### "NaNo horse" Native Nordic horse project

## Genomic characterization as a tool towards sustainable breeding

ERFP Northern European native horse network meeting 17.10.2024



### Background

- Nordic horse network meeting 2020
  - Stiftelsen Hästforskning Swedish/Norwegian horse research funding
  - Working group:
    - NMBU (Peer Berg, Nathalie A. Smogeli)
    - SLU (Susanna Eriksson, Sofia Mikko, Iryna Shutava)
    - Norsk Hestesenter (Therese Selle)
    - NordGen (Maria Kjetså)





### Background cont.

- Genomic characterization needed for the Nordic horse breeds:
  - Questions:
    - Inbreeding and genomic variation within breeds:
      - Best way to conserve the breeds? Can we keep the current breeding program or do we need to make changes?
    - Relationship between the breeds
      - History of exchange of stallions /horses across borders - > how related are they?
      - Can we find unique or important genes giving evidence to the need of conservation?
      - Can we find genes related to fertility or other issues?





### Samples

Breed	Breed abbreviation	N. horses	Sampling Country	
Nordland/Lyngen Horse	NL	30	Norway	
Fjord horse	NFH	25	Norway	
Dola horse	D	30	Norway	
Coldblooded Trotter	KT	28	Norway/ Sweden	
North Swedish Horse	NSB	30	Sweden	
Swedish Ardennes	А	22 Sweden		
Gotland Pony	G	15 Sweden		
Faroese Horse	F	10	Faroe Islands	



### Samples

Norwegian breeds:

- Nordland/Lyngen (north) (Finnhorse?)
- Fjord horse (west)
- Dola horse (east)
- Coldblooded trotter (east «lighter» version of Dola + Sweden)

#### Swedish breeds:

- North Swedish horse (north)
- Swedish Ardennes (south /belgium)
- Gotland pony (Gotlan Island /south east) (Welsh?)
- Coldblooded trotter (from North Swedish and Norway)

Faroese: Viking settlers (Icelandic horse + UK ?)





### Methods

- Whole Genome Sequences (WGS)
  - High resolution DNA
  - Structural variants in addition to

SNPs

- Many possibilites
- Reference genome:
  - "Regular" (From Thoroughbred)
  - New: From Finnhorse



![](_page_5_Picture_10.jpeg)

### **Preliminary results**

Nathalie A. Smogeli

![](_page_6_Picture_2.jpeg)

![](_page_6_Picture_3.jpeg)

### **Principal Component Analysis (PCA)**

![](_page_7_Figure_1.jpeg)

### Principal Component Analysis (PCA)

![](_page_8_Figure_1.jpeg)

### Runs of Homozygosity inbreeding coefficient (F\_ROH)

#### How F\_ROH is Calculated:

- **ROH Segments**: The genome is scanned to detect long contiguous regions where the alleles are identical on both chromosomes.
- These regions are indicative of inbreeding because they suggest that the individual received the same genetic material from both parents.
- **F\_ROH Formula**: The inbreeding coefficient F\_ROH is calculated by dividing the total length of the genome covered by ROH segments by the total length of the genome analyzed. This gives the proportion of the genome that is homozygous due to inbreeding.

![](_page_9_Picture_5.jpeg)

![](_page_9_Picture_6.jpeg)

### Genomic inbreeding coefficient (F\_ROH)

Breed	EquCab3			EquCab_Finn		
	Min (%)	Max (%)	Mean (%)	Min (%)	Max (%)	Mean (%)
Swedish Ardennes	10.0	18.2	13.8	8.9	16.8	12.5
Dola horse	7.7	30.4	23.0	6.4	27.8	21.2
Faroese Horse	28.7	38.1	33-4	27.2	36.6	31.4
Gotland Pony	17.1	25.9	22.5	15.6	24.4	20.5
Coldblooded Trotter	2.6	20.3	15.5	2.1	19.0	14.0
Fjord horse	3.8	18.2	14.7	2.9	17.0	13.3
Nordland/Lyngen Horse	14.7	25.3	20.5	12.6	23.5	18.6
North Swedish Horse	1.2	24.9	15.6	0.6	23.1	14.3

![](_page_10_Picture_2.jpeg)

### Pedigree inbreeding coefficient (F)

Table 1. Inbreeding for horses born in the same year caulcaulated by pedigree («F»)

Breed	Year	F per birth year
Dølahest	2023	13,4 %
Norsk Fjordhest	2023	8,2 %
Nordlandshest/Lyngshest	2023	12,9%
Norsk Kaldblodstraver*	2023	8,6 %
Svensk Kaldblodstraver*	2020	8,1%
Svensk Ardenner	2021	2,3%
Nordsvensk Brukshäst	2021	2,5 %
Gotlandsruss	2021	13,4 %
Færøysk Hest	2016	26,8%

![](_page_11_Picture_3.jpeg)

### Runs of Homozygosity inbreeding (F\_ROH)

Froh of Equcab3 Mapped Data

![](_page_12_Figure_2.jpeg)

### MSc on Faroese horse (Signa K. Joensen)

3.2 Principal Component Analysis

![](_page_13_Figure_2.jpeg)

![](_page_13_Picture_3.jpeg)

![](_page_13_Picture_4.jpeg)

### MSc on Faroese horse (Signa K. Joensen)

![](_page_14_Figure_1.jpeg)

Figure 12 ROHs on chromosome 28 for 15 high-coverage samples. Blue lines indicate homozygous sites and red lines indicate heterozygous sites. Black and grey lines indicate ROHs. The bottom bar shows the length of the chromosome.

### **Further work**

- More in-depth work in progress!
- Structural variants
- Signatures of selection
- Private alleles
- ++

![](_page_15_Picture_6.jpeg)

![](_page_15_Picture_7.jpeg)

# Nordic breeds and relationship with other breeds

![](_page_16_Figure_1.jpeg)

![](_page_16_Picture_2.jpeg)

### Nordic breed analysis

- Collaborations with researchers to get data from Iceland, Finland and Denmark
- We are making a complete map of relationship between all Nordic breeds
- Might be room for other breeds?
- Baltic? UK?
- Interesting with breeds that might have common ancestry or interaction with Nordic breeds

![](_page_17_Picture_6.jpeg)

![](_page_17_Picture_7.jpeg)

### **Questions?**

Final seminar next Thursday 24th of October with more indept results and discussion.

- Scandinavian language
- For horse owners and breeders
- Priogram and registration:
- https://t.ly/cbNXs

![](_page_18_Picture_6.jpeg)

![](_page_18_Picture_7.jpeg)