

Genomic and genealogical coancestries within and between the Norwegian and the Swedish Fjord horses

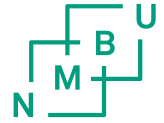
69th Annual Meeting of the EAAP

Saija Tenhunen ^{1),3)}, Hanne Fjerdingsby Olsen ¹⁾, Nils Ivar Dolvik ²⁾, Dag Inge Våge ¹⁾, Gunnar Klemetsdal ¹⁾

Photos: Saija Tenhunen & Anniina Kallioniemi

- 1) Department of Animal and Aquacultural Sciences, Norwegian University of Life Sciences
- 2) Department of Veterinary Sciences, Norwegian University of Life Sciences
- 3) VikingGenetics

Norwegian Fjord Horse



- One of the oldest horse breeds
- Distinct phenotype

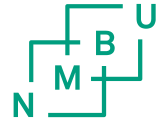
Mongolian wild horse (Przewalski)



Norwegian Fjord Horse



Mongolian wild horse (Przewalski)



- One of the oldest horse breeds
- Distinct phenotype

Registrations
decreasing in Norway

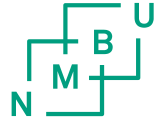


Subpopulations
around the world



Implement tool to
estimate relationships
between populations

Material



Samples

- In total 413 samples
 - 311 Norwegian
 - 102 Swedish

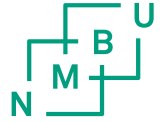
Pedigree data

- Norway
 - 26,446 horses
 - CGE 13.7
- Sweden
 - 14,595 horses
 - CGE 12.4

Molecular data

- Axiom Equine Genotyping Array chip
 - 670,796 SNPs
 - After data quality control 485,918 SNPs

Methods – Coancestry



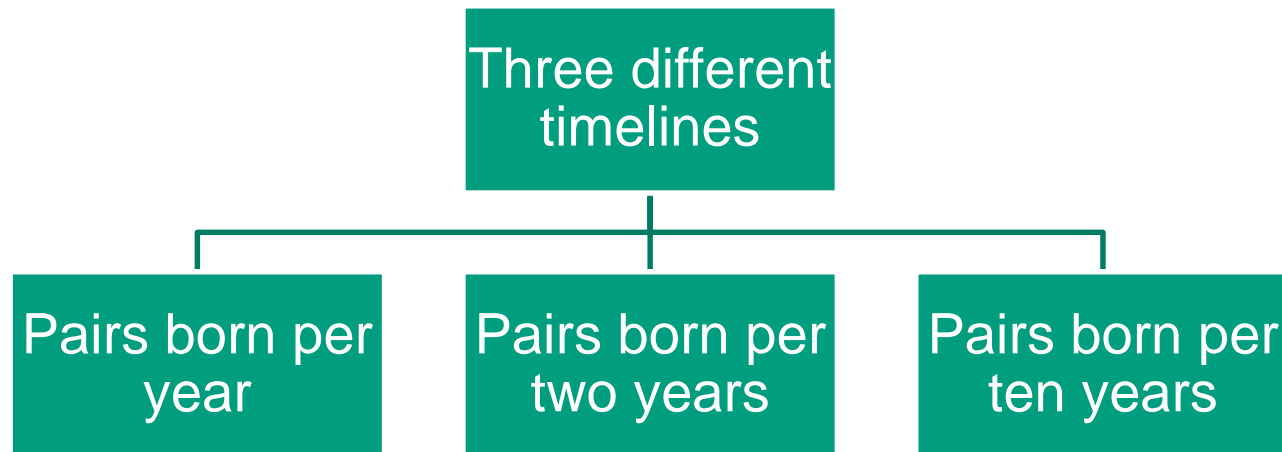
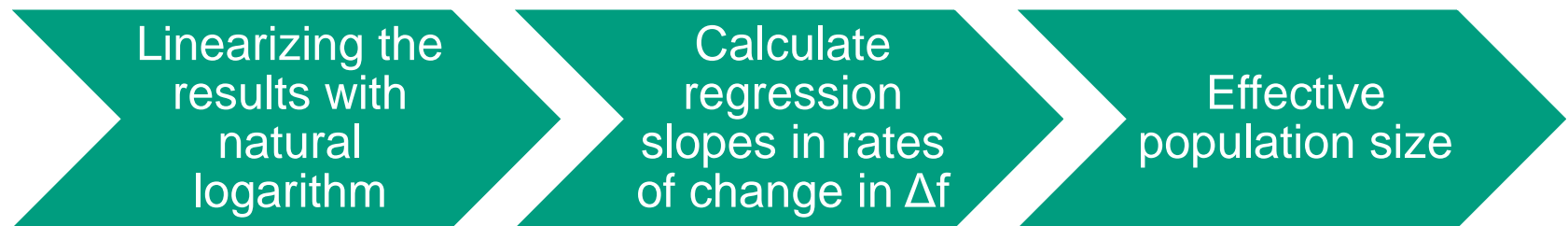
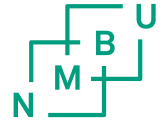
Three coancestry methods

Pedigree (f_{ped})

Molecular homozygosity (f_{hom})

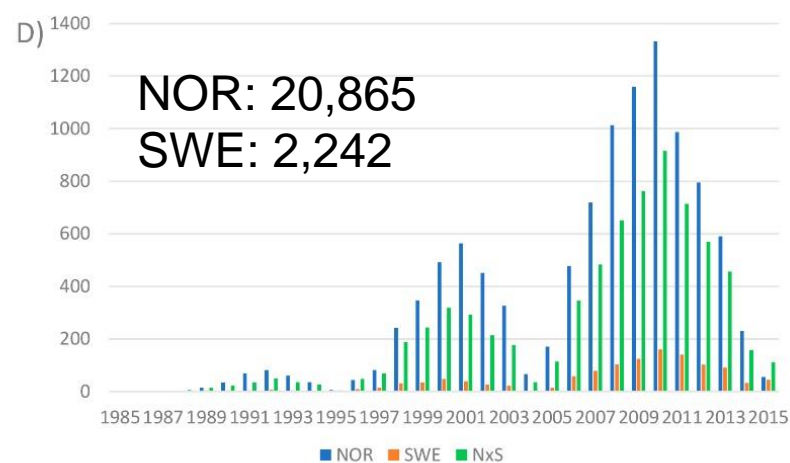
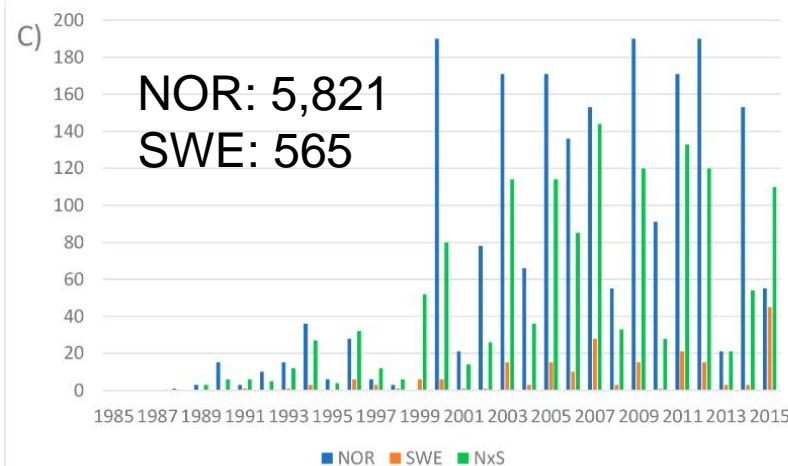
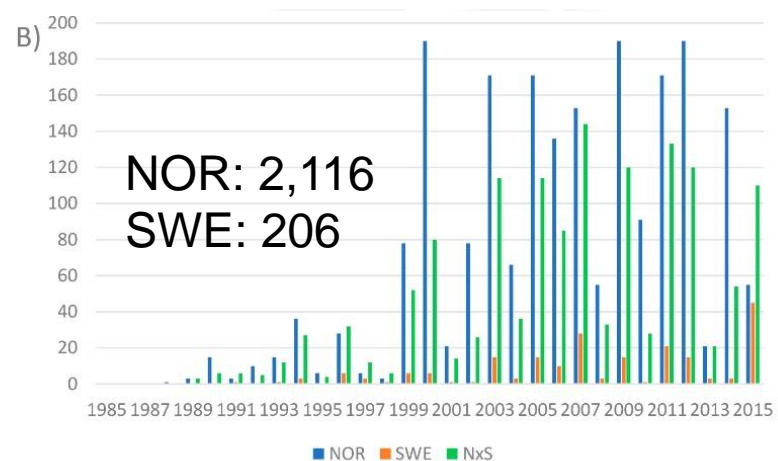
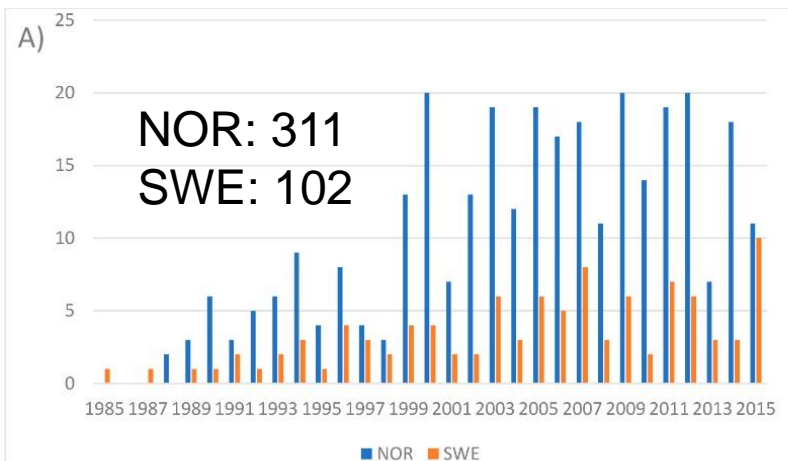
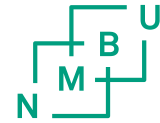
Shared genomic segments (f_{seg})

Methods – Effective population size



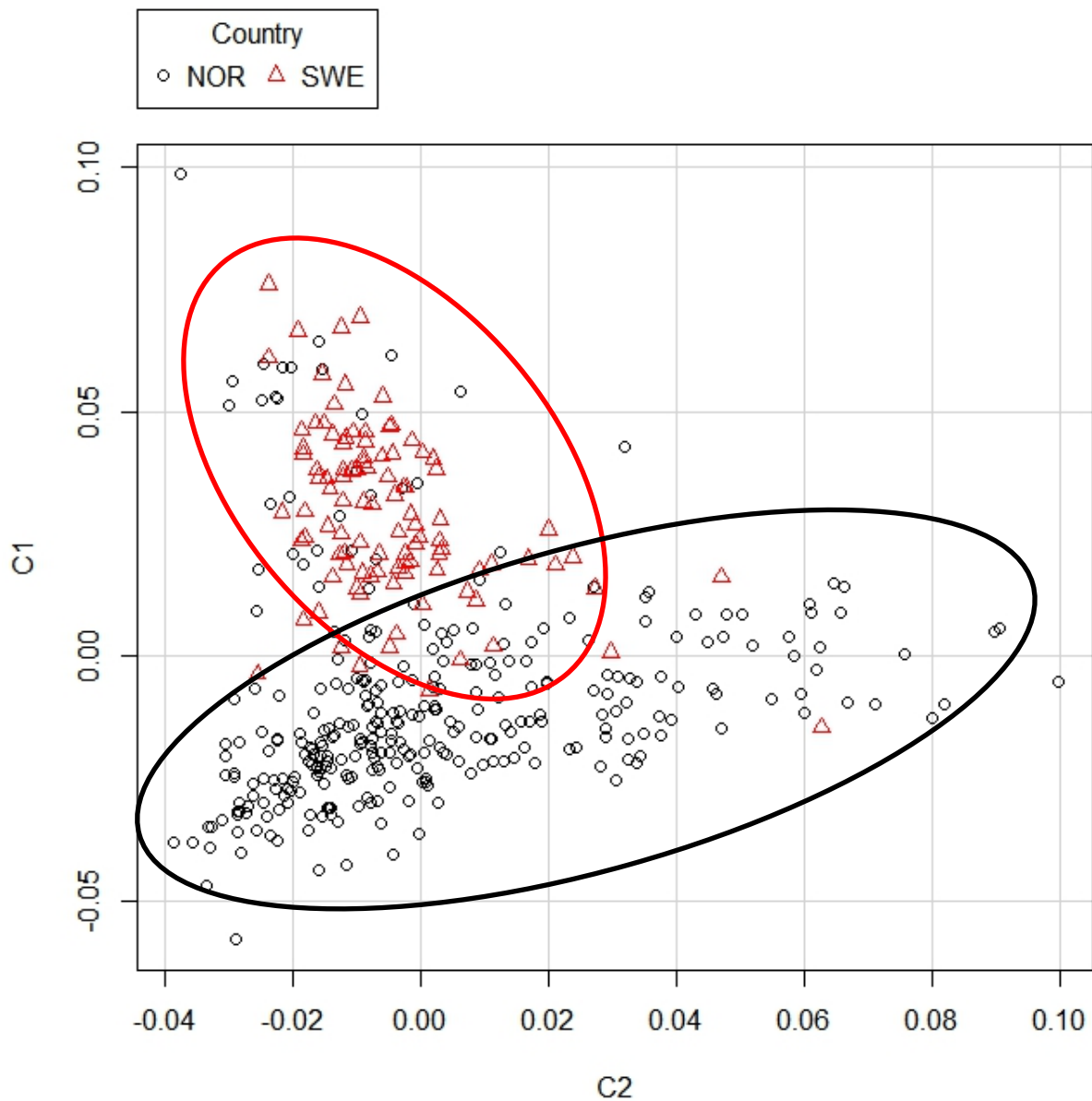
Ne was also calculated from individual pedigree inbreeding

Timelines and animal distribution from 1985 to 2015



A) Animals born per year

B) - D) Animals pairs born per year



Results

Regression of			Intercept			Reg. Coefficient			R ²		
			Nor	Swe	NxS	Nor	Swe	NxS	Nor	Swe	NxS
f_{hom}	on	f_{ped}	-1.417	-1.419	-	1.410	1.531	-	0.703	0.866	-
f_{seg100kb}	on	f_{ped}	-0.068	-0.062	-	0.983	0.952	-	0.636	0.819	-
f_{seg500kb}	on	f_{ped}	-0.063	-0.057	-	0.973	0.950	-	0.630	0.817	-
$f_{\text{seg1.5Mb}}$	on	f_{ped}	-0.038	-0.031	-	0.897	0.886	-	0.560	0.784	-
f_{seg2Mb}	on	f_{ped}	-0.032	-0.024	-	0.863	0.858	-	0.533	0.774	-
f_{seg100kb}	on	f_{hom}	0.838	0.792	0.784	0.644	0.603	0.601	0.770	0.891	0.562
f_{seg500kb}	on	f_{hom}	0.834	0.797	0.777	0.637	0.603	0.593	0.764	0.890	0.551
$f_{\text{seg1.5Mb}}$	on	f_{hom}	0.794	0.762	0.735	0.591	0.560	0.546	0.687	0.848	0.459
f_{seg2Mb}	on	f_{hom}	0.768	0.740	0.704	0.568	0.540	0.520	0.652	0.829	0.422

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f _{seg500kb}	on	f _{ped}	-0.063	-0.057	-	0.973	0.950	-	0.630	0.817	-
f _{seg1.5Mb}	on	f _{ped}	-0.038	-0.031	-	0.897	0.886	-	0.560	0.784	-
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f _{seg1.5Mb}	on	f _{ped}	-0.038	-0.031	-	0.897	0.886	-	0.560	0.784	-
f _{seg2Mb}	on	f _{ped}	-0.032	-0.024	-	0.863	0.858	-	0.533	0.774	-
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f _{seg2Mb}	on	f _{hom}	0.768	0.740	0.704	0.568	0.540	0.520	0.652	0.829	0.422

Results

	Mean			Range						Variance		
	Nor	Swe	NxS	Nor		Swe		NxS		Nor	Swe	NxS
f_{ped}	0.082	0.065	-	0.030	0.344	0.017	0.311	-	-	0.00063	0.00104	-
f_{hom}	0.785	0.782	0.778	0.761	0.885	0.763	0.873	0.760	0.868	0.00009	0.00015	0.00003
$f_{seg100kb}$	0.141	0.119	0.115	0.060	0.439	0.055	0.379	0.047	0.396	0.00085	0.00120	0.00036
$f_{seg500kb}$	0.136	0.114	0.110	0.055	0.427	0.049	0.375	0.038	0.390	0.00085	0.00120	0.00036
$f_{seg1.5Mb}$	0.108	0.087	0.083	0.016	0.401	0.016	0.337	0.011	0.366	0.00088	0.00119	0.00039
f_{seg2Mb}	0.100	0.079	0.076	0.012	0.389	0.008	0.327	0.005	0.354	0.00088	0.00115	0.00039

	Regression Coefficient (b)				Standard Error (SE)			
	Nor	Swe	NxS	All	Nor	Swe	NxS	All
F_{ped}	-0.0007719	-0.0001603	-	-	0.0000053	0.0000031	-	-
N	26446	14677	-	-	-	-	-	-
Pairs per year	Nor	Swe	NxS	All	Nor	Swe	NxS	All
$f_{seg100kb}$	-0.00105	-0.00082	-0.00035	-0.00065	0.00017	0.00051	0.00010	0.00012
f_{hom}	-0.00049	-0.00089	-0.00009	-0.00026	0.00024	0.00080	0.00012	0.00016
N	2116	206	1397	3719	2116	206	1397	3719
Two years	Nor	Swe	NxS	All	Nor	Swe	NxS	All
$f_{seg100kb}$	-0.00090	-0.00017	-0.00034	-0.00061	0.00010	0.00029	0.00006	0.00007
f_{hom}	-0.00040	-0.00023	-0.00006	-0.00024	0.00013	0.00043	0.00007	0.00009
N	5821	565	3839	10225	5821	565	3839	10225
10 years	Nor	Swe	NxS	All	Nor	Swe	NxS	All
$f_{seg100kb}$	-0.00087	-0.00004	-0.00039	-0.00056	0.00005	0.00017	0.00003	0.00004
f_{hom}	-0.00043	0.00007	-0.00016	-0.00023	0.00007	0.00024	0.00004	0.00005
N	20865	2242	13867	36974	20865	2242	13867	36974
	Effective population size (N_e)				Confidence Interval (CI)			
	Nor	Swe	NxS	All	Nor	Swe	NxS	All
F_{ped}	71	269	-	-	70—72	259—279	-	-
N	26446	14677	-	-	26446	14677	-	-
Pairs per year	Nor	Swe	NxS	All	Nor	Swe	NxS	All
$f_{seg100kb}$	52	52	137	75	40—76	24—∞	89—302	55—116
f_{hom}	113	48	525	184	57—3759	18—∞	144—∞	84—∞
N	2116	206	1397	3719	2116	206	1397	3719
Two years	Nor	Swe	NxS	All	Nor	Swe	NxS	All
$f_{seg100kb}$	61	260	141	79	51—77	58—∞	105—214	65—101
f_{hom}	139	189	792	202	84—401	40—∞	233—∞	117—731
N	5821	565	3839	10225	5821	565	3839	10225
10 years	Nor	Swe	NxS	All	Nor	Swe	NxS	All
$f_{seg100kb}$	63	1136	125	87	57—72	119—∞	107—152	77—100
f_{hom}	129	∞	293	209	98—187	106—∞	194—602	149—347
N	20865	2242	13867	36974	20865	2242	13867	36974

	Regression Coefficient (b)				Standard Error (SE)			
	Nor	Swe	NxS	All	Nor	Swe	NxS	All
F_{ped}	-0.0007719	-0.0001603	-	-	0.0000053	0.0000031	-	-
N	26446	14677	-	-	-	-	-	-
Pairs per year	Nor	Swe	NxS	All	Nor	Swe	NxS	All
$f_{seg100kb}$	-0.00105	-0.00082	-0.00035	-0.00065	0.00017	0.00051	0.00010	0.00012
f_{hom}	-0.00049	-0.00089	-0.00009	-0.00026	0.00024	0.00080	0.00012	0.00016
N	2116	206	1397	3719	2116	206	1397	3719
Two years	Nor	Swe	NxS	All	Nor	Swe	NxS	All
$f_{seg100kb}$	-0.00090	-0.00017	-0.00034	-0.00061	0.00010	0.00029	0.00006	0.00007
f_{hom}	-0.00040	-0.00023	-0.00006	-0.00024	0.00013	0.00043	0.00007	0.00009
N	5821	565	3839	10225	5821	565	3839	10225
10 years	Nor	Swe	NxS	All	Nor	Swe	NxS	All
$f_{seg100kb}$	-0.00087	-0.00004	-0.00039	-0.00056	0.00005	0.00017	0.00003	0.00004
f_{hom}	-0.00043	0.00007	-0.00016	-0.00023	0.00007	0.00024	0.00004	0.00005
N	20865	2242	13867	36974	20865	2242	13867	36974
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	Nor	Swe	NxS	All	Nor	Swe	NxS	All
F_{ped}	71	269	-	-	70—72	259—279	-	-
N	26446	14677	-	-	26446	14677	-	-
Pairs per year	Nor	Swe	NxS	All	Nor	Swe	NxS	All
$f_{seg100kb}$	52	52	137	75	40—76	24—∞	89—302	55—116
f_{hom}	113	48	525	184	57—3759	18—∞	144—∞	84—∞
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Two years	Nor	Swe	NxS	All	Nor	Swe	NxS	All
$f_{seg100kb}$	61	260	141	79	51—77	58—∞	105—214	65—101
f_{hom}	139	189	792	202	84—401	40—∞	233—∞	117—731
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10 years	Nor	Swe	NxS	All	Nor	Swe	NxS	All
$f_{seg100kb}$	63	1136	125	87	57—72	119—∞	107—152	77—100
f_{hom}	129	∞	293	209	98—187	106—∞	194—602	149—347
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	Regression Coefficient (b)				Standard Error (SE)			
	Nor	Swe	NxS	All	Nor	Swe	NxS	All
F_{ped}	-0.0007719	-0.0001603	-	-	0.0000053	0.0000031	-	-
N	26446	14677	-	-	-	-	-	-
Pairs per year	Nor	Swe	NxS	All	Nor	Swe	NxS	All
$f_{seg100kb}$	-0.00105	-0.00082	-0.00035	-0.00065	0.00017	0.00051	0.00010	0.00012
f_{hom}	-0.00049	-0.00089	-0.00009	-0.00026	0.00024	0.00080	0.00012	0.00016
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Two years	Nor	Swe	NxS	All	Nor	Swe	NxS	All
$f_{seg100kb}$	-0.00090	-0.00017	-0.00034	-0.00061	0.00010	0.00029	0.00006	0.00007
f_{hom}	-0.00040	-0.00023	-0.00006	-0.00024	0.00013	0.00043	0.00007	0.00009
N	5821	565	3839	10225	5821	565	3839	10225
10 years	Nor	Swe	NxS	All	Nor	Swe	NxS	All
$f_{seg100kb}$	-0.00087	-0.00004	-0.00039	-0.00056	0.00005	0.00017	0.00003	0.00004
f_{hom}	-0.00043	0.00007	-0.00016	-0.00023	0.00007	0.00024	0.00004	0.00005
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Conclusion

- One breed genetically but there is some differences between subpopulations
- Recommendation to use f_{seg} to calculate relationships between Fjord horse populations
- Greatest possibility to build international breeding cooperation
- Practical issues:
 - Rather expensive genotyping
 - Calculating shared segments is still slow
 - New methods to speed up the process?



Thank you!

Email: saten@vikinggenetics.com