

A herd of bison is grazing in a vast, grassy field. In the background, there are rolling hills and mountains under a cloudy sky. The bison are scattered across the field, some standing and some lying down.

Revealing the Past and Present of Bison Using Genome Analysis

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Presentation outline

1. What can genetics teach us about the history of the Yellowstone bison herd?
2. What genetic information can we gain from analyzing bison fecal samples?
3. How can we develop more powerful genetic testing technologies?

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Background

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- Well documented recent bottleneck
- Intensive management and population control is necessary



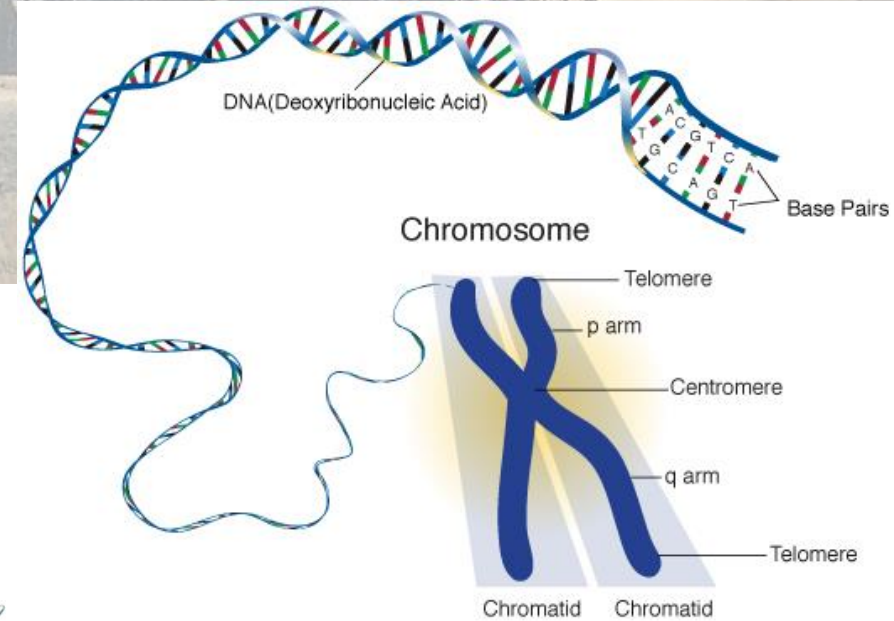
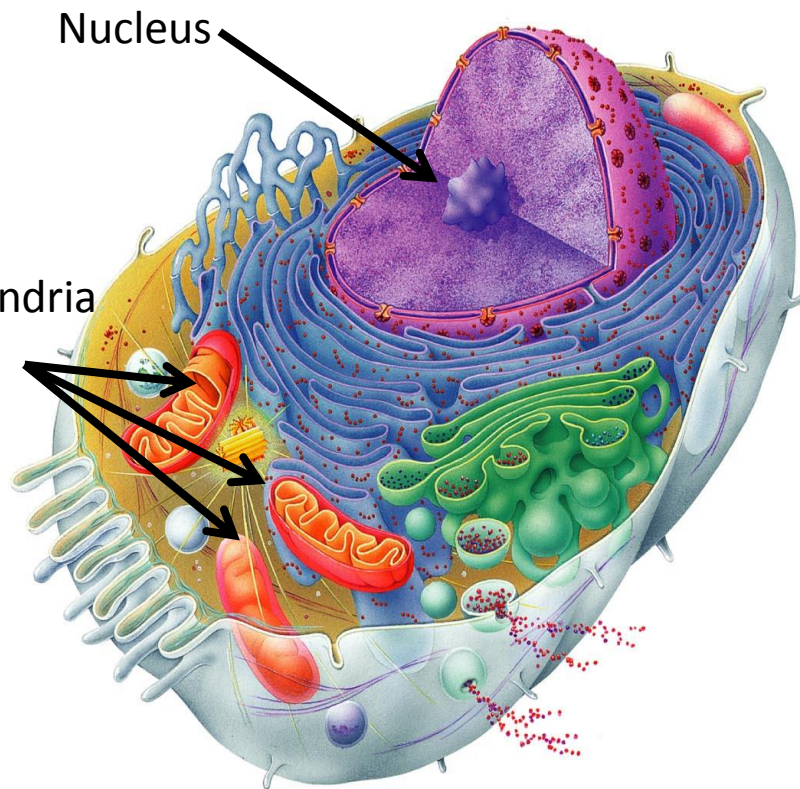
Star Tribune

Background



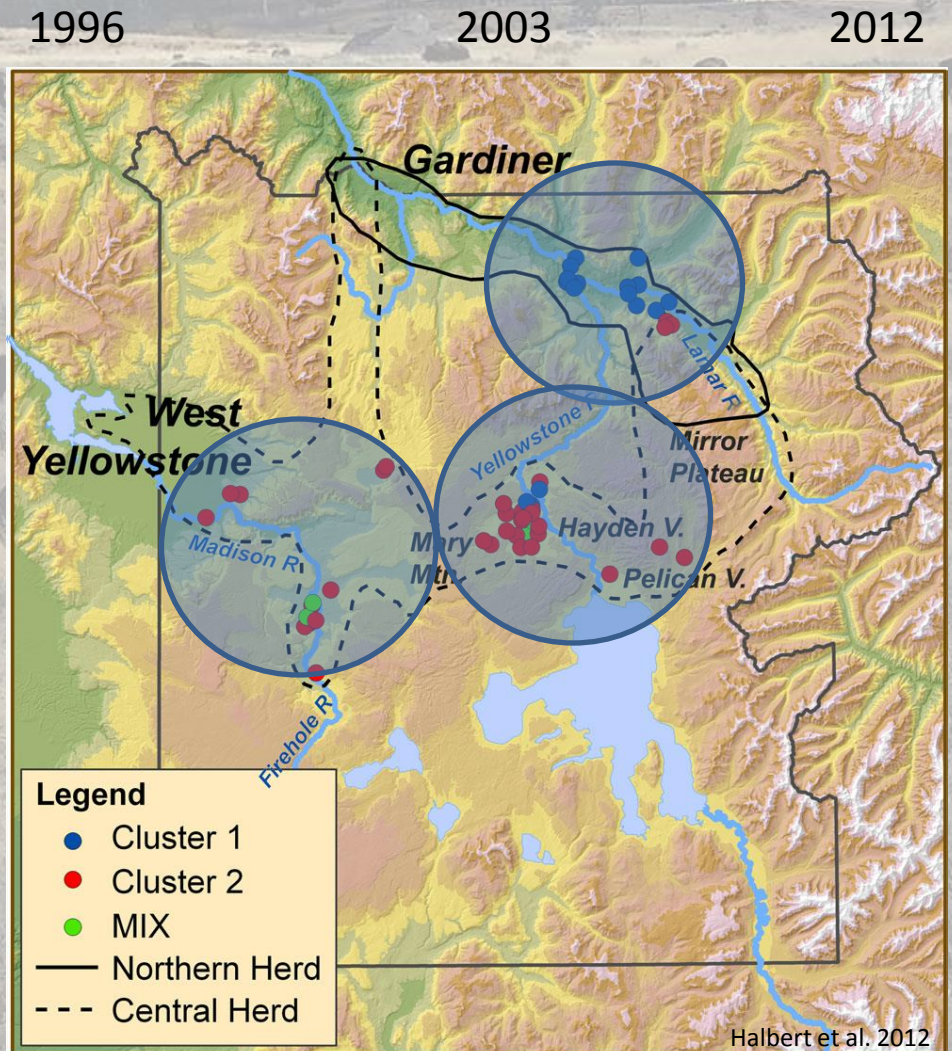
Objective: Analyze the genetic diversity and population structure of Yellowstone bison

The bison cell



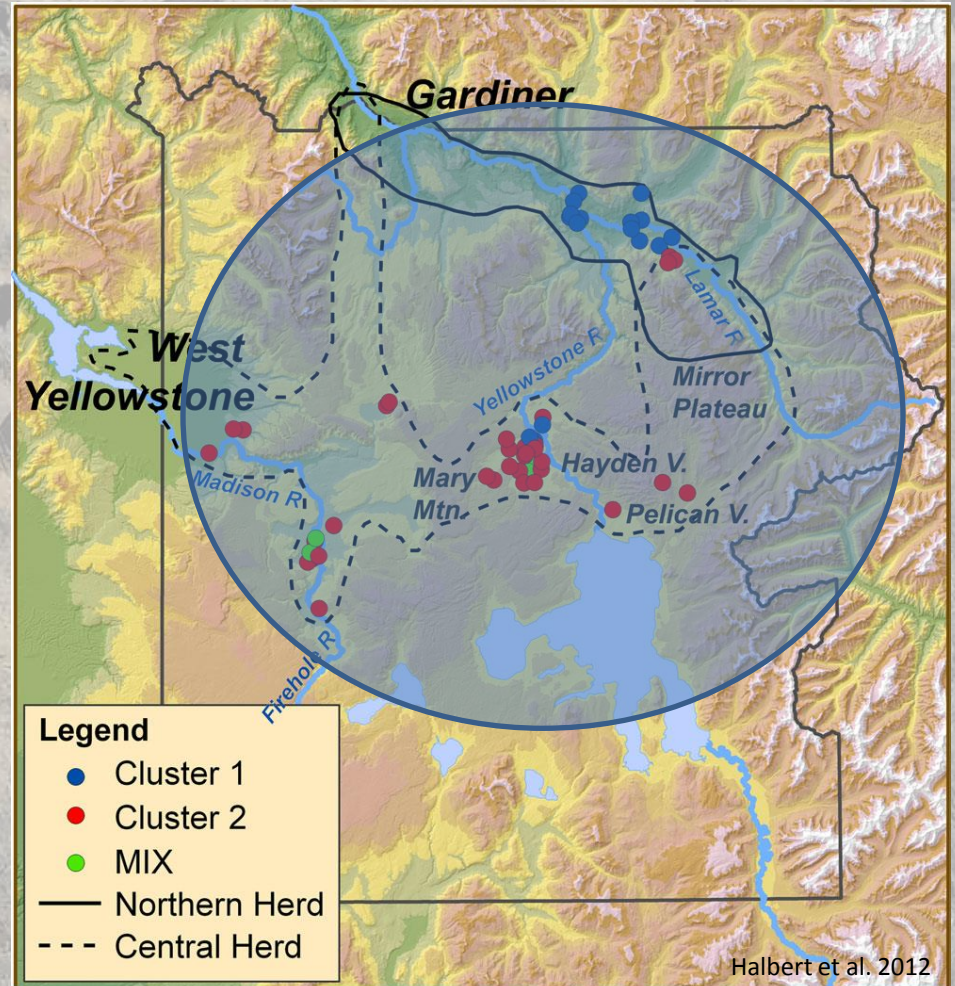
Population structure

- Since the late 1990s:
 - Population size has increased significantly
 - Migration within the park has become commonplace
 - Leading to population differentiation loss

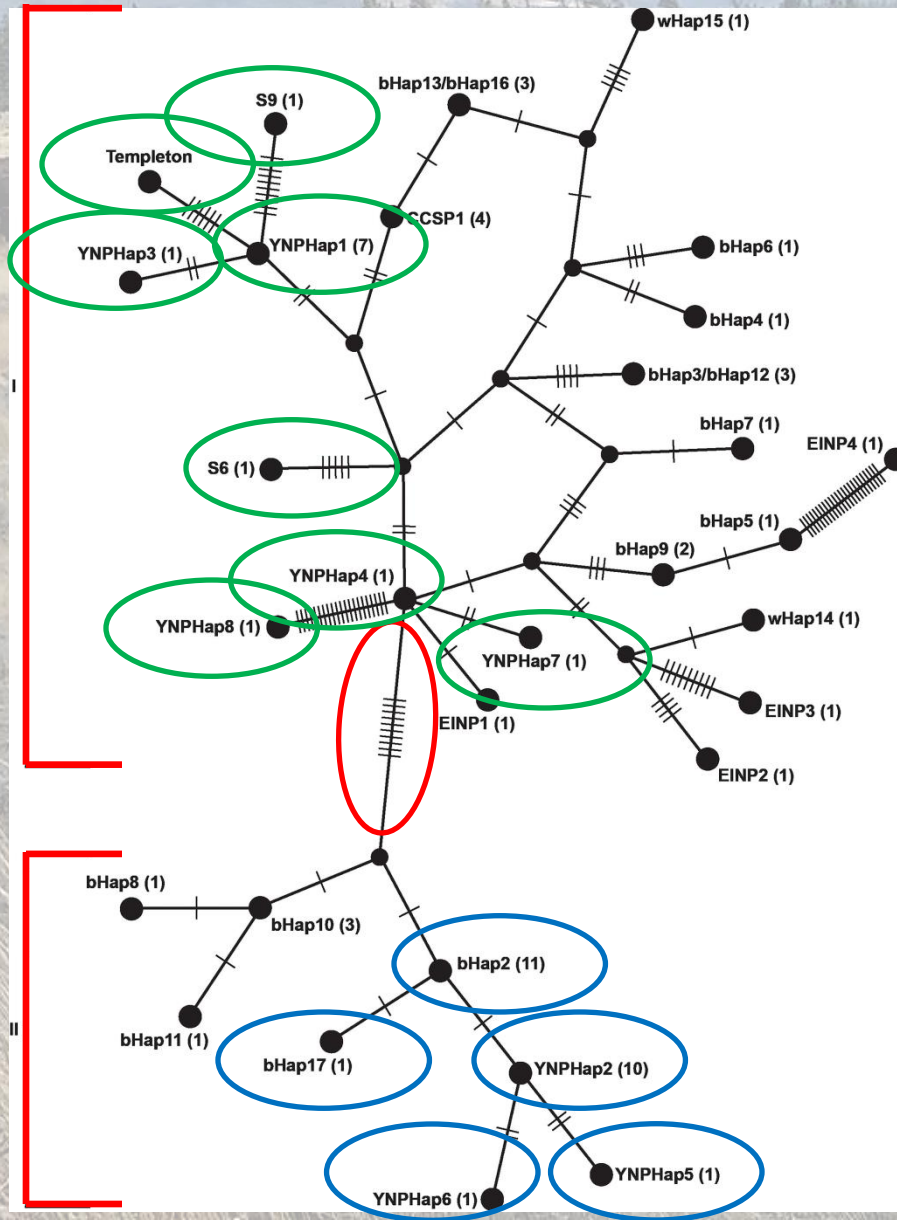


Population structure

- Increase in migration results in:
 - Reduced diversity between populations
 - Increased diversity in the whole population
- High population genetic diversity, but only small differences between individuals
- Signature of healthy recovery after a major bottleneck



Bison diversity beyond Yellowstone



- Two groups with nearly equal number of bison separated by 10 mutations
- Yellowstone bison are also evenly split
- What causes this dichotomy if not current population structure?

The history of Yellowstone bison

- Lowest number of bison in Yellowstone recorded in 1902
- Remaining 22 indigenous animals were supplemented by 21 introduced bison initially corralled in Northern Yellowstone
- Released in 1915



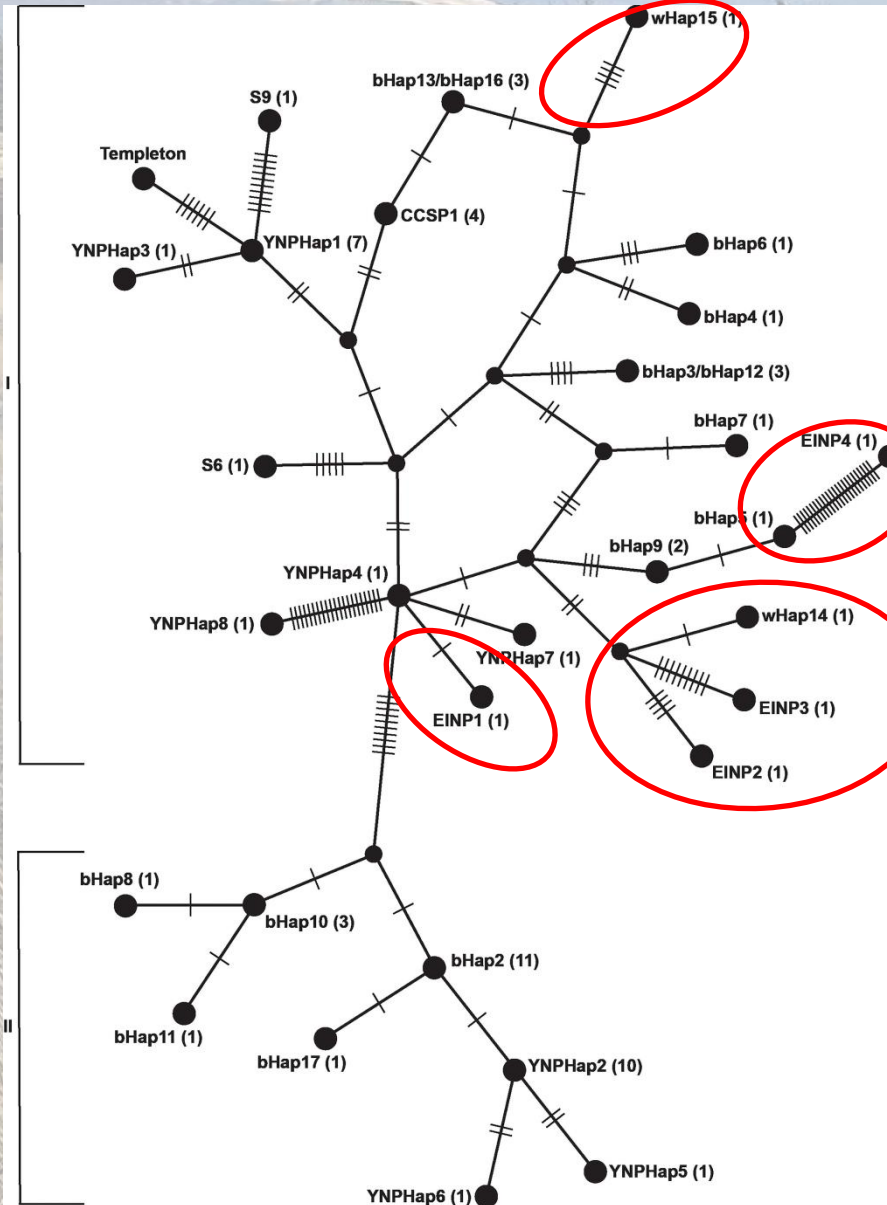
The history of wood bison



Canadian Species at Risk Public Registry

- Wood bison is a bison subspecies with clear conformational differences
- Large-scale displacement of plains bison into Canada in the 1920s
- Some Canadian bison might look like a wood bison but have plains bison mitochondria

The history of wood bison



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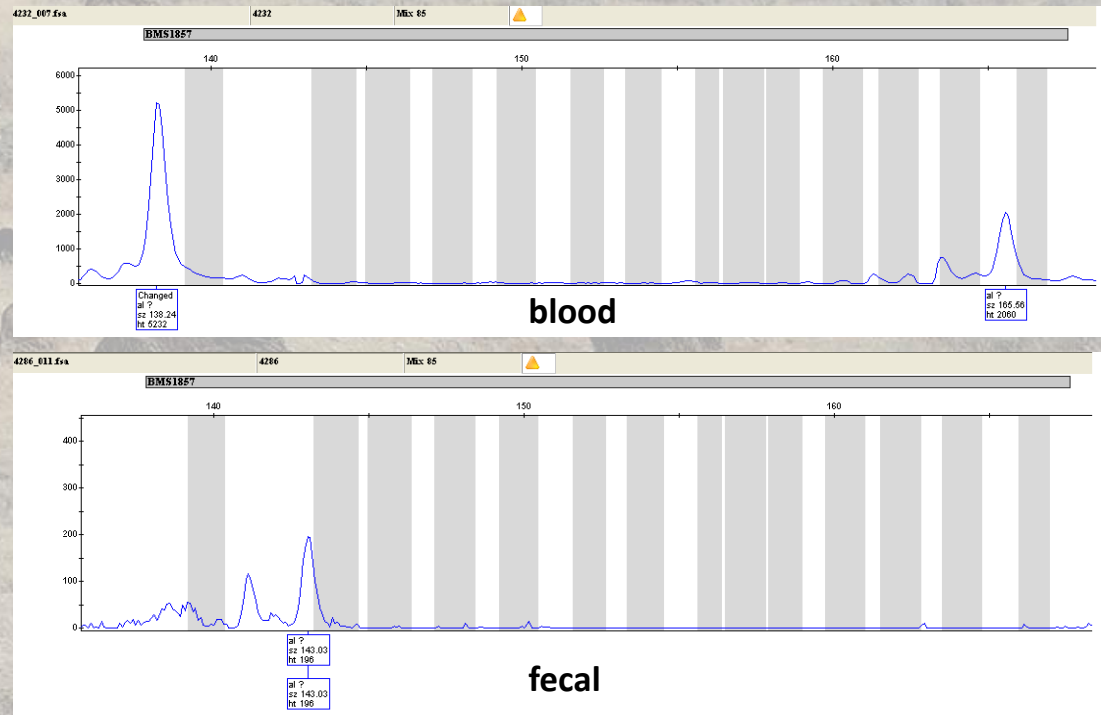
- Fecal DNA samples are widely used in wildlife research
- However, no comprehensive direct comparison between high quality and fecal DNA has ever been done



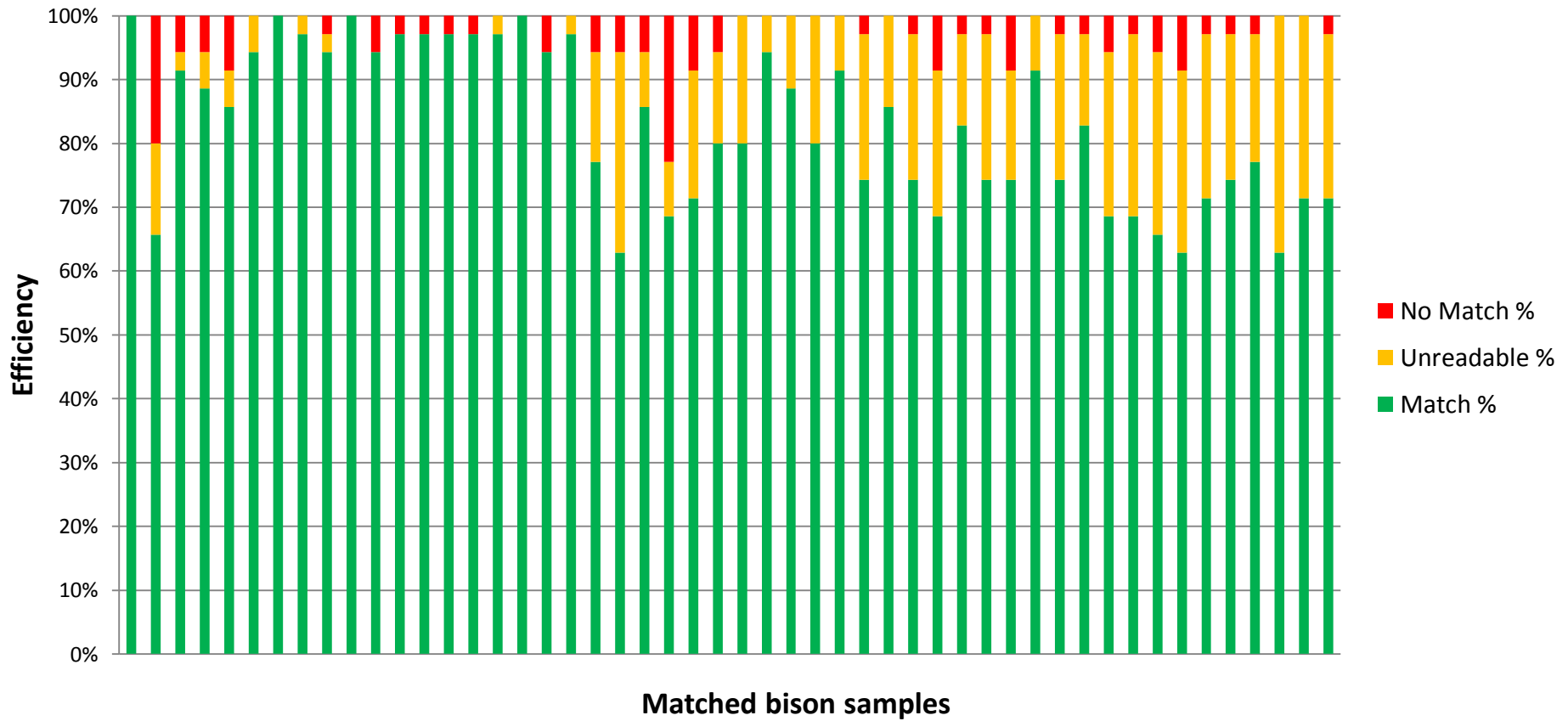
Objective: Analysis of fecal DNA and assembly of a panel of validated markers for genetic testing in bison

False alleles

- Occurs when neither allele matches
 - Misidentification of individual
 - Incorrect results
- 0.46% of cases, negligible

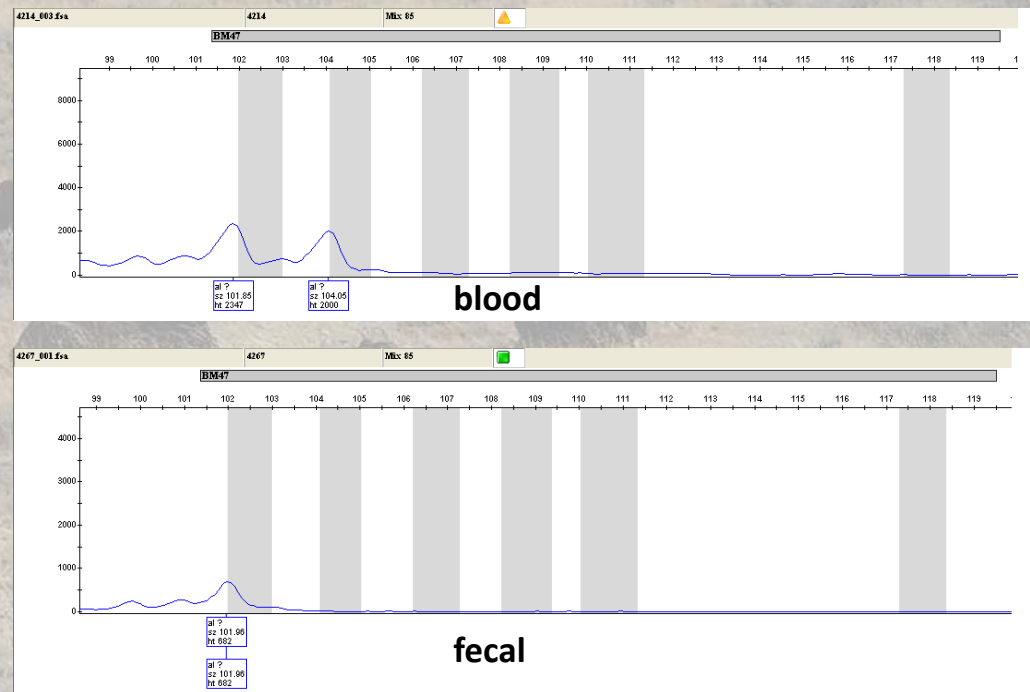


No evidence of contamination

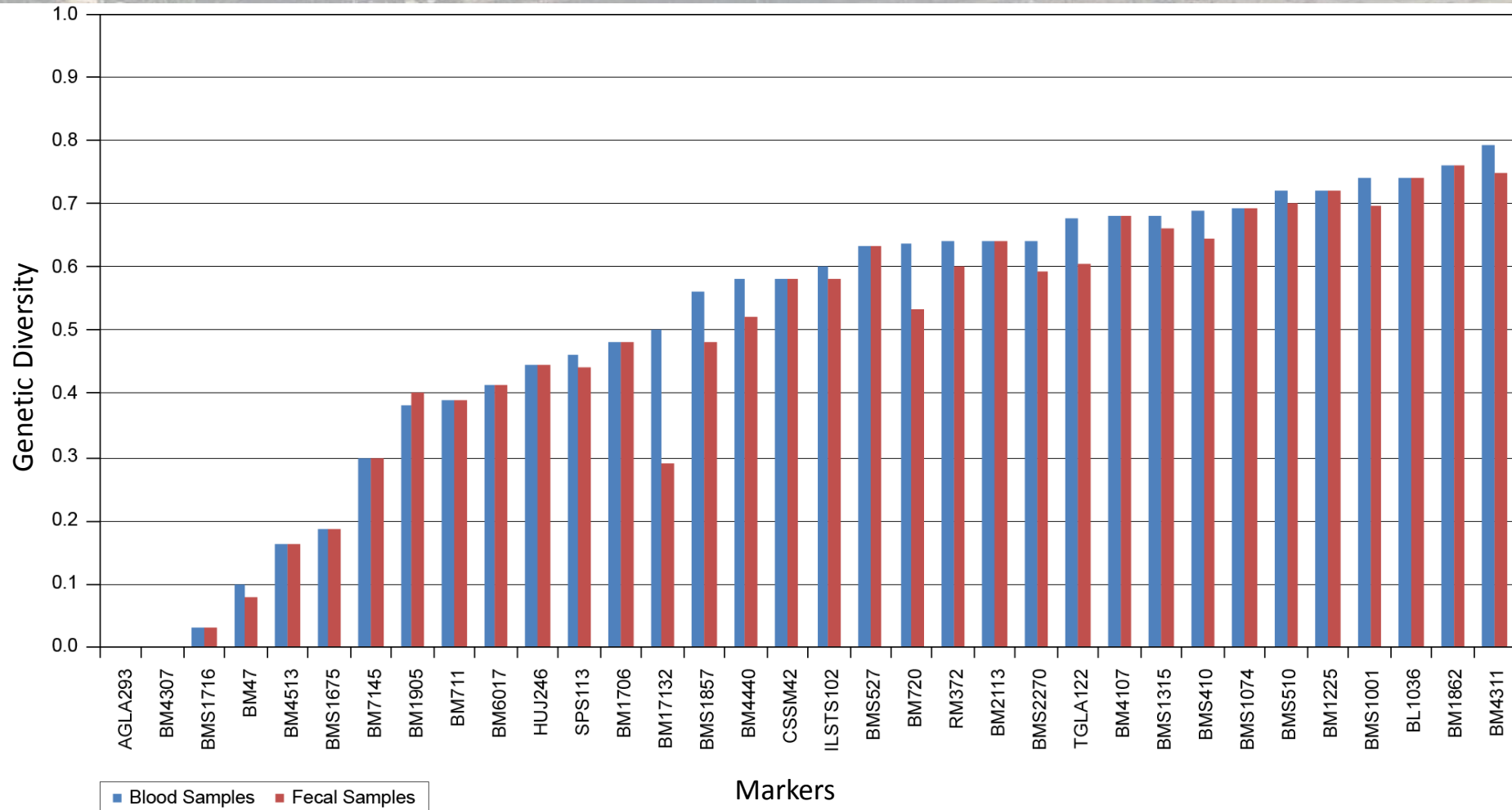


Allelic dropout

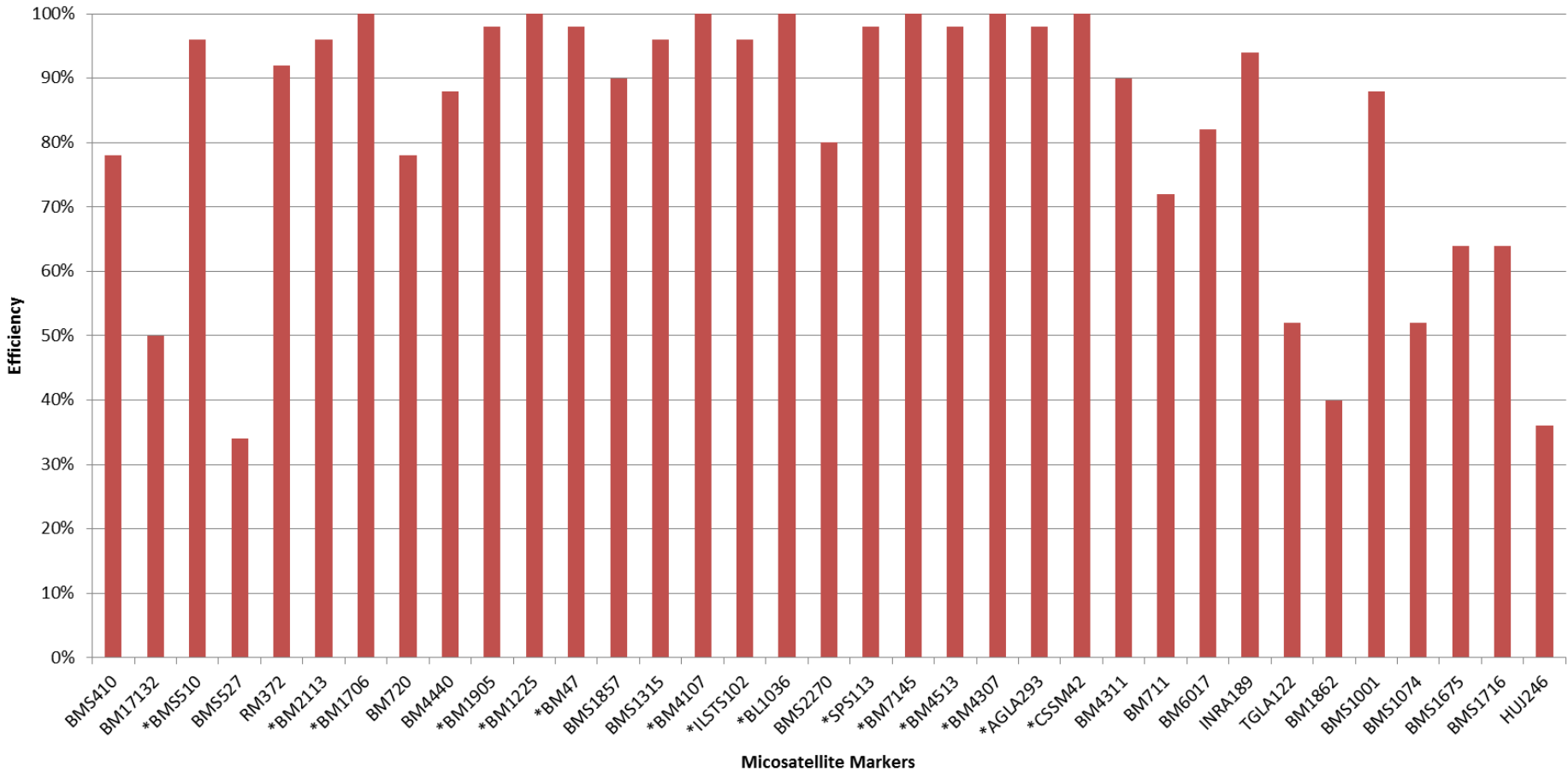
- Occurs in cases when only one allele shows up, leading to biased results
 - False identification
 - Underestimate perceived genetic health
 - Increased inbreeding
 - Lower genetic diversity
- 2.3% of cases



Allelic dropout can lead to underestimated genetic diversity



Genetic testing panel



Genetic testing panel

Marker	Percent matching (excl. reruns)	Percent matching (incl. reruns)	Chromosome
BM7145	100%	100%	1
BM4307	100%	100%	1
BM2113	96%	96%	2
CSSM42	100%	100%	2
AGLA293	100%	98%	5
SPS113	98%	98%	10
BL1036	100%	100%	14
BM4513	100%	98%	14
BM1706	100%	100%	16
BM1225	100%	100%	20
BM4107	100%	100%	20
BM1905	98%	98%	23
BM47	98%	98%	23
ILSTS102	98%	98%	25
BMS510	96%	96%	28



Chance of two bison having
the same alleles at all these
markers: 2.318×10^{-6}

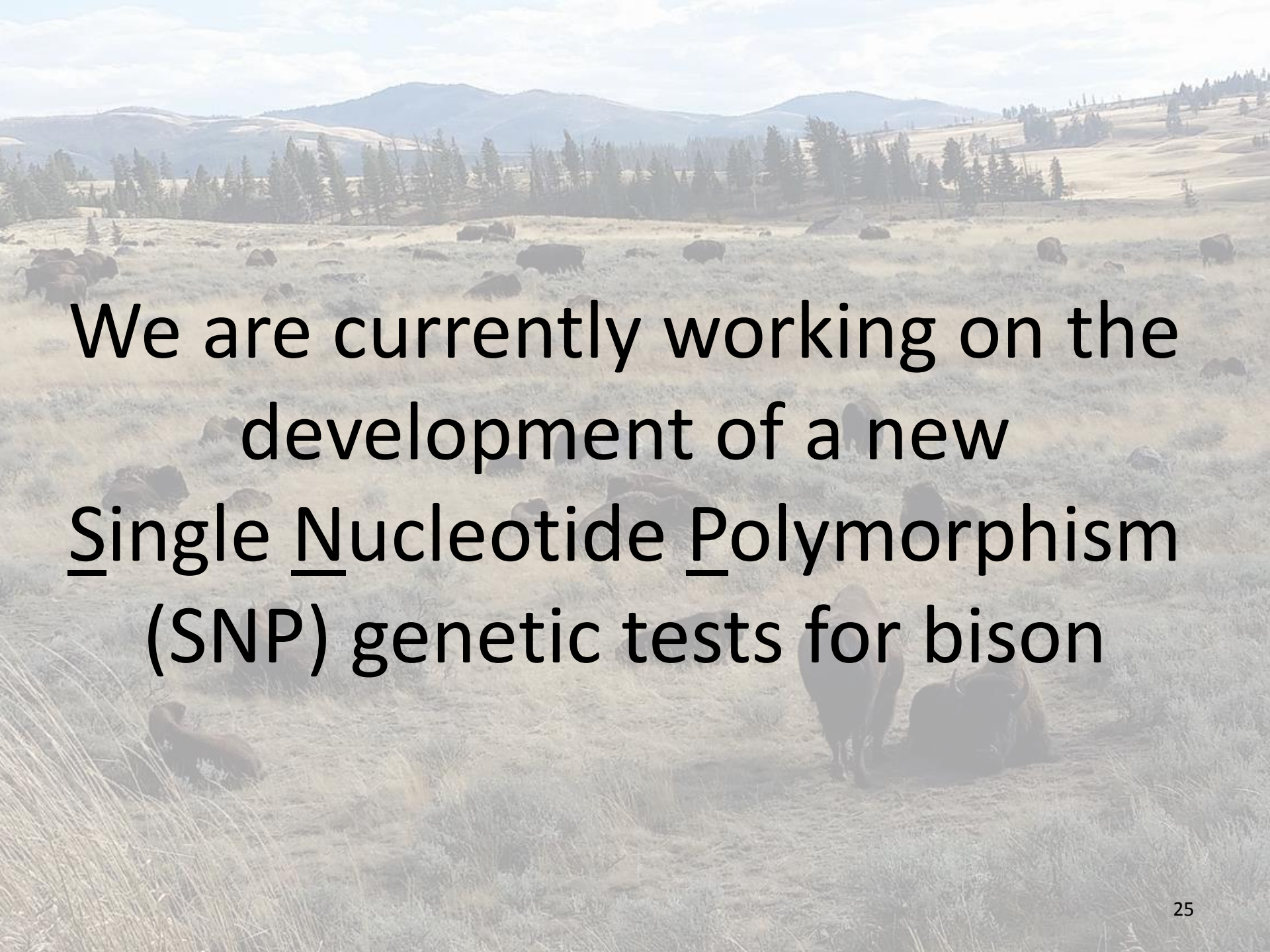
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Current technologies

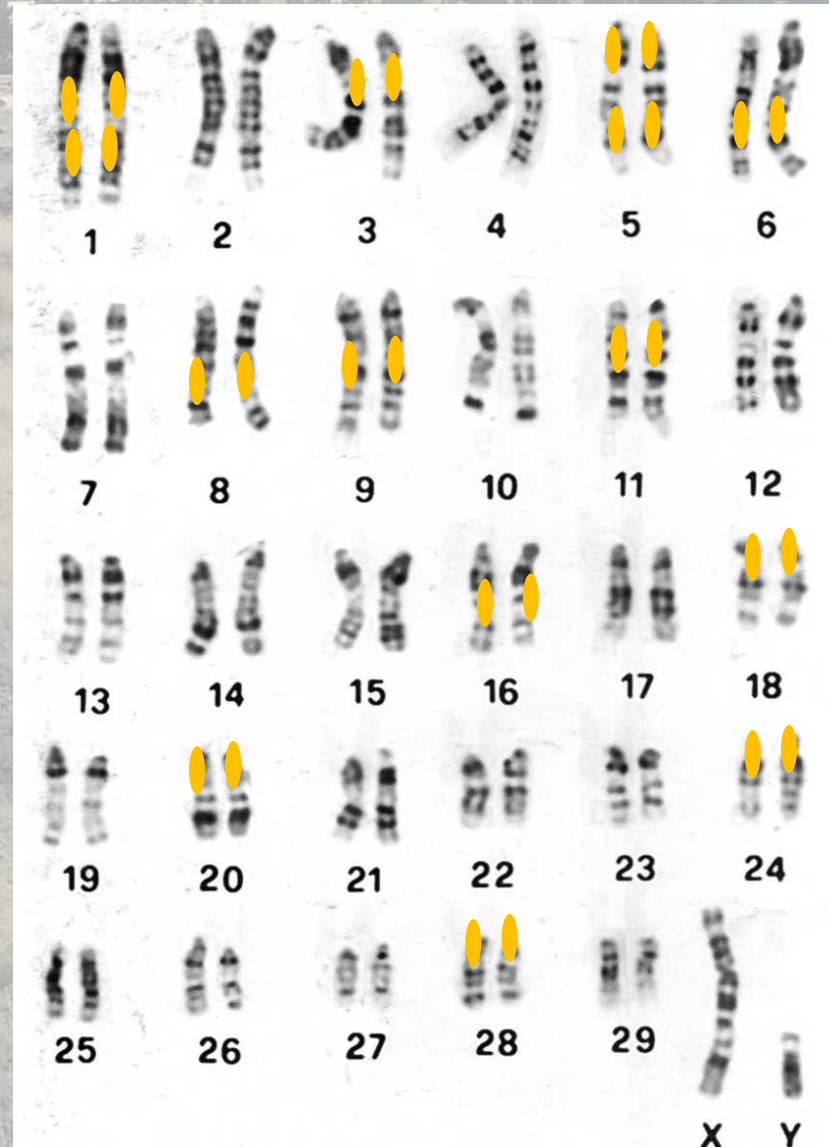
- Developed by the Derr lab over the last 20 years
- Based on nuclear microsatellites to test for:
 - parentage/kinship
 - genetic diversity and inbreeding
 - lineage ancestry
 - domestic cattle introgression
- Tens of thousands of bison successfully tested



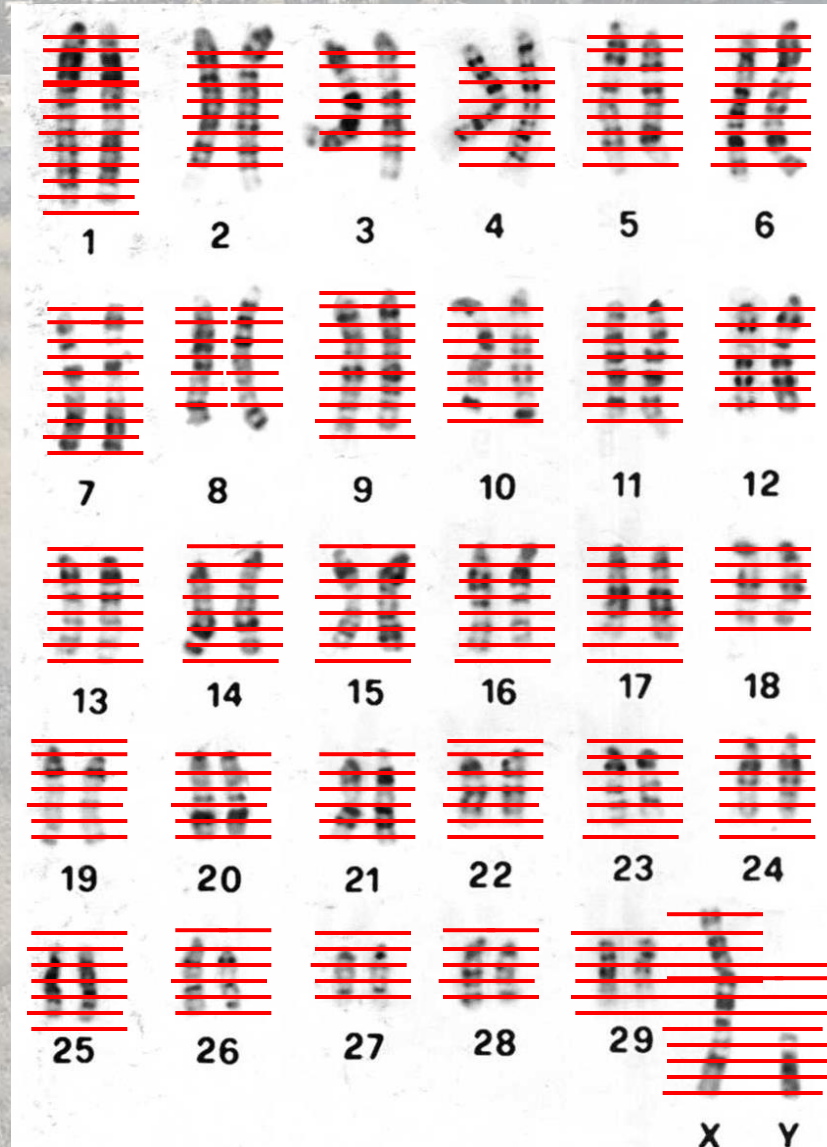
A herd of bison is grazing in a vast, open grassy field. In the background, there are rolling hills and mountains under a cloudy sky. The text is overlaid on the image.

We are currently working on the
development of a new
Single Nucleotide Polymorphism
(SNP) genetic tests for bison

Microsatellites vs SNPs



Microsatellites vs SNPs



SNPs



A

A

C

C

T

T

A

G

C

C

A

A

G

G

SNPs



A A A

C C C

T T T

A G C

C C C

A A A

G G G

Advantages of SNP-based testing

- Increase in marker coverage across the bison genome resulting in a tremendous increase in genetic information per test
- SNP genotyping is cheaper than traditional microsatellite genotyping (about ½ the cost)
- SNP genotyping provides a much faster turnaround time in the laboratory (days vs weeks)
- Allows for future trait-specific marker detection

Final summary

- Yellowstone bison population genetic analysis reveals a healthy herd with high diversity, migration, and a constantly increasing population size
- We have developed a panel of markers for genotyping bison from fecal samples, but special care must be taken when dealing with fecal DNA
- Development of a SNP-based genotyping assay for a wide array of applications is under development

Acknowledgements



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 - Amy Boedeker
 - James Derr
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Questions?