

# Runs of Homozygosity Haplotypes and Their Impact on Growth and Fertility in Angus Cattle

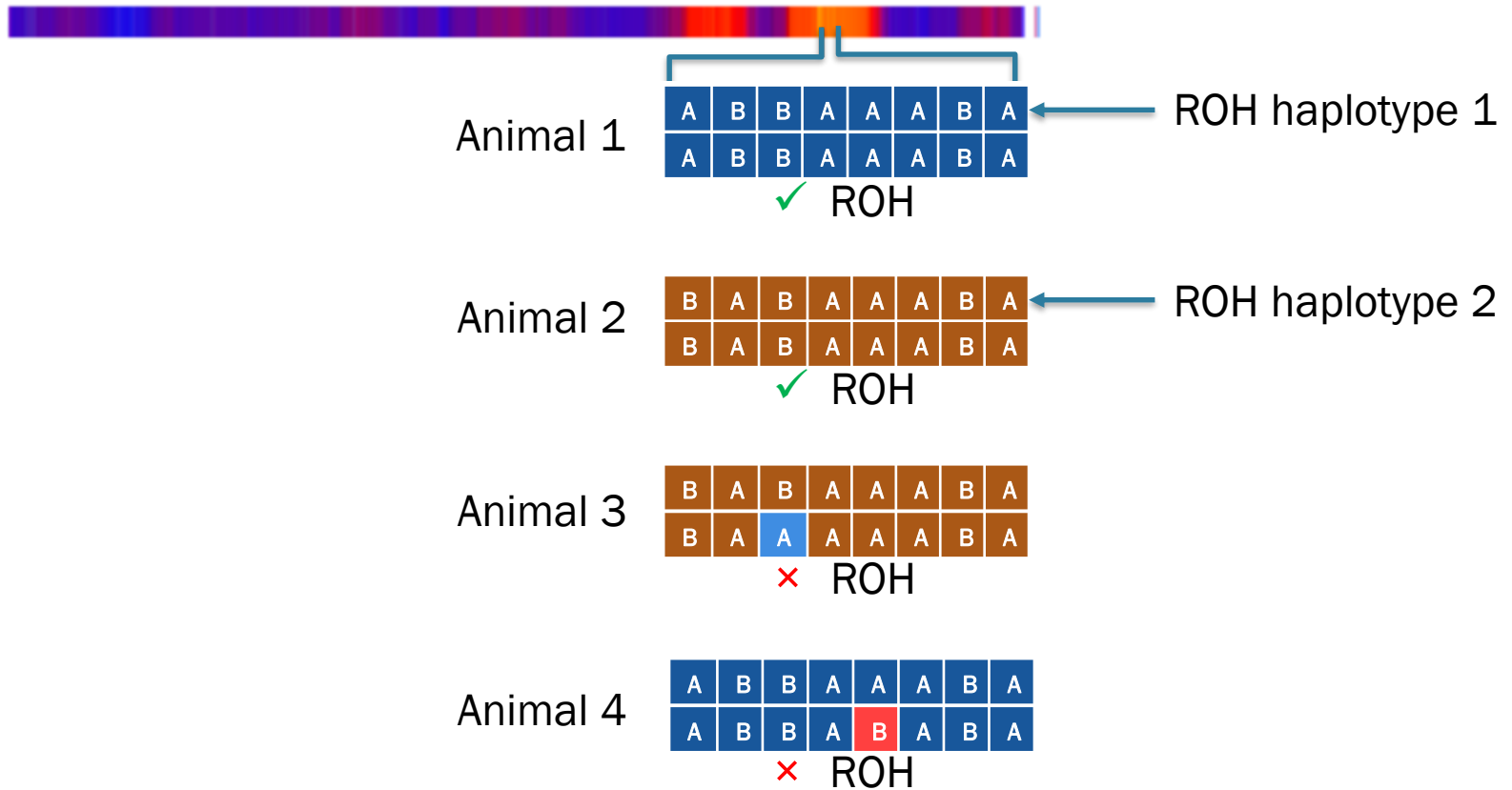
Duc Lu<sup>1</sup>, Mehdi Sargolzaei<sup>2,3</sup>, Dan Moser<sup>1</sup>, Steve Miller<sup>1</sup>

<sup>1</sup>Angus Genetics Inc., American Angus Association, 3201 Frederick Ave, St. Joseph, MO 64506, USA.

<sup>2</sup>Select Sires Inc., Plain City, OH 43064, USA.

<sup>3</sup>University of Guelph, Department of Pathobiology, University of Guelph, Guelph ON N1G2W1, Canada.

# What is ROH?



## Objectives

- ❑ Characterize Runs of Homozygosity (ROH) in the Angus population
- ❑ Assess impact of ROH haplotypes on growth and fertility

## Methodology

- ❑ 567,164 animals born 1969 – 2018
- ❑ Pedigree maximum number of generations 10
- ❑ SNP chips: HD50K, i50K, GGPHD, GGPLD, AngusGS. Total number of common SNP used: 44,818 SNP on 29 autosomes
- ❑ Effective population size, linkage disequilibrium used to estimate minimum window size (45 SNP)
- ❑ Software: snp1101 version 1.0 (Sargolzaei., 2014)

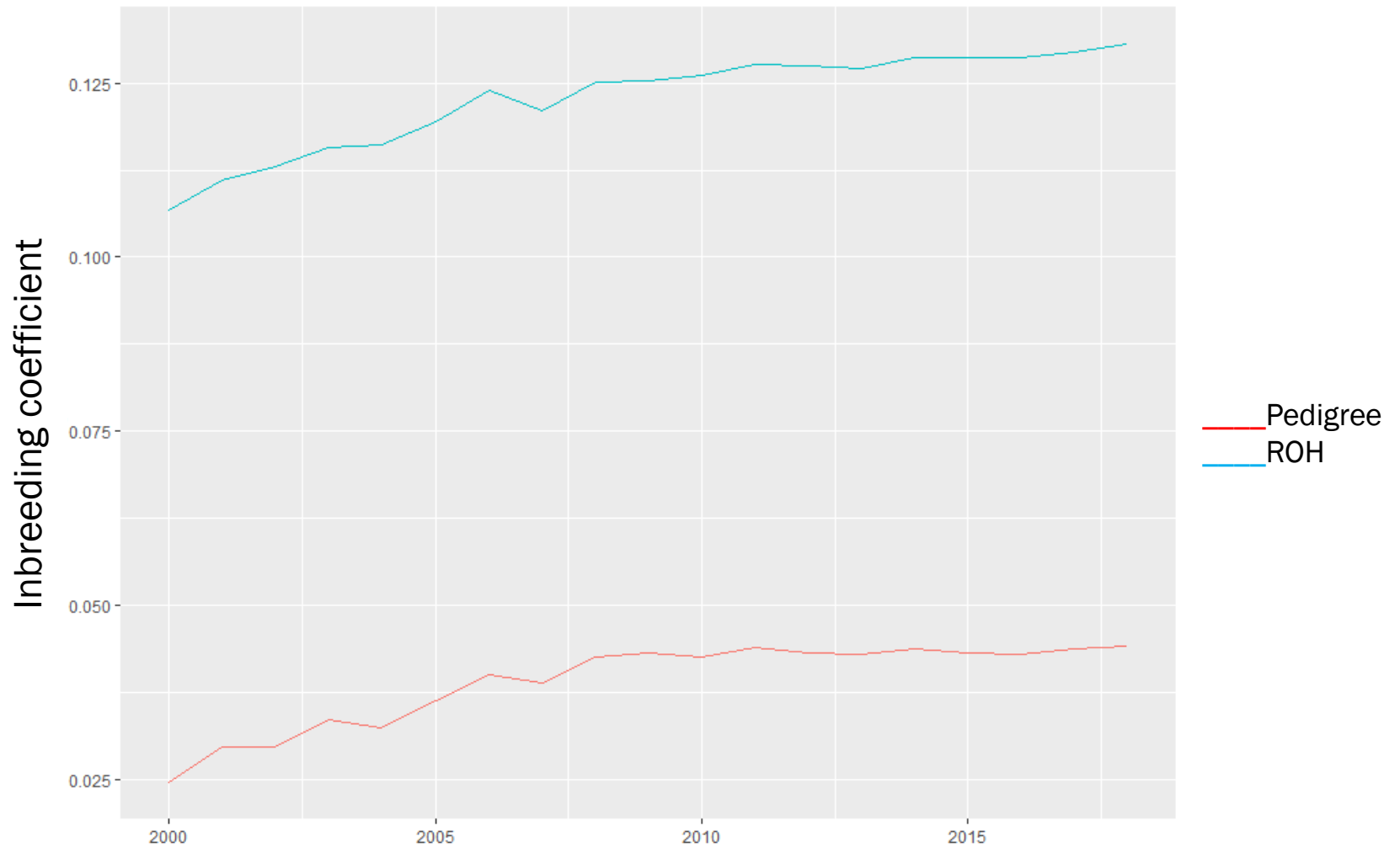
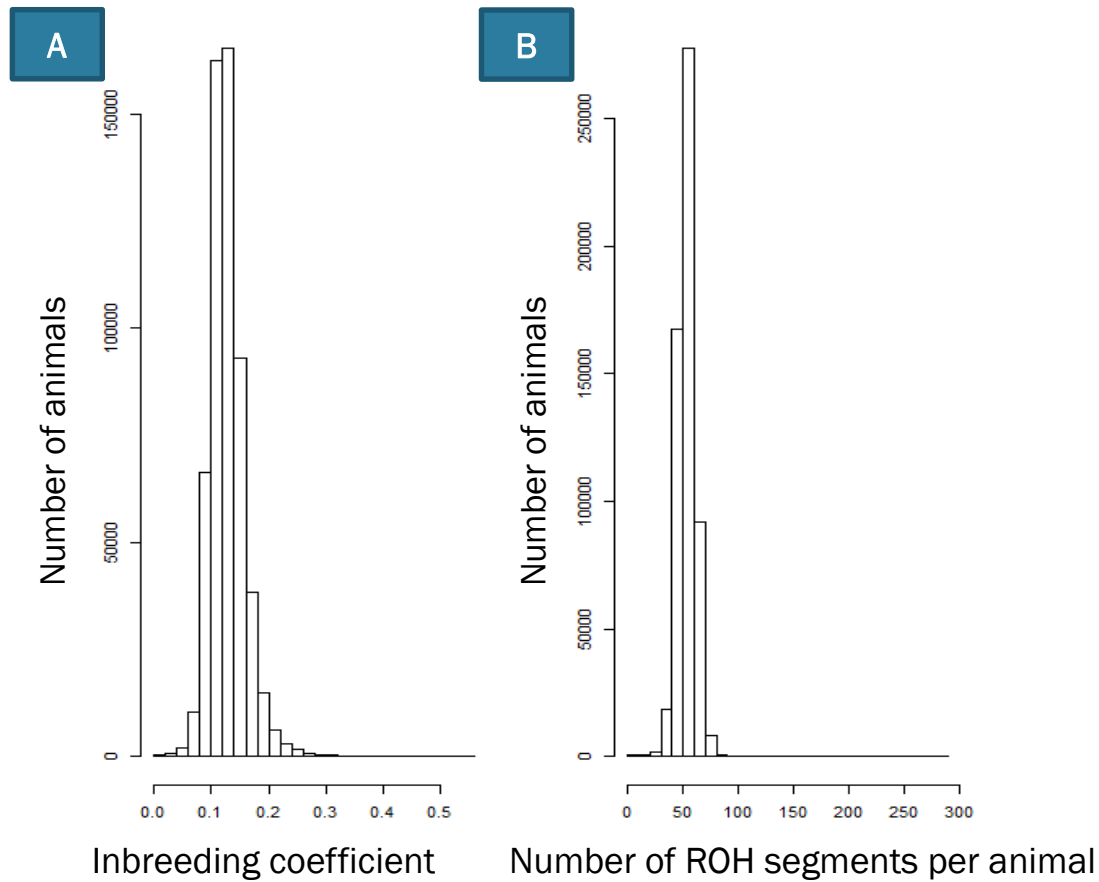
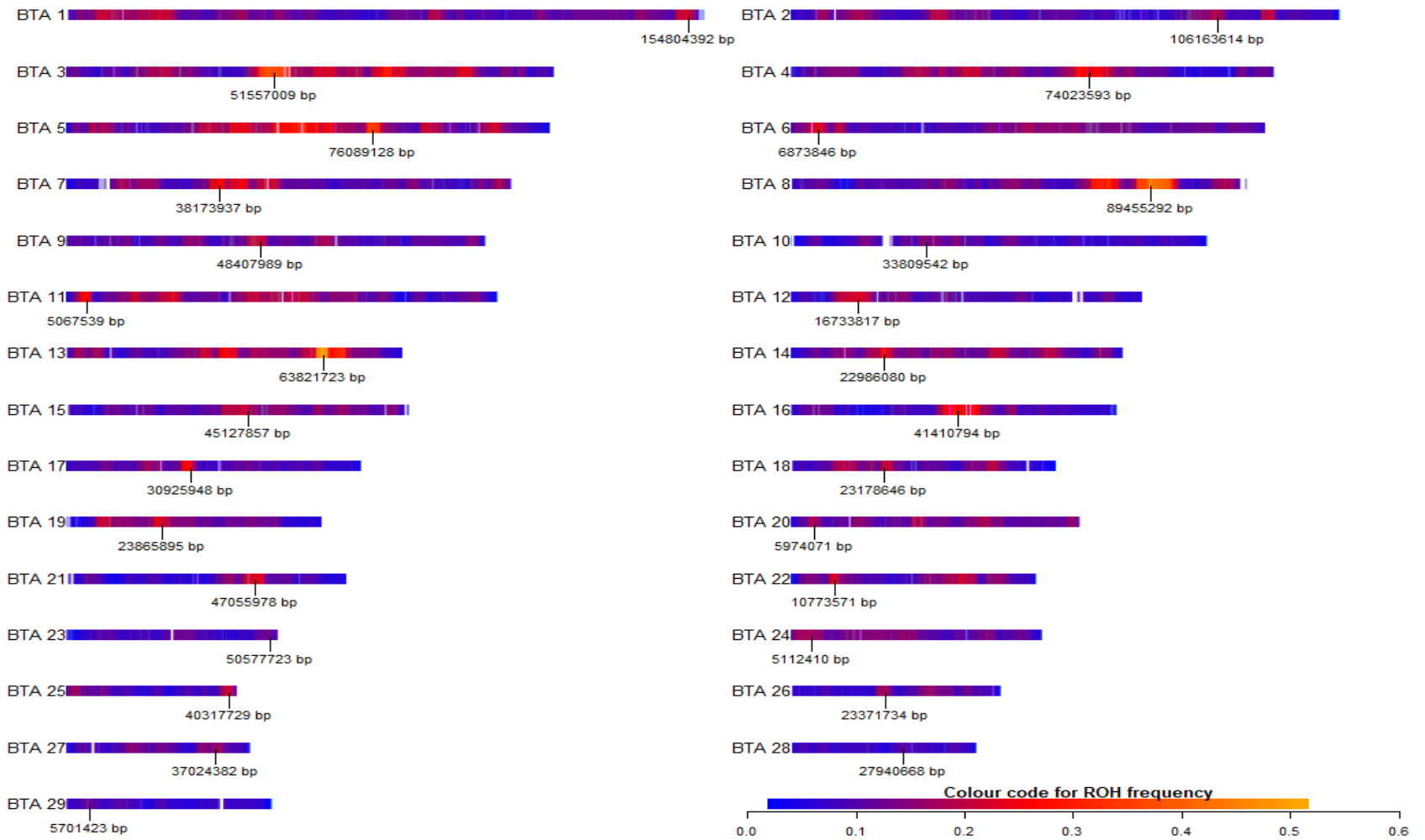


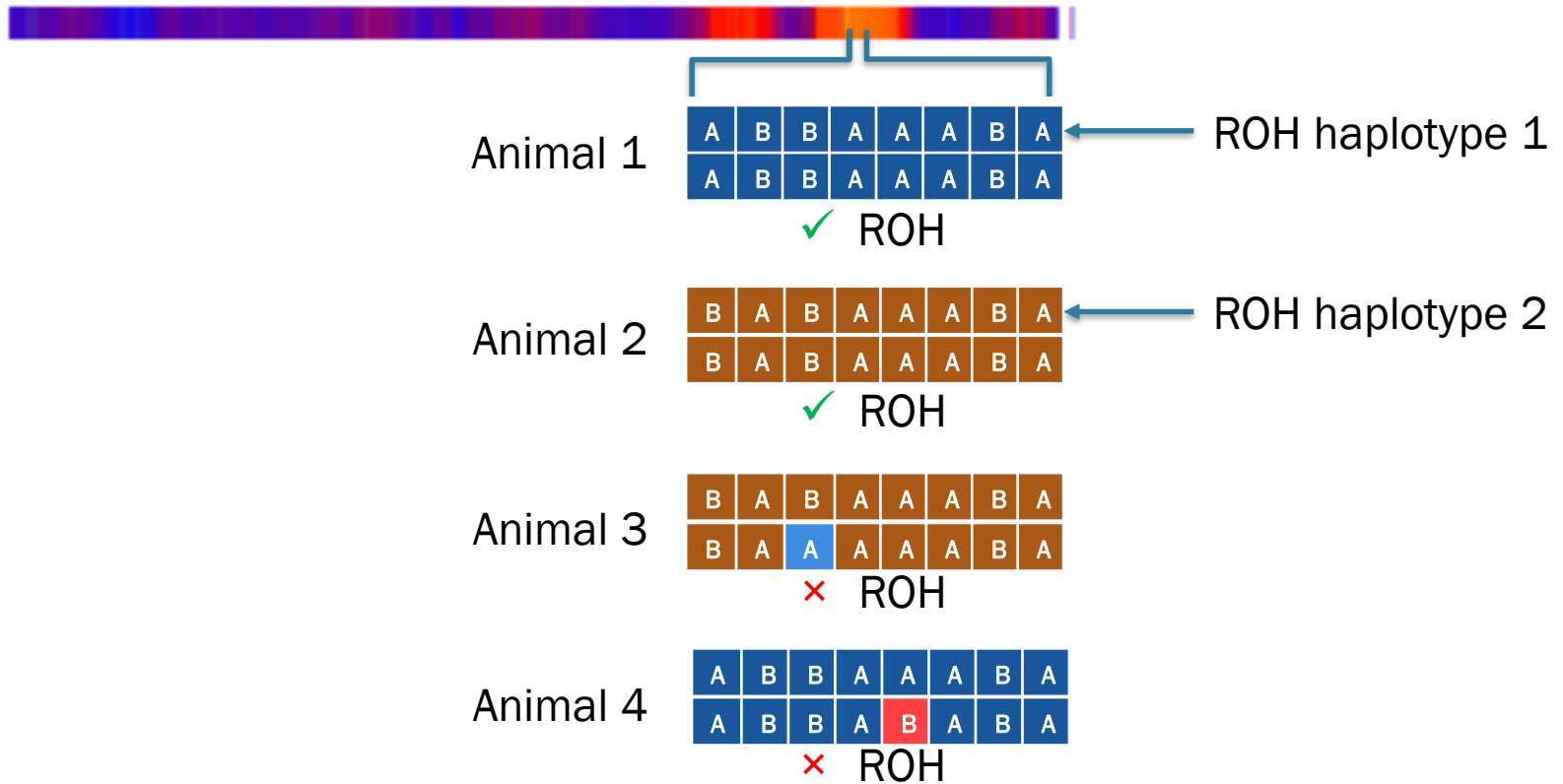
Figure 1. Average inbreeding coefficients by birth year estimated using pedigree *versus* ROH



**Figure 2. Distribution of ROH-based inbreeding (A);  
 Distribution of number of ROH segments per animal (B)**



**Figure 3. Density of ROH across the genome of Angus cattle**



### Single haplotype regression

- ❑ Response: phenotype adjusted for fixed effects and random effects
- ❑ Explanatory variable: number of copies of ROH haplotype
- ❑ P value was adjusted for FDR

# BWT

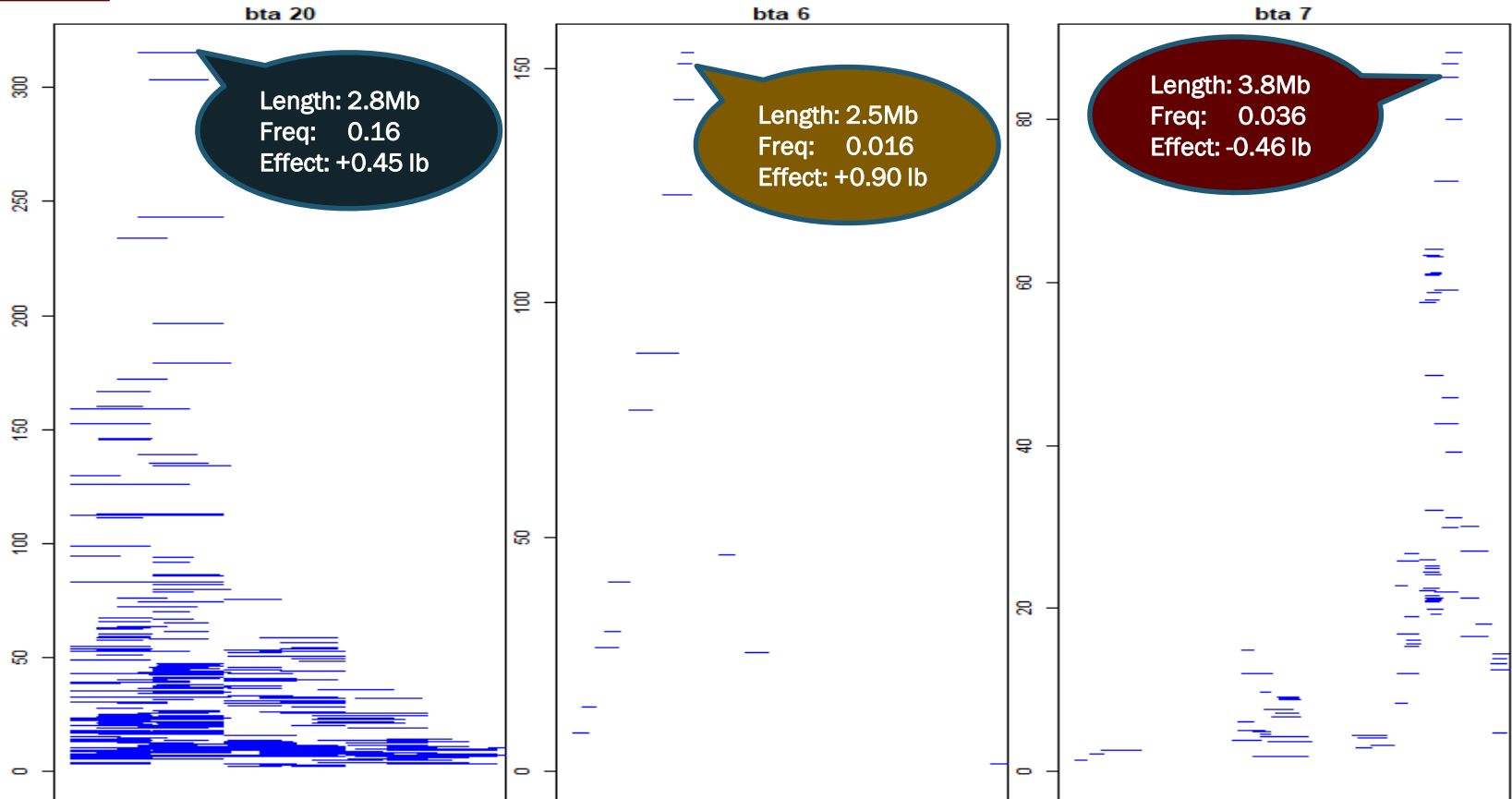


Figure 4. Association between BWT and ROH haplotypes in chromosomes 20, 6, and 7. Y-axis is  $-1\log_{10}(\text{FDR adjusted P value})$ . These haplotypes are significant for all 3 traits. X-axis location of haplotypes in the genome.



# WWT

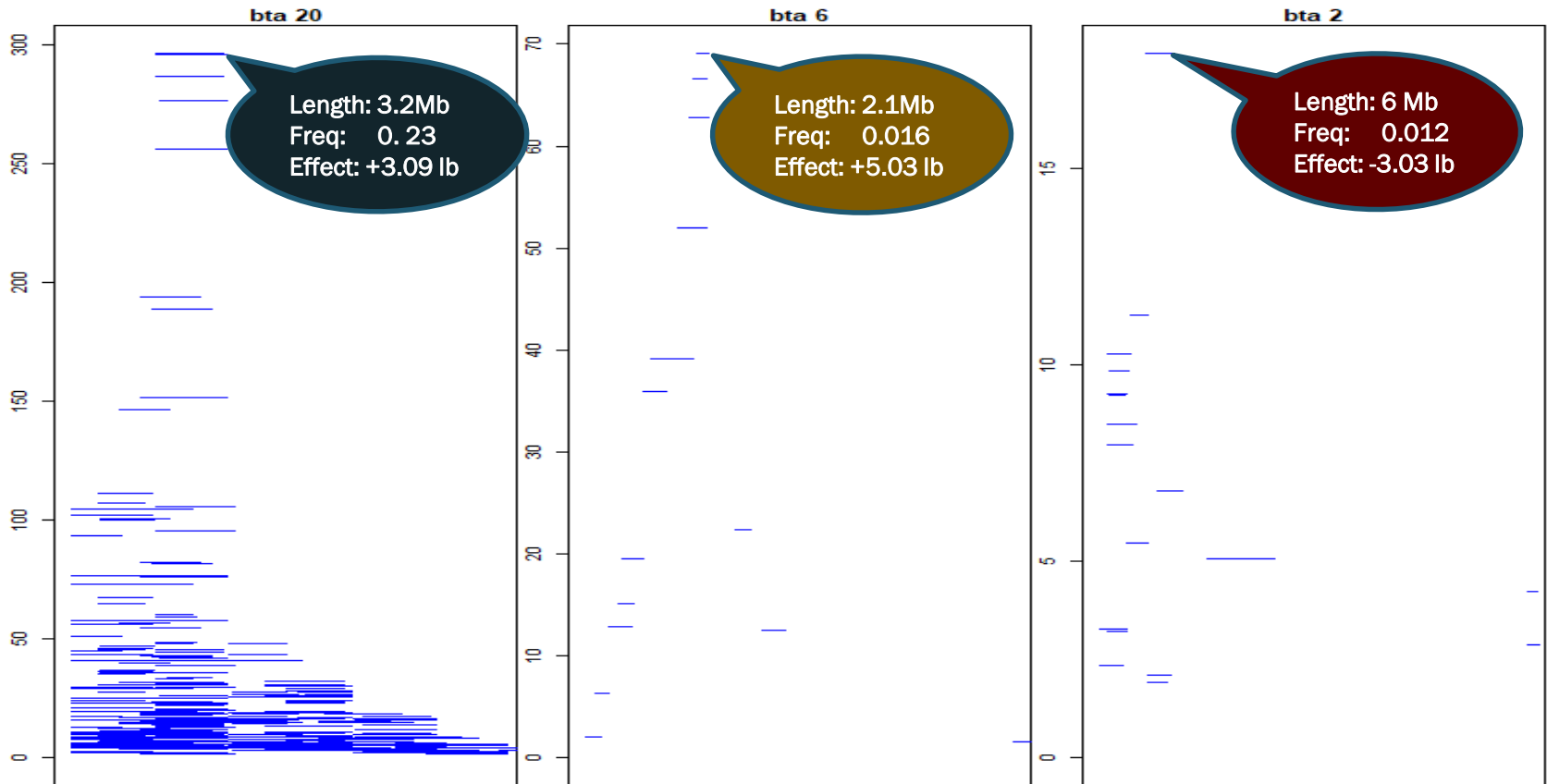


Figure 5. Association between WWT and ROH haplotypes in chromosomes 20, 6, and 2. Y-axis is  $-1\log_{10}(\text{FDR adjusted P value})$ . These haplotypes are significant for all 3 traits. X-axis location of haplotypes in the genome.

# PWG

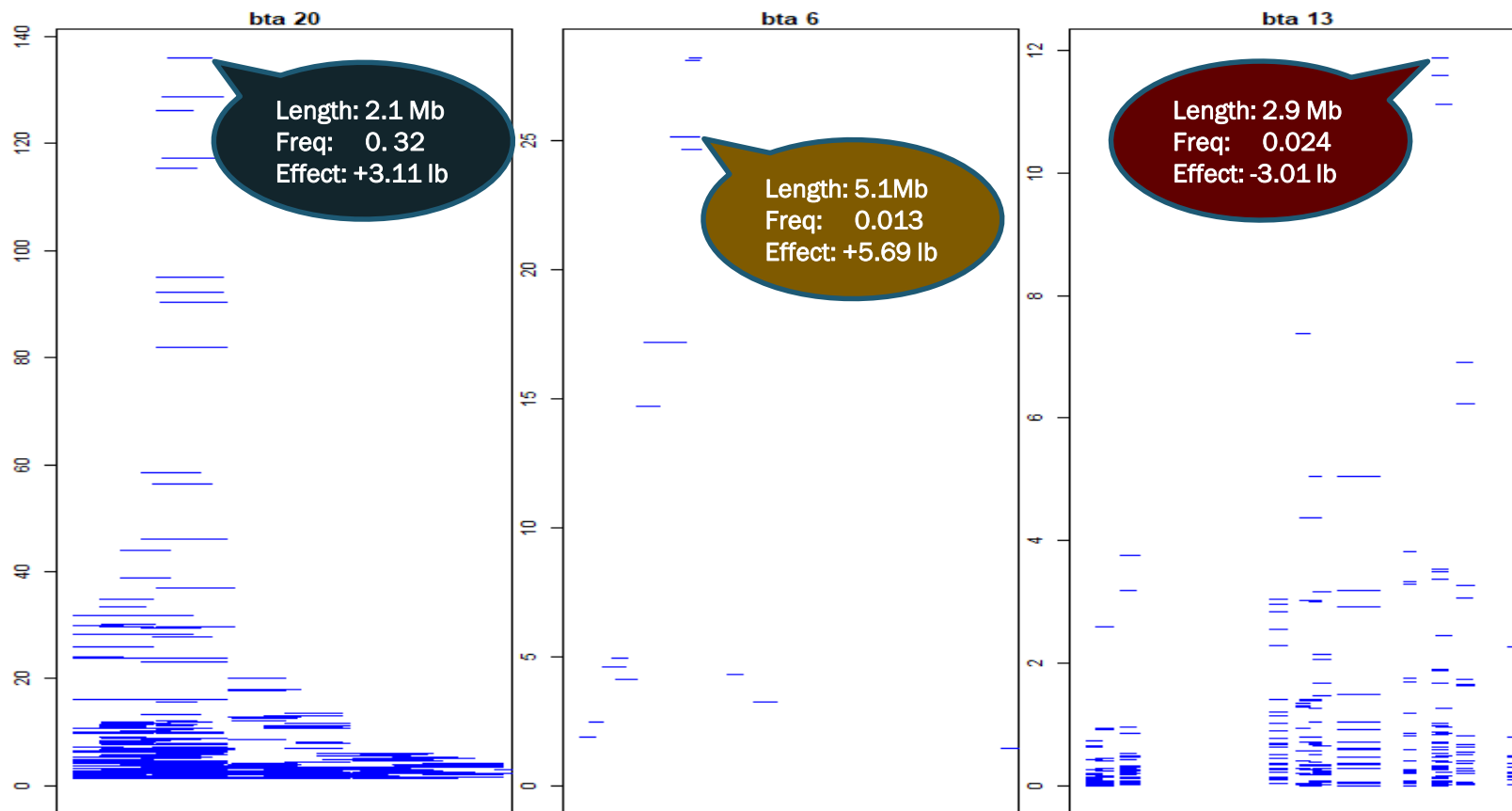
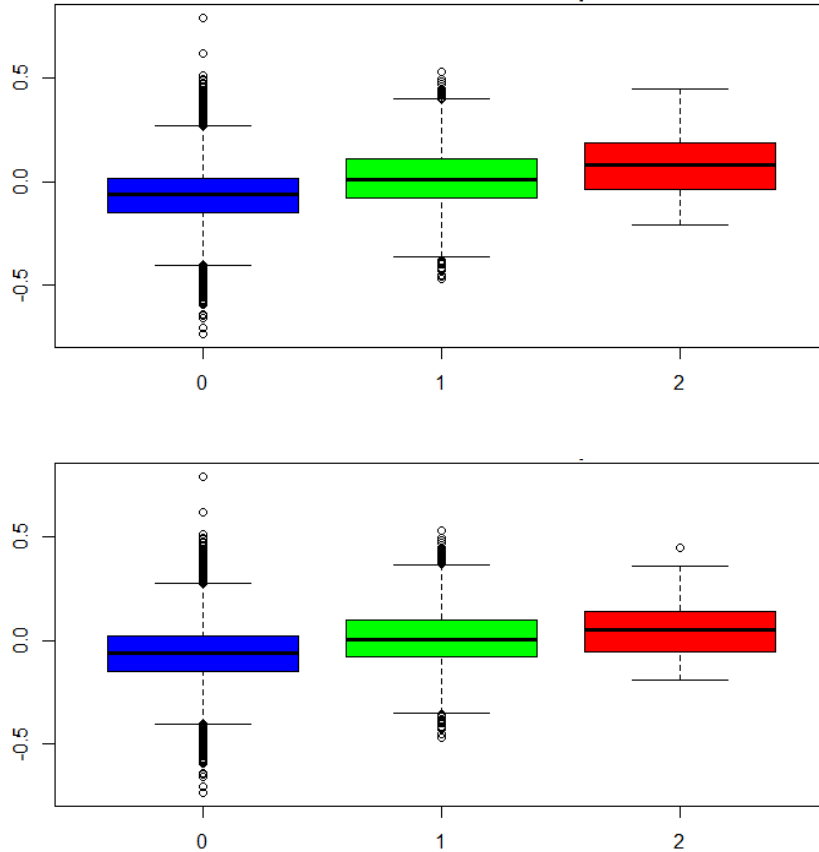


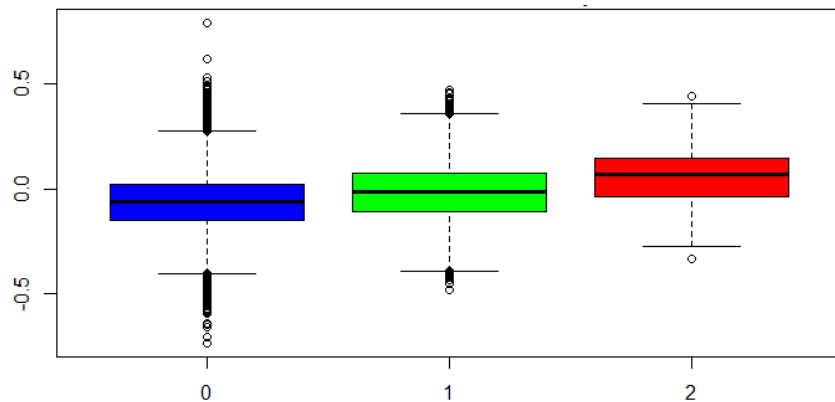
Figure 6. Association between PWG and ROH haplotypes in chromosomes 20, 6, and 13. Y-axis is  $-1\log_{10}(\text{FDR adjusted P value})$ . X-axis location of haplotypes in the genome.



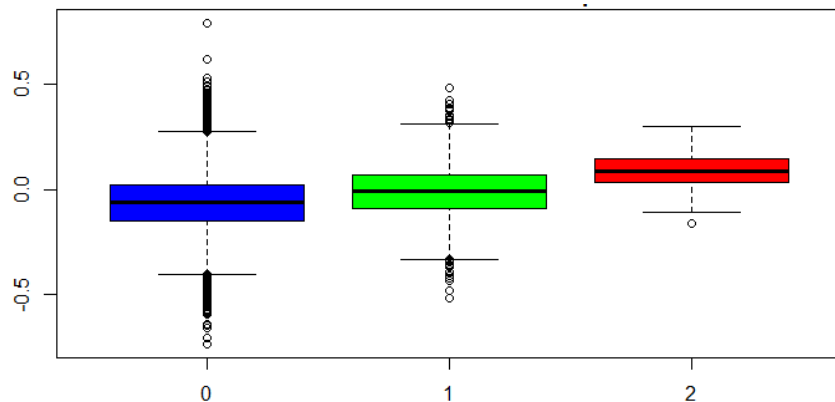
	Haplotype Freq	Haplotype Effect	FDR-adjusted P value
<b>BWT</b>	<b>0.027</b>	<b>-0.39</b>	<b>1.52E-46</b>
<b>WWT</b>	<b>0.027</b>	<b>-2.01</b>	<b>2.22E-18</b>
<b>PWG</b>	<b>0.027</b>	<b>-1.47</b>	<b>1.35E-03</b>

	Haplotype Freq	Haplotype Effect	FDR-adjusted P value
<b>BWT</b>	<b>0.024</b>	<b>-0.38</b>	<b>6.69E-40</b>
<b>WWT</b>	<b>0.024</b>	<b>-1.71</b>	<b>1.39E-11</b>
<b>PWG</b>	<b>0.024</b>	<b>-1.19</b>	<b>2.54E-02</b>

**Figure 7. Distribution of Heifer Pregnancy EPD with regard to number of copies of 2 ROH haplotypes on BTA 7. The tables show haplotype impact on BWT, WWT, and PWG**

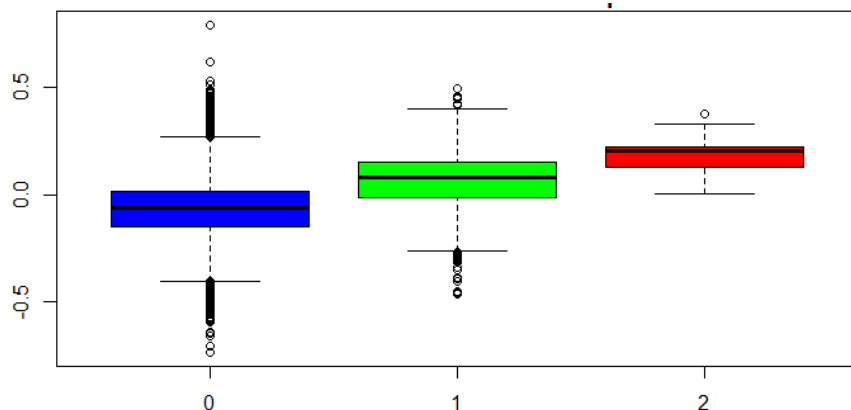


	Haplotype Freq	Haplotype Effect	FDR-adjusted P value
BWT	0.012	0.21	8.61E-07
WWT	0.012	2.28	3.30E-10
PWG	0.012	1.68	3.64E-02

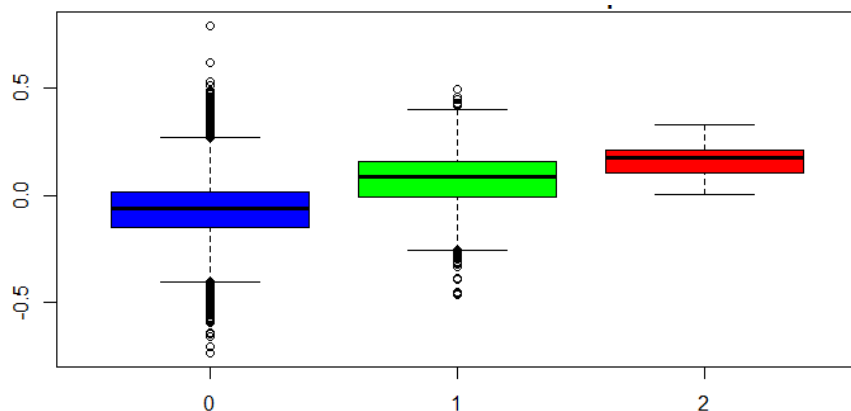


	Haplotype Freq	Haplotype Effect	FDR-adjusted P value
BWT	0.011	-0.26	9.55E-09
WWT	0.011	-1.54	1.38E-04
PWG	0.011	-1.64	4.96E-02

**Figure 8. Distribution of Heifer Pregnancy EPD with regard to number of copies of 2 ROH haplotypes on BTA 20. The tables show haplotype impact on BWT, WWT, and PWG**

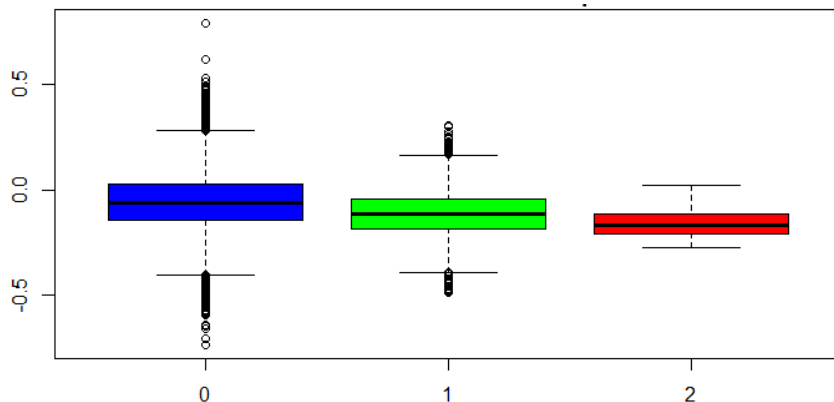
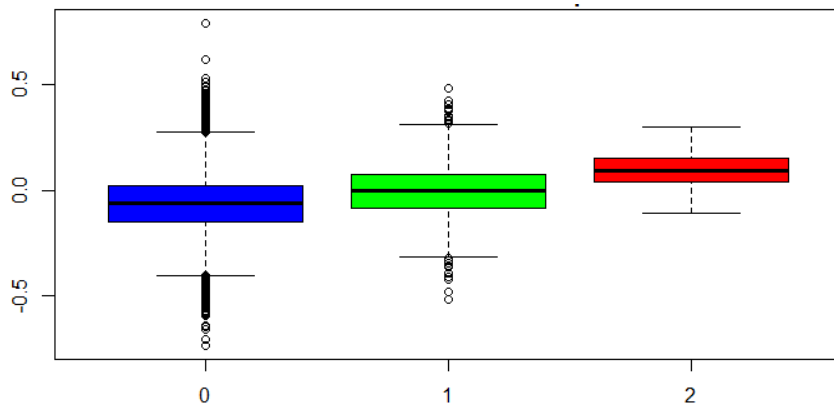


	Haplotype Freq	Haplotype Effect	FDR-adjusted P value
<b>BWT</b>	<b>0.014</b>	<b>-0.19</b>	<b>1.75E-06</b>
<b>WWT</b>	<b>0.014</b>	<b>-0.97</b>	<b>1.17E-02</b>
<b>PWG</b>	<b>0.014</b>	<b>-1.54</b>	<b>2.92E-02</b>



	Haplotype Freq	Haplotype Effect	FDR-adjusted P value
<b>BWT</b>	<b>0.013</b>	<b>-0.22</b>	<b>2.36E-07</b>
<b>WWT</b>	<b>0.013</b>	<b>-1.45</b>	<b>1.08E-04</b>
<b>PWG</b>	<b>0.013</b>	<b>-1.86</b>	<b>7.91E-03</b>

**Figure 9. Distribution of Heifer Pregnancy EPD with regard to number of copies of 2 ROH haplotypes on BTA 21. The tables show haplotype impact on BWT, WWT, and PWG**



	Haplotype Freq	Haplotype Effect	FDR-adjusted P value
BWT	0.011	0.22	1.63E-06
WWT	0.011	2.45	3.28E-11
PWG	0.011	1.72	3.65E-02

	Haplotype Freq	Haplotype Effect	FDR-adjusted P value
BWT	0.012	-0.28	2.35E-11
WWT	0.012	-1.10	6.28E-03
PWG	0.012	-2.16	2.39E-03

**Figure 10. Distribution of Heifer Pregnancy EPD with regard to number of copies of 2 other ROH haplotypes on BTA 20. The tables show haplotype impact on BWT, WWT, and PWG**

# Conclusions

- ❑ Distribution of ROH and their haplotypes vary among chromosomes
- ❑ Distribution of ROH density might reflect past selection programs
- ❑ ROH haplotypes in association with growth traits were identified
- ❑ Mixed signals on haplotypes affecting both growth and fertility



**Thank you!**

**Questions?**

**Duc Lu**  
**[dlu@angus.org](mailto:dlu@angus.org)**