose	2013	180		180	Critical maintained	DAD-IS
Dølahest	Dola horse	Horse	2022	1331	50	1281	Endangered	DAD-IS
Fjordhest	Fjord horse	Horse	2022	1509	38	1471	Endangered	DAD-IS
Nordlandshest lyngshest	Nordland lyngen horse	Horse	2022	893	40	853	Endangered	DAD-IS

Norsk kaldblodstraver	Norwegian coldblooded trotter	Horse	2022	5100		5100	Vulnerable	DAD-IS
Bleset sau	Bleset sheep	Sheep	2022	3320		3320	Endangered maintained	DAD-IS
Dalasau	Dala sheep	Sheep	2022	800		800	Endangered maintained	DAD-IS
Fuglestadbrogete sau	Fuglestadbrogete sheep	Sheep	2022	880		880	Endangered maintained	DAD-IS
Gammelnorsk sau	Old norwegian sheep	Sheep	2022	10 989		10989	Not at risk	DAD-IS
Gammelnorsk spælsau	Old norwegian spel sheep	Sheep	2022	14 828		14828	Not at risk	DAD-IS
Grå trøndersau	Grey tronder sheep	Sheep	2022	1750		1750	Endangered maintained	DAD-IS
Kvit spælsau	White spel sheep	Sheep	2022	37 914		37 914	Not at risk	DAD-IS
Norsk kvit sau	Norwegian white sheep	Sheep	2022	261 404		261 404	Not at risk	DAD-IS
Norsk pelssau	Norwegian fur sheep	Sheep	2022	9261		9261	Not at risk	DAD-IS
Rygja	Rygja sheep	Sheep	2022	2500		2500	Endangered maintained	DAD-IS
Sjeviot	Norwegian Cheviot sheep	Sheep	2022	2748		2748	Endangered maintained	DAD-IS
Steigar	Steigar sheep	Sheep	2022	646		646	Endangered maintained	DAD-IS
Norsk landsvin	Norwegian Landrace pig	Pig	2001	23 050	50	23 000	Not at risk	DAD-IS

Norsk skogkatt	Norwegian forest cat	Cat	2023	239			Undefined	External[1]
Norsk huskatt	Norwegian landrace cat	Cat					Undefined	No data
Trønderkanin	Tronder rabbit	Rabbit					Critical*	No data

[1] Source: Norwegian Purebred Cat Association (NRR); number of kittens born in Norway in 2023 (katt.nrr.no)
* Source: Norwegian Genetic Resource Center

Supplementary Table F. Swedish national breeds, population size and conservation status.

Breed/Most common name	English/other name	Specie	Year (data)	Population size	Breeding males	Breeding females	Conservation Status	Source
Svensk röd och vit boskap (SRB)	Swedish Red and White cattle	Cattle	2022	217 869	58 852	159 017	Not at risk	DAD-IS
Bohuskulla	Bohuskulla cattle	Cattle	2022	131	38	93	Critical maintained	DAD-IS
Fjällnära boskap	Fjallnara cattle	Cattle	2022	300	54	246	Critical	DAD-IS
Ringamålako	Ringamala cattle	Cattle	2022	111	28	83	Critical	DAD-IS
Rödkulla	Red polled cattle	Cattle	2021	944	270	674	Endangered maintained	DAD-IS
Svensk Fjällras	Swedish mountain cattle	Cattle	2021	7802	2032	5770	Vulnerable	DAD-IS
Svensk Lågland	Swedish lowland cattle	Cattle	2022	5-20	3	10	Critical	DAD-IS

Svensk kullig boskap (skb)	Swedish polled cattle	Cattle	2022	2522	789	1733	Endangered	DAD-IS
Väneko	Vaneko cattle	Cattle	2022	300	30	205	Critical maintained	DAD-IS
Bjurholmshöna	Bjurholms chicken	Chicken	2021	1060	159	871	Endangered	DAD-IS
Bohuslän - Dals svarthöna	Bohuslan - dals black chicken	Chicken	2021	492	115	377	Endangered	DAD-IS
Gotlandshöna	Gotland chicken	Chicken	2021	781	161	620	Endangered	DAD-IS
Hedemorahöna	Hedemora chicken	Chicken	2021	3063	494	2569	Not at risk	DAD-IS
Kindahöna	Kinda chicken	Chicken	2021	1027	216	811	Endangered	DAD-IS
Orusthöna	Orust chicken	Chicken	2021	474	84	390	Endangered	DAD-IS
Skånsk Blommehöna	Scanic blomme chicken	Chicken	2021	957	161	796	Endangered	DAD-IS
Svensk dvärghöna	Swedish dwarf chicken	Chicken					Undefined	No data
Gammalvensk dvärghöna	Old swedish dwarf chicken	Chicken	2021	485	107	378	Endangered	DAD-IS
Åsbohöna	Asbo chicken	Chicken	2021	2139	401	1738	Vulnerable	DAD-IS
Ölandshöns	Oland chicken	Chicken	2021	749	156	593	Endangered	DAD-IS
Öländsk Dvärghöna	Oland dwarf chicken	Chicken	2021	371	75	296	Endangered	DAD-IS
Fiftyfive Flowery	Fiftyfive Flowery	Chicken					Undefined	No data
Blekingeanka	Blekinge duck	Duck	2021	191	76	115	Endangered	DAD-IS
Svensk Blå Anka	Swedish blue duck	Duck	2021	282	92	190	Endangered	DAD-IS

Svensk Gul Anka	Swedish yellow duck	Duck	2021	236	74	162	Endangered	DAD-IS
Svensk Myskanka	Swedish mysk duck	Duck	2021	189	56	133	Endangered	DAD-IS
Göingeget	Goinge goat	Goat	2021	438	79	359	Endangered	DAD-IS
Jämtget	Jamt goat	Goat	2020	533	100	433	Endangered	DAD-IS
Lappget	Lapponian goat	Goat	2020	374	64	310	Endangered	DAD-IS
Svensk Lantras Get	Swedish landrace goat	Goat	2022	1153	35	1118	Endangered maintained	DAD-IS
Skånegås	Scanic goose	Goose	2021	166	62	104	Endangered	DAD-IS
Ölandsgås	Oland goose	Goose	2021	105	42	63	Critical	DAD-IS
Gotlandruss	Gotland pony	Horse	2020	4500-5000	140	2500	Endangered	DAD-IS
Kallblodstravare	Swedish coldblooded trotter	Horse	2022	8000			Not at risk	DAD-IS
Nordsvensk Brukshäst	North swedish horse	Horse	2022	8000-9000		4500	Vulnerable	DAD-IS
Svensk ardennerhäst	Swedish Ardennes	Horse	2018	3000-4000	75	700	Endangered	DAD-IS
Linderödssvin	Linderod pig	Pig	2022	674	165	509	Endangered	DAD-IS
Gotlandskanin	Gotland rabbit	Rabbit	2022	879	339	540	Endangered	DAD-IS
Mellerudskanin	Mellerud rabbit	Rabbit	2022	191	82	109	Endangered	DAD-IS
Pälskanin	Swedish fur rabbit	Rabbit	2007	36	17	19	Undefined	DAD-IS
Dala pälsfår	Dala fur sheep	Sheep	2022	506	57	331	Endangered	DAD-IS
Fjällnäsfår	Fjallnas sheep	Sheep	2022	181	17	124	Critical	DAD-IS

Gestrikefår	Gestrike sheep	Sheep	2022	432	31	283	Critical	DAD-IS
Gotlandsfår	Gotland sheep	Sheep	2022	18 470	1178	17 292	Not at risk	DAD-IS
Gutefår	Gute sheep	Sheep	2022	1850	155	1695	Endangered maintained	DAD-IS
Helsingefår	Helsinge sheep	Sheep	2022	2907	263	1884	Endangered	DAD-IS
Klövsjöfår	Klovsjo sheep	Sheep	2021	1864	171	1162	Endangered maintained	DAD-IS
Roslagsfår	Roslag sheep	Sheep	2022	1182	107	820	Endangered	DAD-IS
Ryafår	Rya sheep	Sheep	2015	1000	68	826	Endangered	DAD-IS
Svenskt finullsfår	Swedish fine wool sheep	Sheep	2020	3493	242	2223	Endangered	DAD-IS
Svärdsjöfår	Svardsjo sheep	Sheep	2020	428	78		Endangered	DAD-IS
Tabacktorpsfår	Tabacktorp sheep	Sheep	2022	98	18	54	Critical	DAD-IS
Värmlandsfår	Varmland sheep	Sheep	2019	3742	601	3141	Vulnerable	DAD-IS
Åsenfår	Asen sheep	Sheep	2022	1171	104	774	Endangered	DAD-IS
Europé	European shorthair	Cat					Undefined	No data
Svensk bondkatt	Swedish landrace cat	Cat					Undefined	No data
Drever	Swedish hound / Drever	Dog	2012	10 010			Endangered	External[1]
Gotlandsstövare	Gotland hound	Dog	2012	149			Critical	External[1]
Hamiltonstövare	Hamilton hound	Dog	2012	5021			Endangered	External[1]

Hälleforshund	Hallefors elkhound	Dog	2012	670			Undefined	External[1]
Jämthund	Swedish elkhound /Jamthund	Dog	2012	17 483			Endangered	External[1]
Schillerstövare	Schiller hound	Dog	2012	1699			Critical	External[1]
Smålandsstövare	Smaland hound	Dog	2012	977			Critical	External[1]
Svensk lapphund	Swedish lapponian dog	Dog	2012	1213			Critical	External[1]
Svensk vit älghund	Swedish white elkhound	Dog	2012	915			Undefined	External[1]
Västgötaspets	Swedish vallhund	Dog	2012	2509			Critical	External[1]
Norrbottenspets	Norrbotten spitz	Dog	2012	1626			Critical	External[1]

[1] External source: Jansson et al. 2018 https://doi.org/10.1371/journal.pone.0202849

Supplementary Table G. Transboundary Nordic breeds, population size and conservation status.

Breed/Most common name	English/other name	Country	Specie	Year (data)	Population size	Conservation Status	Source
VikingRed	Viking Red	Denmark, Sweden and Finland	Cattle	2017	125 000	Not at risk	External[1]
Dansk Svensk Gårdhund	Danish Swedish Farmdog	Denmark	Dog	2023	293-390	Endangered	DAD-IS
Dansk Svensk Gårdshund	Danish Swedish Farmdog	Sweden	Dog	2012	6272	Endangered	External[2]
Brun Læsøbi	Nordic Brown Bee	Denmark	Honeybee	2022	200	Critical	External[3]
Den bruna bia	Nordic Brown Bee	Norway	Honeybee	2022	4000	Critical	External [3]
Tumma mehiläinen (Nordiskt honungsbi)	Nordic Brown Bee	Finland	Honeybee	2022	300	Critical	External [3]
Nordiskt bi	Nordic Brown Bee	Sweden	Honeybee	2022	2000-3000	Critical	External [3]
Reinsdyr	Domestic Reindeer	Norway	Reindeer	2022	217 000	Not at risk	Both[4]
Poro (Fennoskandisk ren)	Domestic Reindeer	Finland	Reindeer	2021	195 000	Not at risk	DAD-IS
Tamren	Domestic Reindeer	Sweden	Reindeer	2019	241 000	Not at risk	External[5]

[1] NAV – Nordisk Avlsværdi Vurdering (https://nordicebv.info/suomi-nordic-dairy-cattle)

[2] Jansson et al. 2018 (https://doi.org/10.1371/journal.pone.0202849)

[3] NordGen Brown Bee Network (https://www.nordgen.org/en/native-breed/the-nordic-brown-bee/)

[4] Ressursregnskap for reindriftsnæringen 2023 (https://www.landbruksdirektoratet.no/nb/nyhetsrom/nyhetsarkiv/ressursregnskapet-i-reindriften-for-2022)

[5] Rennäringens tilstånd 2020 (https://www.sametinget.se/158400)

2: POPULATION TRENDS

Table 1. Population data from Danish native breeds for the years 2013-2023. Extracted from DAD-IS.

Breed name	Specie	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Trend (DAD-IS)
Agersøkvæg	Cattle	128	118	189	226	184	184	159	140	150	164	152	undefined
Jysk Kvæg	Cattle	851	800	972	988	1003	1001	995	1060	1076	1029	1095	undefined
Dansk Malkekorthorn	Cattle	590	602	638	721	715	712	758	805	793	772	790	undefined
Rød Dansk Malkerace anno 1970	Cattle			348	373	366					424	408	undefined
Sortbroget Dansk Malkerace anno 1965	Cattle			212	196	197					337	339	undefined
Danske Land Høns	Chicken				2400	2100							decreasing
Broholmeren	Dog			104	145	153	172	151	195	192	157	87	undefined
Dansk Spids	Dog			20	391	485	30	61	73	89	64	550	increasing
Gammel Dansk Hønsehund	Dog			20	1451	1466	167	124	146	101	100	102	undefined

Sort hvidbrystet dansk and	Duck			50	50	50							undefined
Dansk Landraceged	Goat			1343	1379	1432					1465		increasing
Grå og Gråbrogede Danske Gæs	Goose				95	125							undefined
Den Jydske Hest	Horse			1797	1834	1859	1527	1516	1517	1501	1480	1462	decreasing
Frederiksborg-heste	Horse			2079	2084	2107	1827	1770	1687	1611	1576	1542	decreasing
Knabstrupper	Horse			1920	1950	1998	1796	1766	1743	1736	1729	1736	increasing
DL-1970	Pig	30	40	53	38	25						28	decreasing
Sortbroget Landracesvin	Pig	100	200	430	530	956						174	decreasing
Parykduen	Pigeon				200	200							stable
Svaberduen	Pigeon				280								undefined
Tumlingeduen	Pigeon				750	750							stable
Hvid Dansk Landkanin	Rabbit			389	500	225						450	undefined
Dansk Landfår	Sheep			1179	1054	1118					1297	1326	increasing
Hvithovedet Marskfår	Sheep			1035	822	822					802		decreasing

Grønlands-hund*	Dog	15671	14620	14607	15028	15632	14130	13315	13417	13395	13123		undefined

* Data from Grønlandshund is the total number of sled dogs from the Greenland statistics databank (Statbank Greenland) and the number of pure bred Grønlandshund is probably much lower.

Table 2. Population data from Finnish native breeds for the years 2013-2023. Extracted from DAD-IS.

Breed name	Specie	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Trend (DAD-IS)
Itäsuomen-karja	Cattle							1620				1800	increasing
Länsisuomen-karja	Cattle							1510				1000	decreasing
Pohjoissuo-menkarja	Cattle							850				800	stable
Maatiaiskana	Chicken							3000				5000	increasing
Karjalankar-hukoira	Dog							4000					stable
Lapinporo-koira	Dog							1500					stable
Suomenajo-koira	Dog							14000					stable
Suomenlapin-koira	Dog							8000					stable
Suomen-pystykoria	Dog							4000					decreasing
Suomenvuohi	Goat							4000				3000	decreasing
Suomen-hevonen	Horse							18000				19000	stable

Ahvenan-maanlammas	Sheep							1000				4500	increasing
Kainuun-harmas	Sheep											4000	decreasing
Suomen-lammas	Sheep											40000	decreasing

Table 3. Population data from Icelandic and Faroese native breeds for the years 2013-2023*. Extracted from DAD-IS.

Breed name	Country	Specie	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Trend (DAD-IS)
Icelandic cattle	Iceland	Cattle	70461	74444	78776	80024	80895	81573	80872	81170	80563	79306	undefined
Islanski hænsnas-tofninn	Iceland	Chicken				3000	3000	3000					stable
Icelandic goat	Iceland	Goat	891	987	1008	1188	1300	1491	1471	1621	1672	1875	increasing
Islenski Hesturinn	Iceland	Horse	72626	67997	75000	69000	64679	80000	71000	58466	54095	53015	undefined
Icelandic Leadersheep	Iceland	Sheep				1400		1200	1200	1200	1200	1200	stable
Icelandic Sheep	Iceland	Sheep	476262	484108	472461	473144	458665	432023	415949	401022	385194	365290	decreasing
Færøsk hest	Faroe Islands	Horse				81	81						decreasing
Færøsk får	Faroe Islands	Sheep					7500						undefined

* no data was available from 2023 and thus the column was removed to save space.

Table 4. Population data from Norwegian native breeds for the years 2013-2023*. Extracted from DAD-IS.

Breed name	Specie	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Trend (DAD-IS)
Norsk rødt fe	Cattle	200790	202833	201726	192592	189217					175975	undefined
Dølafe	Cattle	156	179	222	253	269	294	326	358	401	405	undefined
Østlandsk rødkolle	Cattle	216	248	330	388	439	485	501	519	611	612	undefined
Sidet trønderfe og nordlandsfe	Cattle	1191	1468	1670	1771	1767	1876	1874	1933	2094	2352	undefined
Telemarkfe	Cattle	306	329	382	407	409	439	500	572	580	582	undefined
Vestlandsk fjordfe	Cattle	613	617	756	786	843	900	1040	1088	1250	1419	undefined
Vestlandsk raudkolle	Cattle	155	169	166	176	183	212	250	296	348	354	undefined
Norbrid 1	Chicken	285			255					289		undefined
Norbrid 4	Chicken	231			243					222		undefined
Norbrid 7	Chicken	232			263					266		undefined
Norbrid 8	Chicken	239			271					288		undefined
Norsk jærhøne	Chicken	392			401						323	undefined
Dunker	Dog	12	12	21	12	17					17	undefined

Haldenstover	Dog	3	3	2	2	4					4	undefined
Hygenhund	Dog	7	1	4	3	5					5	undefined
Lundehund	Dog	25	26	32	33	36					43	undefined
Norsk buhund	Dog	17	14	21	15	32					42	undefined
Norsk elghund grå	Dog	184	182	180	192	161					176	undefined
Norsk elghund sort	Dog	29	32	41	40	43					71	undefined
Kystgeit	Goat			283	317	345	326	348	432	557	704	undefined
Norsk melkegeit	Goat	32834	31645	23794	25719	25580					35472	undefined
Norsk hvit gås	Goose	130										undefined
Smaalensgås	Goose	180										undefined
Dølahest	Horse	262	212	263	276	285	281	300	329	339	1331	undefined
Fjordhest	Horse	236	183	277	290	266	321	294	325	328	1509	undefined
Nordlandshest lyngshest	Horse	156	227	191	212	183	189	196	214	205	893	undefined
Norsk kaldblods-traver	Horse	930	871	897			944	828	854	704	5100	undefined
Bleset sau	Sheep	1156		1111	1454	1746	1961	2247	2584	2866	3320	undefined
Dalasau	Sheep	1000		620	674	707	727	733	761	864	800	undefined

Fuglestad-brogete sau	Sheep	490		410	446	517	551	561	652	728	880	undefined
Gammelnorsk sau	Sheep	20121		20000		6995					10989	undefined
Gammelnorsk spælsau	Sheep	3392		6656	8981	10991	12518	13825	14689	14229	14828	undefined
Gra trøndersau	Sheep	1076		765	1009	1181	1364	1517	1632	1618	1750	undefined
Kvit spælsau	Sheep	32455		43071		47155					37914	undefined
Norsk kvit sau	Sheep	216805		252439		270193					261404	undefined
Norsk pelssau	Sheep	4191		5718		7589					9261	undefined
Rygja	Sheep	2000		1808	1954	1734	1779	1802	1948	2189	2500	undefined
Sjeviot	Sheep	3572		3358		3286					2748	undefined
Steigar	Sheep	300		66	101	178	255	341	474	639	646	undefined

* no data was available from 2023 and thus the column was removed to save space.

Table 5. Population data from Swedish native breeds for the years 2013-2023*. Extracted from DAD-IS.

Breed name	Species	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Trend (DAD-IS)
Bohuskulla	Cattle	71	85	91	99	100	111	114	118	136	131	stable
Fjällnära boskap	Cattle	147	148	175	213	240	279	304	311	300	300	stable
Ringamålako	Cattle	194	164	185	222	254	182	156	140	122	111	decreasing
Rödkulla	Cattle									944		undefined
Svensk Fjällras	Cattle									7802		undefined
Svensk Lågland (u/ holstein)	Cattle								10	12	5	stable
Svensk kullig boskap	Cattle		3074	2777	2660	2663	2663		2532		2522	stable
Väneko	Cattle	222	190	233	246	235	217	201	259	280	300	increasing
Bjurholmshöna	Chicken		379		573		757	812	911	1060		increasing
Bohuslän - Dals svarthöna	Chicken		412		403		353	389	401	492		increasing
Gotlandshöna	Chicken		878		981		795	818	817	781		decreasing
Hedemorahöna	Chicken		3085		3511		3296	3268	3255	3063		stable
Kindahöna	Chicken		1743		1346		1375	1180	1065	1027		decreasing
Orusthöna	Chicken		401		479		388	480	477	474		stable

Skånsk Blommehöna	Chicken		1592		1449		1141	1123	1135	957		decreasing
Gammalvensk dvärghöna	Chicken		437		507		454	454	505	485		stable
Åsbohöna	Chicken		2191		2513		2303	2035	2113	2139		stable
Ölandshöns	Chicken		687		631		536	682	762	749		stable
Öländsk Dvärghöna	Chicken		302		417		272	313	368	371		stable
Blekingeanka	Duck		204		183		139	117	121	191		increasing
Svensk Blå Anka	Duck		135		210		274	245	253	282		increasing
Svensk Gul Anka	Duck		203		205		235	224	221	236		increasing
Svensk Myskanka	Duck		222		241		217	224	228	189		stable
Göingeget	Goat	347	392	424	431	454	404	439	441	438		stable
Jämtget	Goat	525	498	487	478	486	472	493	533			increasing
Lappget	Goat	191	215	259	277	341	404	378	374			stable
Svensk Lantras Get	Goat		2500								1153	stable
Skånegås	Goose		238		235		201	192	190	166		decreasing
Ölandsgås	Goose		119		105		120	105	105	105		stable
Gotlandruss	Horse	4000	4000	4000	4000	4500	4000	4000	4500			stable

Kallblods-travare	Horse							1500			8000	decreasing
Nordsvensk Brukshäst	Horse	5000		5000	5000		9000	8000	8000	8000	8000	stable
Svensk ardennerhäst	Horse	5000			1000		3000					stable
Linderödssvin	Pig	370	435	435	505	587	658	715	628	615	674	increasing
Gotlandskanin	Rabbit	1175	1243	1040							879	decreasing
Mellerudskanin	Rabbit	175			191						191	stable
Dala pälsfår	Sheep			368			400	429		507	506	stable
Fjällnäsfår	Sheep			86			153	73	142		181	stable
Gestrikefår	Sheep			421				227	461	443	432	decreasing
Gotlandsfår	Sheep			20000			18000				18470	stable
Gutefår	Sheep			5388		5250					1850	undefined
Helsingefår	Sheep	975	1094	1302	1603	1623		1435	2268	2740	2907	increasing
Klövsjöfår	Sheep			821				1046	1724	1864		stable
Roslagsfår	Sheep			915			1241	926	1277	1208	1182	stable
Ryafår	Sheep			1000								undefined
Svenskt finullsfår	Sheep	3770	4416	3836	3645	3727	3487	3256	3493			undefined
Svärdsjöfår	Sheep			340				259	428			undefined
Tabacktorpsfår	Sheep			41				64	88	98	98	increasing
Värmlandsfår	Sheep			3127				3742				undefined

Åsenfår	Sheep	1705		1331				871		1230	1171	stable

* no data was available from 2023 and thus the column was removed to save space.

3: GENETIC PARAMETERS

Table 1. Population data from Danish native breeds for the years 2013-2023. Extracted from DAD-IS.

Breeds	Country	FG*	ΔFG	F*	ΔF	Paper
Danish Red cattle	DK	-	-	0.014	1.07%	Sørensen, Sørensen and Berg, 2005
Dansk landraceged	DK	0.160	-	-	-	Cardoso et al., 2018
Knabstrupperhesten	DK	-	-	0.030	-	Thirstup, Pertoldi and Loeschcke, 2008
Frederiksborgerhesten	DK	-	-	0.040	-	Thirstup, Pertoldi and Loeschcke, 2008
Den Jydske hest	DK	-	-	0.060	-	Thirstup, Pertoldi and Loeschcke, 2008
Hvidhovedet Marskfår	DK	-	-	-	>2.00%	Sørensen and Norberg, 2008
Dansk Landfår (incl. Ertebøllefår)	DK	-	-	-	>2.00%	Sørensen and Norberg, 2008
Danske Landhøns	DK	-	-	-	0.10 %	Spalona et al., 2007
Broholmer	DK	0.420	-	-	-	Meadows et al., 2023
Greenland dog	DK	0.330	-	-	-	Meadows et al., 2023
Føroysk Ross	FO	-	-	0.268	-	Kettunen et al., 2022
Porokoira (Lapinporokoira)	FI	-	-	0.038	-	The Finnish Kennel Club (n.d.)
Karjalankarhukoira	FI	-	-	0.045	-	Suomen Pystykorvajärjestö Finska Spetsklubben Ry, 2010
Suomenajokoira	FI	0.280	-	0.027	-	Meadows et al., 2023

Suomenlapinkoira	FI	-	-	0.030	-	The Finnish Kennel Club (n.d.)
Suomenpystykorva	FI	0.330	-	0.072	-	Meadows et al., 2023; Karjalainen and Ojala. 1997
Suomenvuohi	FI	0.090	-	-	-	Cardoso et al., 2018
Suomenhevonen	FI	-	-	0.048	-	Tehnunen and Salonpääm, 2016
Suomenlammas	FI	-	-	0.006-0.030	0.15%	Kantanen, 2010
Íslenskir nautgripir	IS	0.100	-	-	-	Gautason et al., 2011
Íslenskar geitur	IS	0.660	-	-	-	Cardoso et al., 2018
Íslenski Hesturinn	IS	0,030	-	-	-	Hreidarsdottir et al., 2014
Íslenski hundurinn	IS	0.210	-	-	-	Ólafsdóttir et al., 2008
Íslenskt forystufé	IS	-	-	0.027	-	Jónmundsson et al., 2015
Dølafe	NO	-	-	-	0.83%	Holene, A., et al., 2021
Sidet trønderfe og nordlandsfe	NO	-	-	-	0.41%	Holene, A., et al., 2021
Telemarkfe	NO	-	-	-	1.41%	Holene, A., et al., 2021
Vestlandsk fjordfe	NO	-	-	-	0.83%	Holene, A., et al., 2021
Vestlandsk raudkolle	NO	-	-	-	0.90%	Holene, A., et al., 2021
Østlandsk rødkolle	NO	-	-	-	1.12%	Holene, A., et al., 2021
Norske Jærhøns	NO	0.700	-	-	-	Brekke, C., 2020
Dunker	NO	-	-	0.070	-	Svihus and Wetten 2023 a
Haldenstøver	NO	-	-		-	

Hygenhund	NO	-	-	0.019	-	Hygenringen
Lundehund	NO	0.82	-	0.360-0.380	1.00%	Meadows et al., 2023; Kettunen et al., 2017
Norsk buhund	NO	0.32	-		-	Meadows et al., 2023
Norsk elghund sort	NO	-	-	0.160	0.52%	Svihus and Wetten, 2023 b
Norsk elghund grå	NO	0.25	-	0.036	0.30%	Meadows et al., 2023; Elghundforbundet
Norsk melkegeit	NO	0.074	-	-		Berg et al., 2020
Kystgeit	NO	0.115, 0.347	-	-		Berg et al., 2020
Dølahest	NO	-	-	0.134		Norsk hestesenter, 2023
Fjordhest	NO	-	-	0.823		Norsk hestesenter, 2023
Nordlandshest/lynghest	NO	-	-	0.129		Norsk hestesenter, 2023
Norsk kaldblodstraver	NO	-	-	0.086		Norsk hestesenter, 2023
Kvit spælsau	NO	-	-	.	0.42%	Blichfeldt and Jakobsen, 2017
Norsk kvit sau	NO	0.001	-	.	0.49%	Olivera et al., 2020; Blichfeldt and Jakobsen, 2017
Norsk pelssau	NO	-	-	.	0.20%	Blichfeldt and Jakobsen, 2017
Sjeviot	NO	-	-	.	0.40%	Blichfeldt and Jakobsen, 2017
Bohuslän-Dals svarthöna	SE	-0.090	-	-	-	Johansson and Nelson, 2015
Gotlandshöna	SE	0.171	-	-	-	Abebe, 2013
Hedemorahöna	SE	0.170	-	-	-	Johansson and Nelson, 2015

Kindahöna	SE	0.280	-	-	-	Abebe, 2013
Gammalsvensk dvärghöna	SE	-0.028	-	-	-	Abebe, 2013
Orusthöna	SE	0.103	-	-	-	Abebe, 2013
Skånsk blommehöna	SE	0.216	-	-	-	Abebe, 2013
Åsbohöna	SE	0.132	-	-	-	Abebe, 2013
Ölandshöna	SE	0.181	-	-	-	Abebe, 2013
Öländsk dvärghöna	SE	0.157	-	-	-	Abebe, 2013
Dansk/Svensk gårdshund	SE	0.210	-	0.041	-	Meadows et al., 2023; Jansson and Laikre 2018
Drever	SE	0.350	-	0.073	-	Meadows et al., 2023; Jansson and Laikre 2018
Gotlandsstövare	SE	0.280	-	0.103	-	Meadows et al., 2023; Jansson and Laikre 2018
Hamiltonstövare	SE	0.240	-	0.060	-	Meadows et al., 2023; Jansson and Laikre 2018
Hälleforshund	SE	0.330	-	0.085	-	Meadows et al., 2023; Jansson and Laikre 2018
Jämthund	SE	0.250	-	0.078	-	Meadows et al., 2023; Jansson and Laikre 2018
Norrbottenspets	SE	0.170	-	0.049	-	Meadows et al., 2023; Jansson and Laikre 2018
Schillerstövare	SE	-	-	0.068	-	Jansson and Laikre 2025
Smålandsstövare	SE	-	-	0.063	-	Jansson and Laikre 2026
Svensk lapphund	SE	0.270	-	0.081	-	Meadows et al., 2023; Jansson and Laikre 2018
Svensk vit älghund	SE	0.320	-	0.018	-	Meadows et al., 2023; Jansson and Laikre 2018
Västgötaspets	SE	0.360	-	0.089	-	Meadows et al., 2023; Jansson and Laikre 2018

Svensk lantrasget	SE	Varies between herds	-	-	-	Hegedűs, 2022
Gotlandsruss	SE	0.110	0.75%		-	Andersson, 2010
Svensk Ardenner	SE		-	0.012	-	Siekas, 2006
Svensk kallblodig travare	SE	8.69%	-	-	-	Velie et al., 2019
Linderödssvin	SE		-	0.150	-	Hansson, 2008
Dala pälsfår	SE	0.300#	-	-	-	Rochus et al., 2020
Fjällnäs	SE	0.360#	-	-	-	Rochus et al., 2020
Gotlandsfår	SE	0,030#	-	-	-	Rochus et al., 2020
Gestrikefår	SE	0.17	-	-	-	Sinhalage, 2023
Gutefår	SE	0.250#	-	-	-	Rochus et al., 2020
Helsingefår	SE	0.2	-	-	-	Sinhalage, 2023
Klövsjöfår	SE	0.260#	-	-	-	Rochus et al., 2020
Roslagsfår	SE	0.250	-	-	-	Sinhalage, 2023
Ryafår	SE	0.200	-	-	-	Sinhalage, 2023
Svenskt finullsfår	SE	0.180	-	-	-	Sinhalage, 2023
Svärdsjöfår	SE	0.230	-	-	-	Sinhalage, 2024
Värmlandsfår	SE	0.220	-	-	-	Sinhalage, 2025
Åsenfår	SE	0.210	-	-	-	Sinhalage, 2026
Tabacktorpsfår	SE	0.170	-	-	-	Sinhalage, 2027

* There are several ways of computing the F value both using pedigree and genomics – these measurements can therefore not be compared sensibly. For more information concerning the methods used for calculating the F values the reader is encouraged to look at the references.
# The references paper used three methods for calculating the inbreeding coefficient, the numbers presented in this table is the Fhat2 estimate

Supplementary table 2: Effective population size.

The provides and overview of the available information regarding effective population size for the different Nordic breeds.

Breed	Species	Country	Available information	Available from
The Nordic Brown Bee	Bee	TRA	NA	-
Danish red	Cattle	DK, TRA	Available	Sørensen, Sørensen and Berg, 2005
Fennoscandinavian reindeer	Reindeer	TRA	NA	-
Jysk kvæg	Cattle	DK	NA	
Rød dansk malkerace anno 1970	Cattle	DK	NA	-
Sortbroget dansk malkekvæg anno 1965	Cattle	DK	NA	-
Dansk malkekorthorn	Cattle	DK	NA	-
Agersø-kvæg	Cattle	DK	NA	-
Broholmeren	Dog	DK	NA	-
Dansk/svensk gårdhund	Dog	DK	NA	-
Gammel dansk hønsehund	Dog	DK	NA	-
Dansk spids	Dog	DK	NA	-
Den danske landand	Duck	DK	NA	-
Dansk landraceged	Goat	DK	NA	-
Den danske landgås	Goose	DK	NA	-

Den jydske hest	Horse	DK	Available	Thirstup, Pertoldi and Loeschcke, 2008
Knapstrupperhesten	Horse	DK	Available	Thirstup, Pertoldi and Loeschcke, 2009
Frederiksborghesten	Horse	DK	Available	Thirstup, Pertoldi and Loeschcke, 2010
Sortbroget landracesvin	Pig	DK	NA	-
(DI-1970)	Pig	DK	NA	-
Svaberduen	Pigeon	DK	NA	-
Parykduen	Pigeon	DK	NA	-
Tumlingeduen	Pigeon	DK	NA	-
Hvid dansk landkanin	Rabbit	DK	NA	-
Dansk landfår, herunder ertebøllefår	Sheep	DK	NA	-
Hvidhovedet marskfår	Sheep	DK	Available	Sørensen and Norberg, 2007
Finnish landrace	Cat	FI	NA	-
Itäsuomenkarja, isk (östfinsk boskap)	Cattle	FI	NA	-
Länsuomenkarja, lsk (västfisk boskap)	Cattle	FI	NA	-
Pohjoissuomenkarja, psk (nordfinsk boskap)	Cattle	FI	NA	-
Maatiaiskana (lantrashöna)	Chicken	FI	NA	-

(Lapinporokoira) porokoira (lapsk renhund)	Dog	FI	Available	Finnish Kennel Club
Karjalankarhukoira (karelsk björnhund)	Dog	FI	Available	Suomen pystykorvajärjestö finska spetsklubben ry
Pohjanpystykorva (norrbottenspets)	Dog	FI	NA	-
Suomenajokoira (finsk stövare)	Dog	FI	NA	-
Suomenlapinkoira (finsk lapphund)	Dog	FI	Available	Finnish Kennel Club
Suomenpystykorva (finsk spets)	Dog	FI	Available	Kumpulainen et al., 2017
Suomenvuohi (finngeit)	Goat	FI	NA	-
Suomenhevonen (finnhäst)	Horse	FI	Available	Tenhunen and Salonpää, 2016
Ahvenanmaanlammas (ålandsfår)	Sheep	FI	NA	-
Kainuunharmas (kajanalandsfår)	Sheep	FI	NA	-
Suomenlammas	Sheep	FI	Available	
Íslenskir nautgripir	Cattle	IS	Available	Gautason et al., 2021
Íslensk hænsn	Chicken	IS	Available	Breed association for Icelandic landrace chicken
Íslenski hundurinn	Dog	IS	NA	-
Íslenskar geitur	Goat	IS	Available	Baldursdottir, Kristjansson and Hallsson, 2012
Íslenski hesturinn	Horse	IS	Available	Hreidarsdottir et al., 2014

Íslenskt sauðfé	Sheep	IS	NA	-
Íslenskt forystufé	Sheep	IS	NA	-
Føroysk dunna	Duck	FO	NA	-
Føroysk gás	Goose	FO	NA	-
Føroysk ross	Horse	FO	Available	Kettunen, Joensen and Berg, 2022
Føroyskur seyður	Sheep	FO	NA	-
Norsk skogskatt	Cat	NO	NA	-
Dølafe	Cattle	NO	Available	Holene, Berg and Sæther, 2021
Sidet trønderfe og nordlandsfe (stn)	Cattle	NO	Available	Holene, Berg and Sæther, 2021
Telemarkfe	Cattle	NO	Available	Holene, Berg and Sæther, 2021
Vestlandsk fjordfe	Cattle	NO	Available	Holene, Berg and Sæther, 2021
Vestlandsk raudkolle	Cattle	NO	Available	Holene, Berg and Sæther, 2021
Østlandsk rødkolle	Cattle	NO	Available	Holene, Berg and Sæther, 2021
Norske jærhøns	Chicken	NO	Available	Brekke et al., 2020
Dunker	Dog	NO	NA	-
Haldenstøver	Dog	NO	NA	-
Hygenhund	Dog	NO	NA	-
Lundehund	Dog	NO	Available	Pfahler and Disti, 2015
Norsk buhund	Dog	NO	NA	-

Norsk elghund sort	Dog	NO	Available	Svihus and Wetten, 2023
Norsk elghund grå	Dog	NO	Available	Norske elghundklubbers forbund, 2021
Norsk melkegeit	Goat	NO	Available	Berg et al., 2020
Kystgeit	Goat	NO	Available	Berg et al., 2021
Norsk hvit gås	Goose	NO	NA	-
Smålensgås	Goose	NO	NA	-
Dølahest	Horse	NO	Available	Olsen, 2010
Fjordhest	Horse	NO	Available	Olsen et al., 2020
Nordlandshest/lynghest	Horse	NO	Available	Olsen, 2010
Norsk kaldblodstraver	Horse	NO	Available	Olsen, 2010
Norsk landrace	Pig	NO	NA	-
Trønderkanin	Rabbit	NO	NA	-
Gammelnorsk spælsau	Sheep	NO	NA	-
Blæset sau	Sheep	NO	NA	-
Grå trøndersau	Sheep	NO	NA	-
Rygjasau	Sheep	NO	NA	-
Dalasau	Sheep	NO	NA	-
Fuglestadbrogete sau	Sheep	NO	NA	-
Gammelnorsk sau	Sheep	NO	NA	-
Kvit spælsau	Sheep	NO	Available	NSG

Norsk kvit sau	Sheep	NO	Available	NSG
Norsk pelssau	Sheep	NO	NA	-
Sjeviot	Sheep	NO	Available	NSG
Steigarsau	Sheep	NO	NA	-
Hus/bondkatt	Cat	SE	NA	-
Bohuskulla	Cattle	SE	Available	Adepoju, 2022
Fjällnära boskap	Cattle	SE	Available	Adepoju, 2022
Ringamålako	Cattle	SE	Available	Adepoju, 2022
Väneko	Cattle	SE	Available	Adepoju, 2022
Rödkulla	Cattle	SE	Available	Adepoju, 2022
Svensk kullig boskap (skb)	Cattle	SE	Available	Adepoju, 2022
Svensk låglandsboskap (slb)	Cattle	SE	Available	Adepoju, 2022
Svensk röd och vit boskap (srb)	Cattle	SE	NA	-
Svensk Fjällras	Cattle	SE	Available	Adepoju, 2022
Gammalsvensk dvärghöna	Chicken	SE	Available	Hilding, 2023
Bohuslän-dals svarthöna	Chicken	SE	Available	Johansson and Nelson, 2015
Gotlandshöna	Chicken	SE	Available	Hilding, 2023
Svensk dvärghöna	Chicken	SE	NA	Hilding, 2023
Orusthöna	Chicken	SE	Available	Hilding, 2023
Ölandshöna	Chicken	SE	Available	Hilding, 2023

Öländsk dvärghöna	Chicken	SE	Available	Hilding, 2023
Bjurholmshöna	Chicken	SE	Available	Hilding, 2023
Kindahöna	Chicken	SE	Available	Hilding, 2023
Skånsk blommehöna	Chicken	SE	Available	Hilding, 2023
Hedemorahöna	Chicken	SE	Available	Hilding, 2023
Åsbohöna	Chicken	SE	Available	Hilding, 2023
Norrbottenspets	Dog	SE	Available	Jansson and Laikre, 2018
Schillerstövare	Dog	SE	Available	Jansson and Laikre, 2018
Smålandsstövare	Dog	SE	Available	Jansson and Laikre, 2018
Svensk lapphund	Dog	SE	Available	Jansson and Laikre, 2018
Västgötaspets	Dog	SE	Available	Jansson and Laikre, 2018
Gotlandsstövare	Dog	SE	Available	Jansson and Laikre, 2018
Dansk/svensk gårdshund	Dog	SE	Available	Jansson and Laikre, 2018
Drever	Dog	SE	Available	Jansson and Laikre, 2018
Hamiltonstövare	Dog	SE	Available	Jansson and Laikre, 2018
Jämthund	Dog	SE	Available	Jansson and Laikre, 2018
Hälleforshund	Dog	SE	Available	Jansson and Laikre, 2018
Svensk vit älghund	Dog	SE	Available	Jansson and Laikre, 2018
Svensk blå anka	Duck	SE	NA	-
Svensk gul anka	Duck	SE	NA	-

Svensk myskanka	Duck	SE	NA	-
Blekingeanka	Duck	SE	NA	-
Göingeget	Goat	SE	NA	-
Jämtget	Goat	SE	NA	-
Svensk lantrasget	Goat	SE	NA	-
Lappget	Goat	SE	NA	-
Ölandsgås	Goose	SE	NA	-
Skånegås	Goose	SE	NA	-
Gotlandsruss	Horse	SE	Available	
Nordsvensk brukshäst	Horse	SE	Available	
Svensk ardenner	Horse	SE	Available	
Svensk kallblodig travare	Horse	SE	NA	
Linderödssvin	Pig	SE	Available	
Svensk pälskanin	Rabbit	SE	NA	-
Gotlandskanin	Rabbit	SE	NA	
Mellerudskanin	Rabbit	SE	NA	
Dala pälsfår	Sheep	SE	Available	Rochus, Jonas and Johansson, 2020
Tabacktorpsfår	Sheep	SE	NA	Sinhalage, 2023
Dala pälsfår	Sheep	SE	Available	Rochus, Jonas and Johansson, 2020

Gestrikefår	Sheep	SE	NA	-
Helsingefår	Sheep	SE	NA	-
Klövsjöfår	Sheep	SE	Available	Rochus, Jonas and Johansson, 2020
Roslagsfår	Sheep	SE	NA	-
Ryafår	Sheep	SE	NA	-
Svensk finullsfår	Sheep	SE	NA	-
Åsenfår	Sheep	SE	NA	-
Svärdsjöfår	Sheep	SE	NA	-
Gotlandsfår	Sheep	SE	Available	Rochus, Jonas and Johansson, 2020
Gutefår	Sheep	SE	Available	Rochus, Jonas and Johansson, 2020
Värmlandsfår	Sheep	SE	NA	-

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NordGen

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