USDA National Institute of Food and Agriculture
U.S. DEPARTMENT OF AGRICULTURE

American Angus Association

MICHIGAN STATE UNIVERSITY

Longitudinal analysis of environmental effects for American Angus cattle

Gabriel Rovere[1,2], BCD Cuyabano[2] and C Gondro[1]

[1] *Animal Science, MSU*
[2] *INRAe –GABI – Jouy-en Josas*

INRAE science for people, life & earth

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Introduction

- Breeding stocks, in the USA, are mostly pasture-based, where animals spend most of their life outdoors.
- Herds are exposed to different degrees of climate variability across locations that influence animal performance.
- This project aims to look **how climate variability affects animal performance in the long term.**

Research question

Are phenotypic and genetic trends different in locations with more frequency of heat stress events?

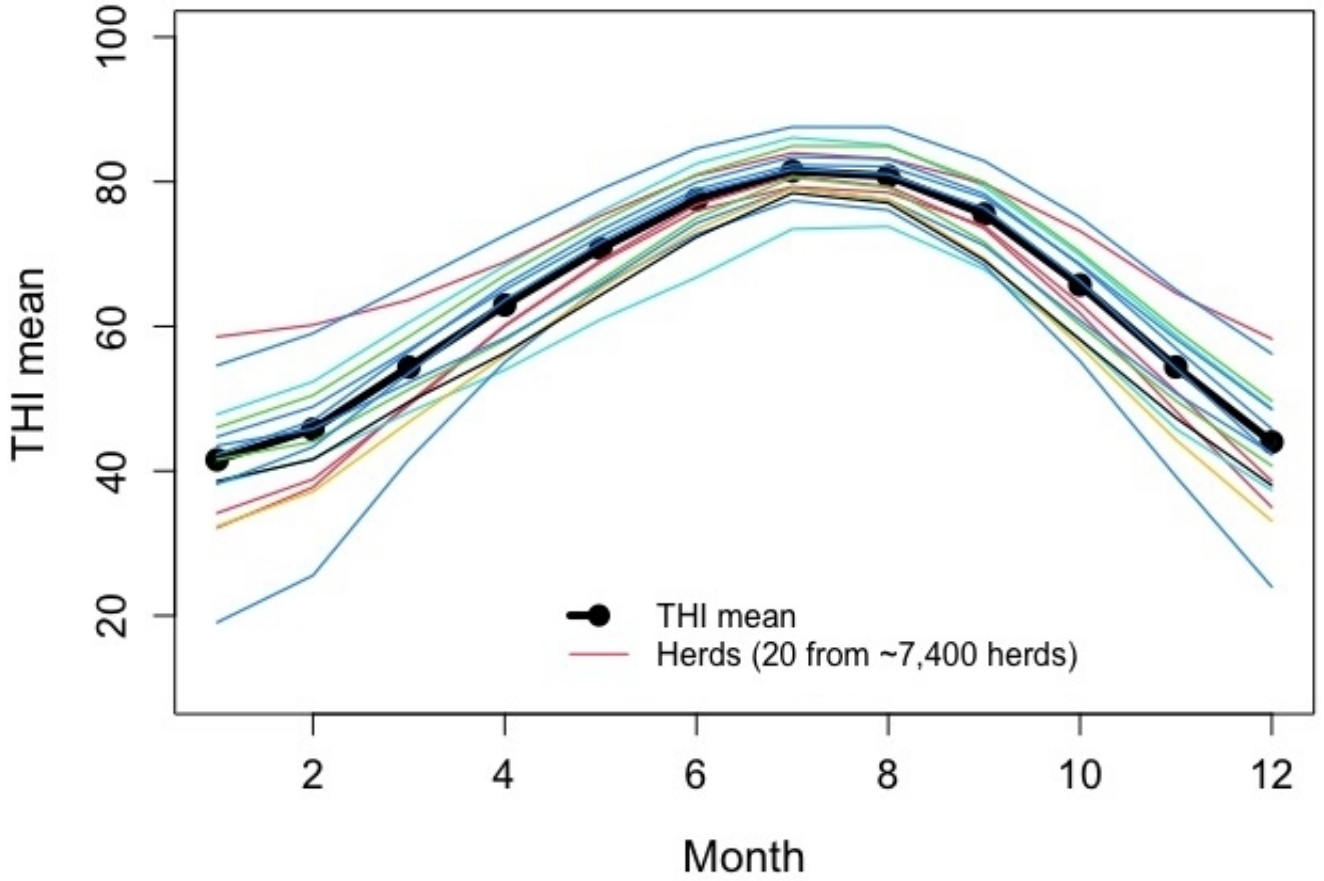
Climate data

1. Daily records of climate variables between 1980-2020 (NASA power)
2. Calculate historical series of Temperature-Humidity Index (THI)

$$THI = (1.8 \times T + 32) - (0.55 - 0.0055 \times RH) \times (1.8 \times T - 26)$$ (NRC, 1971)

3. Link with breeder herds GPS location
4. Frequency of weeks with THI higher than local THI mean of the 80s was calculated for ~ 7,400 locations.

Average THI by month

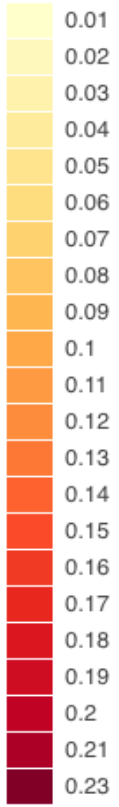


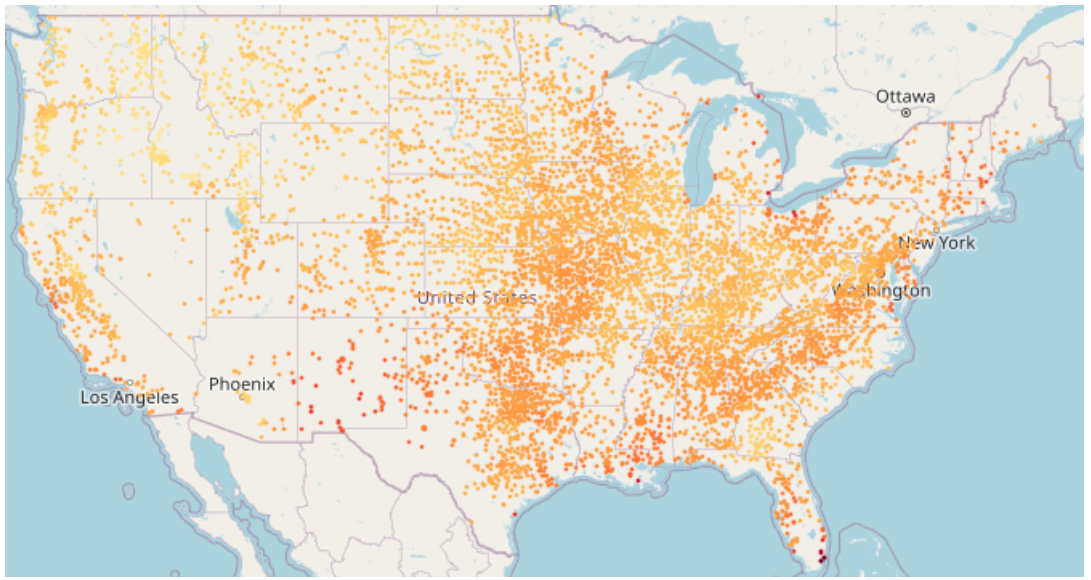
Frequency of high THI outliers week

1981 - 1990

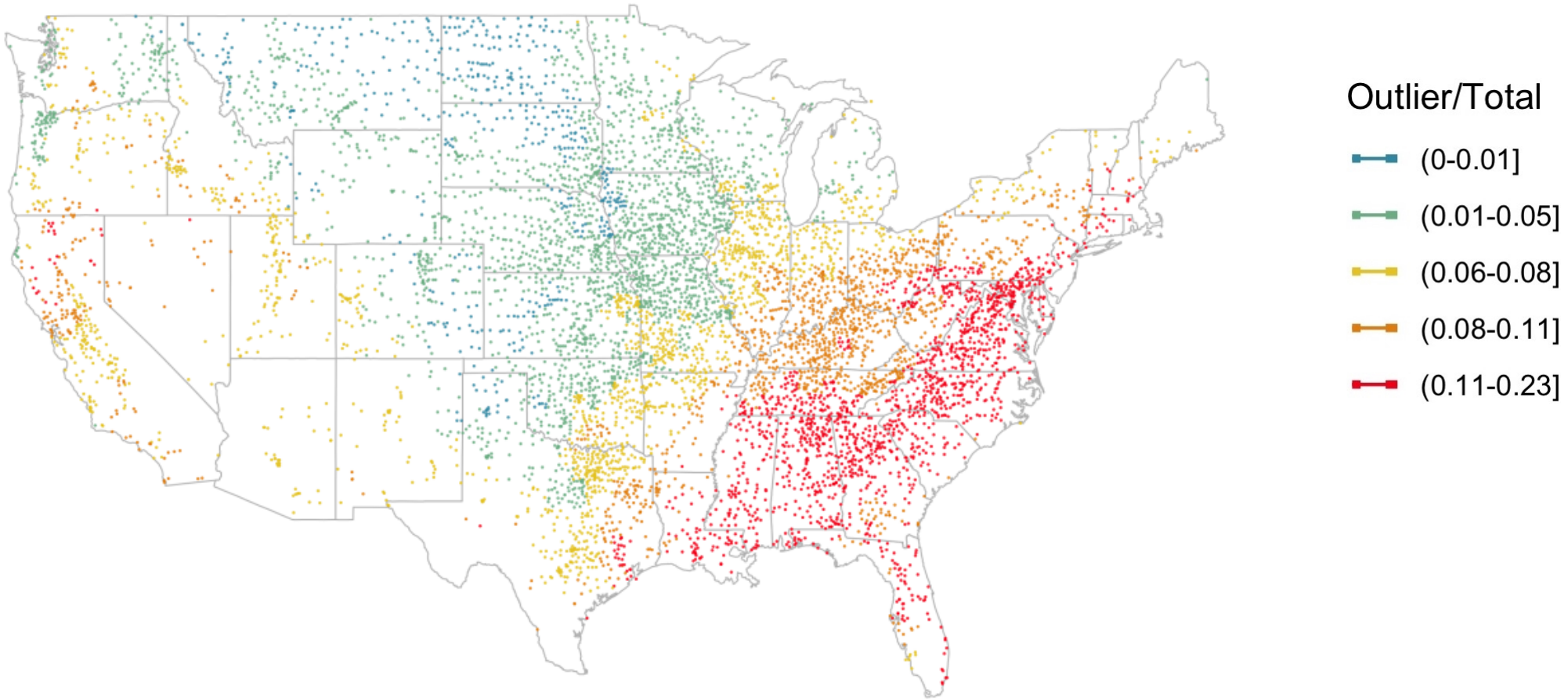
$$\frac{Outliers\ Weeks}{Total\ Weeks}$$

2011 - 2020





Location Groups by high THI outliers frequency



Phenotypic data

American Angus Association

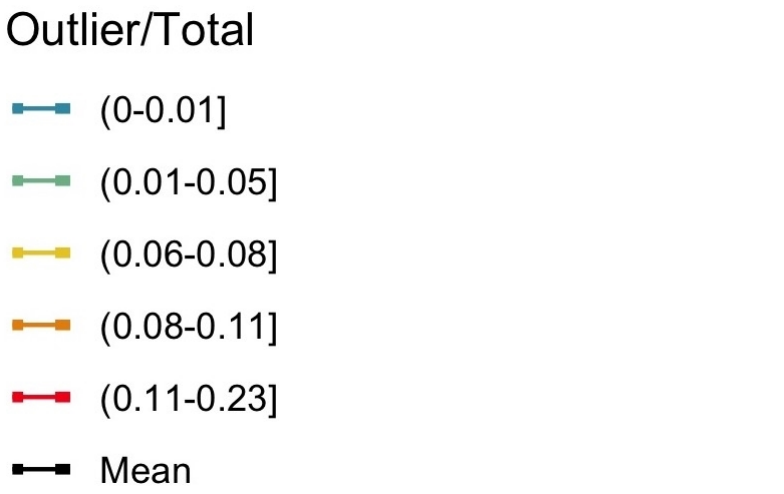
~ 7.400 herds

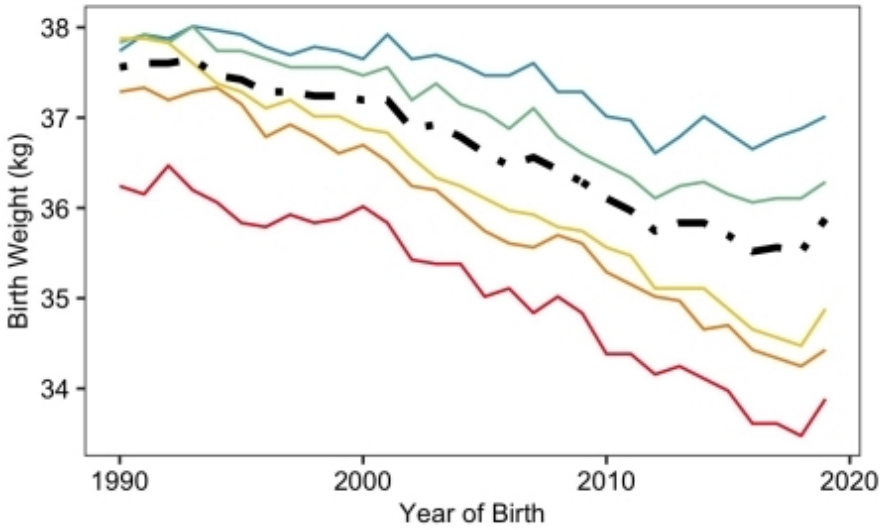
Birth Weight BW ~ 6.7 million records	Weaning Weight WW ~ 6.6 million records	Post-Weaning Gain PWG ~ 3.4 million records

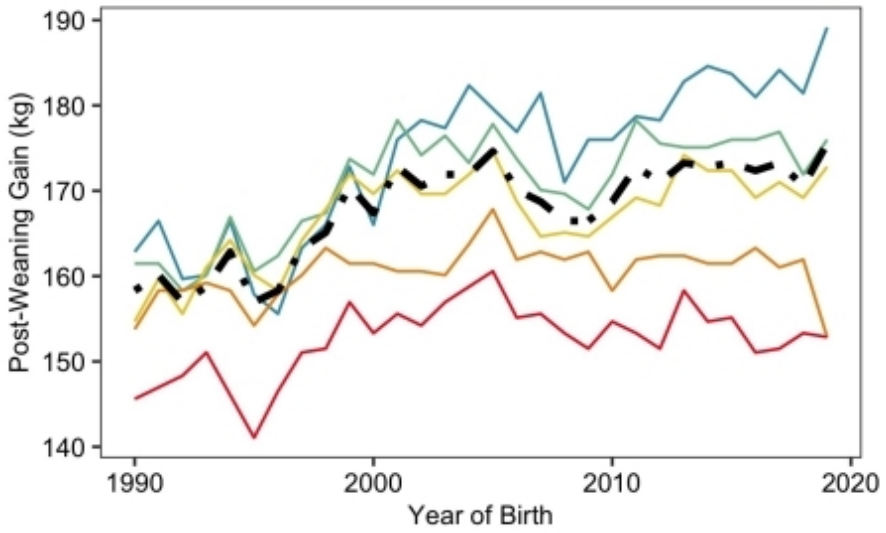
Current genetic evaluation model used by the Breeder Association
Single-Step Multi trait model

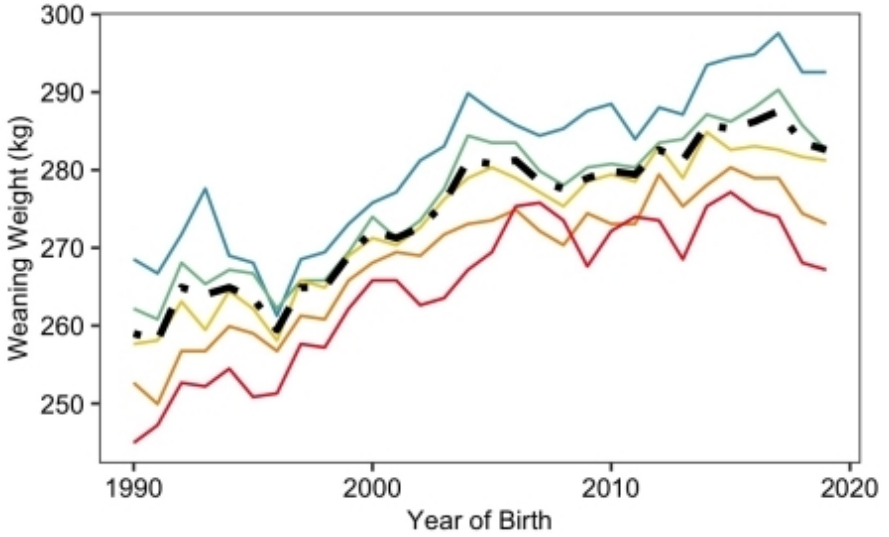
$$y = Xb + Z_1u + Z_2\,mat + Z_3\,perm + e$$

Phenotypic Trends





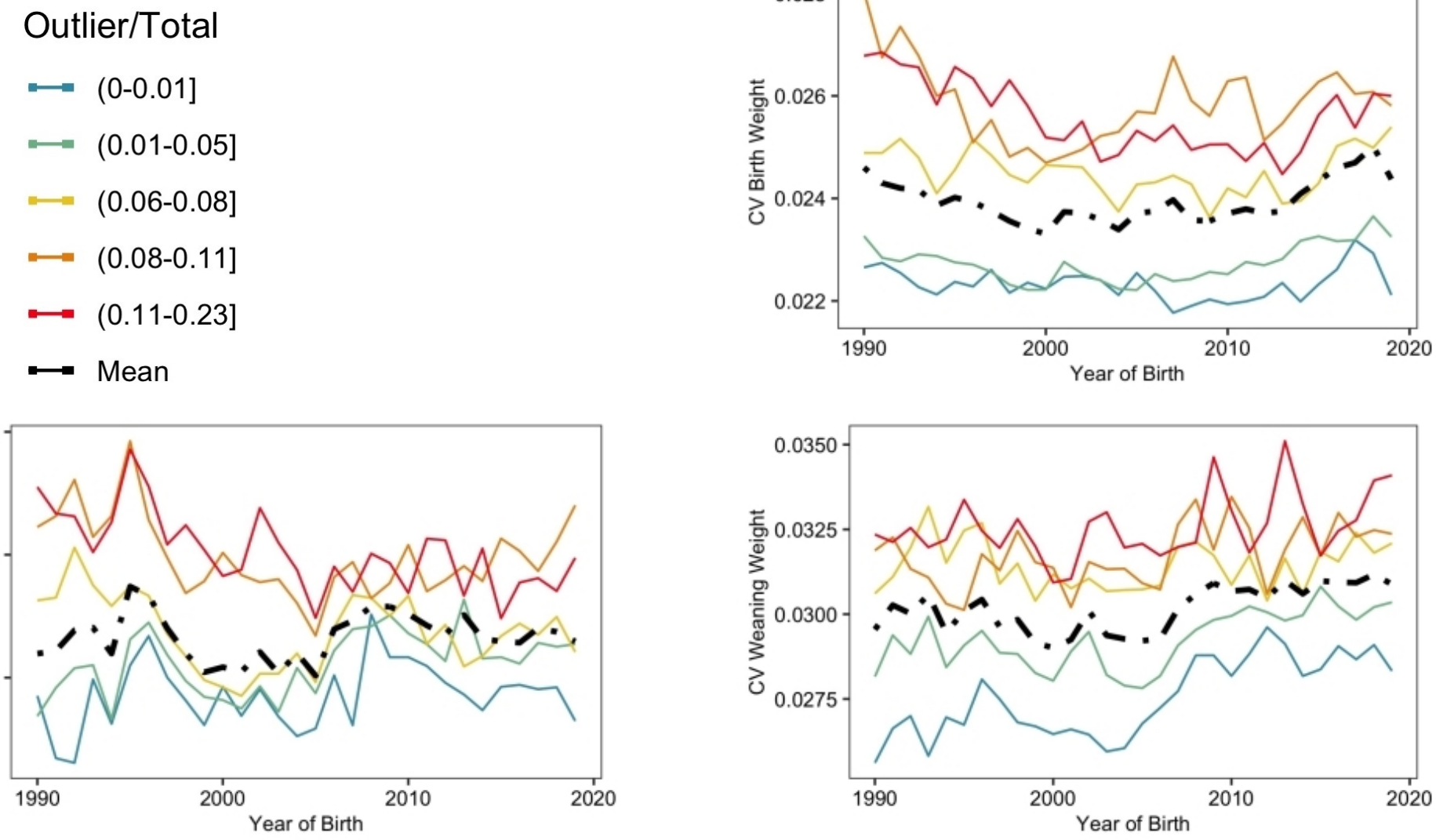




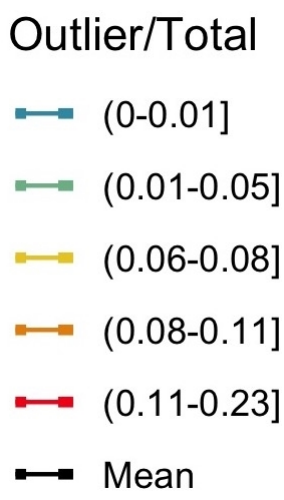
Are the phenotypic trends different?

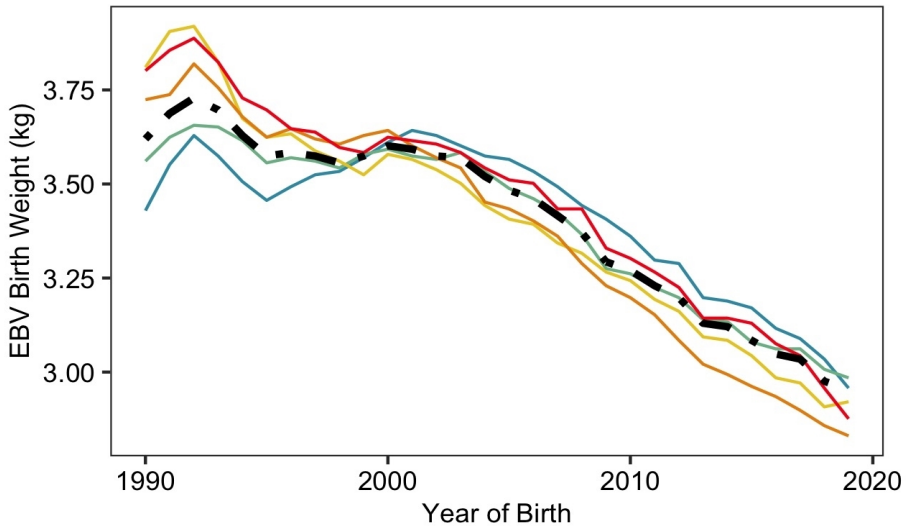
Contrast	BW contrast	WW contrast	PWG contrast
1 – 2	0.0516 ***	0.16018 ***	0.711 ***
1 – 3	0.1439 ***	0.19074 ***	1.079 ***
1 – 4	0.1288 ***	0.16324 ***	1.147 ***
1 – 5	0.1026 ***	-0.25233 ***	1.252 ***
2 – 3	0.0923 ***	0.03056 ***	0.368 ***
2 – 4	0.0772 ***	0.00307	0.436 ***
2 – 5	0.0510 ***	-0.41250 ***	0.541 ***
3 – 4	-0.0151***	-0.02750	0.068
3 – 5	-0.0413 ***	-0.44307 ***	0.173 ***
4 – 5	-0.0262 ***	-0.41557 ***	0.105 ***

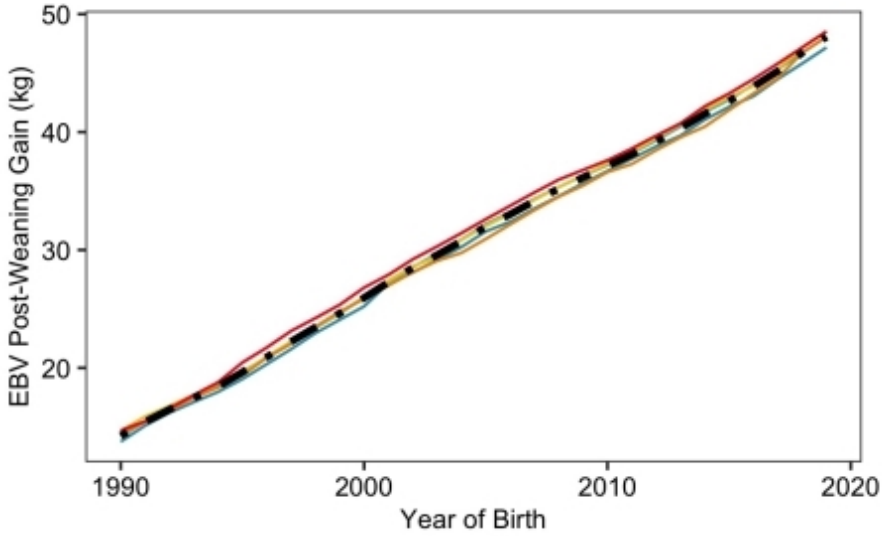
Phenotypic Trend – Coefficient of Variation

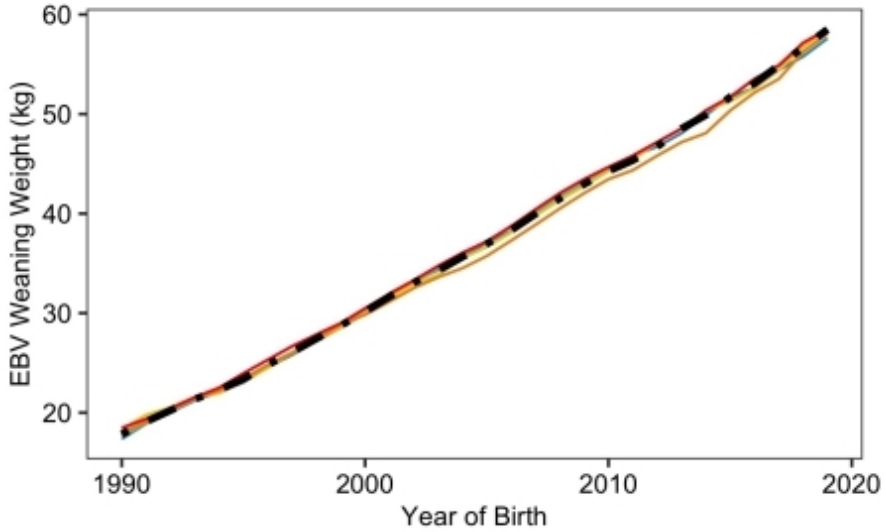


Genetic Trend

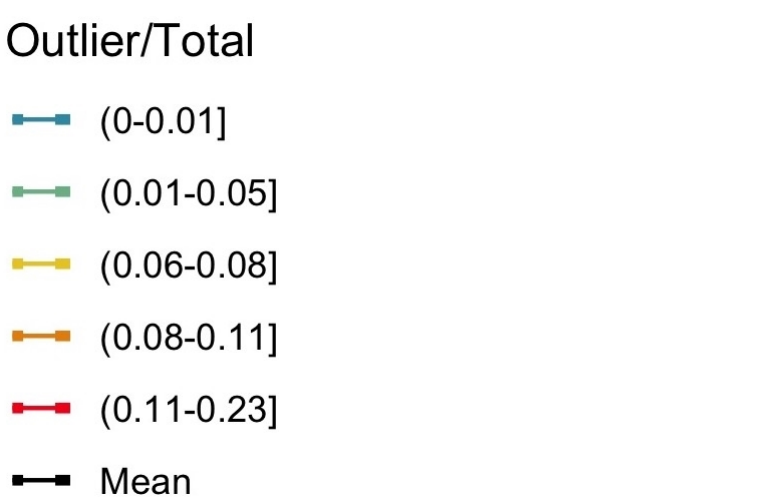


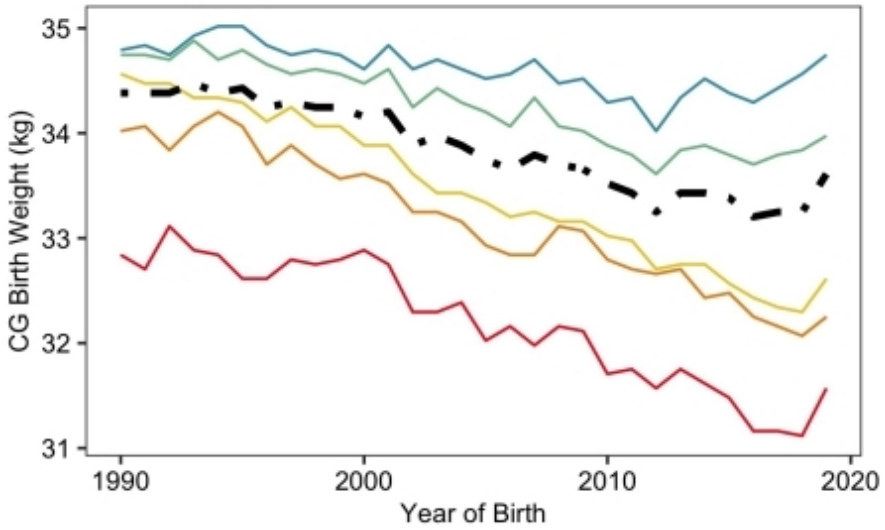


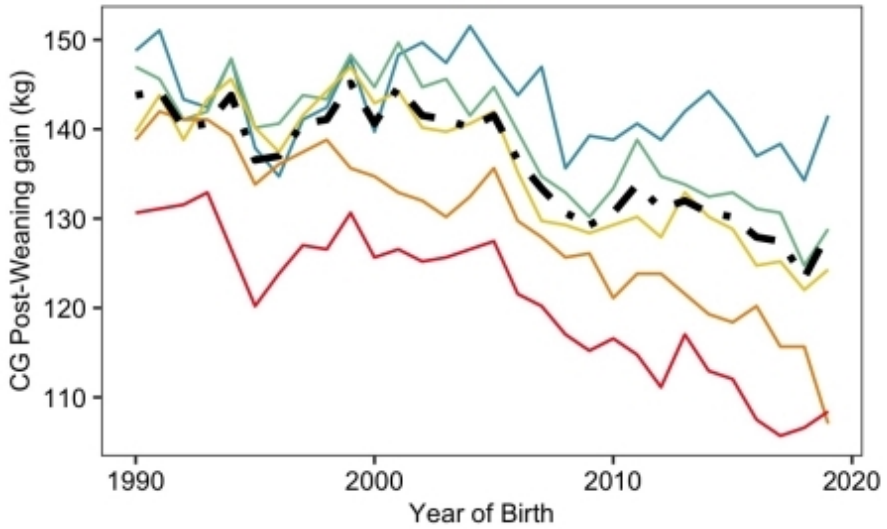


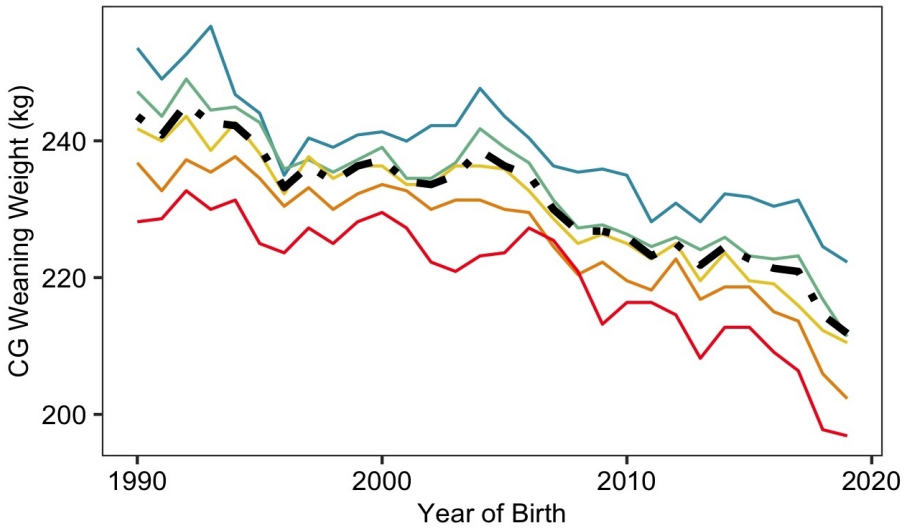


Contemporary Group Trends

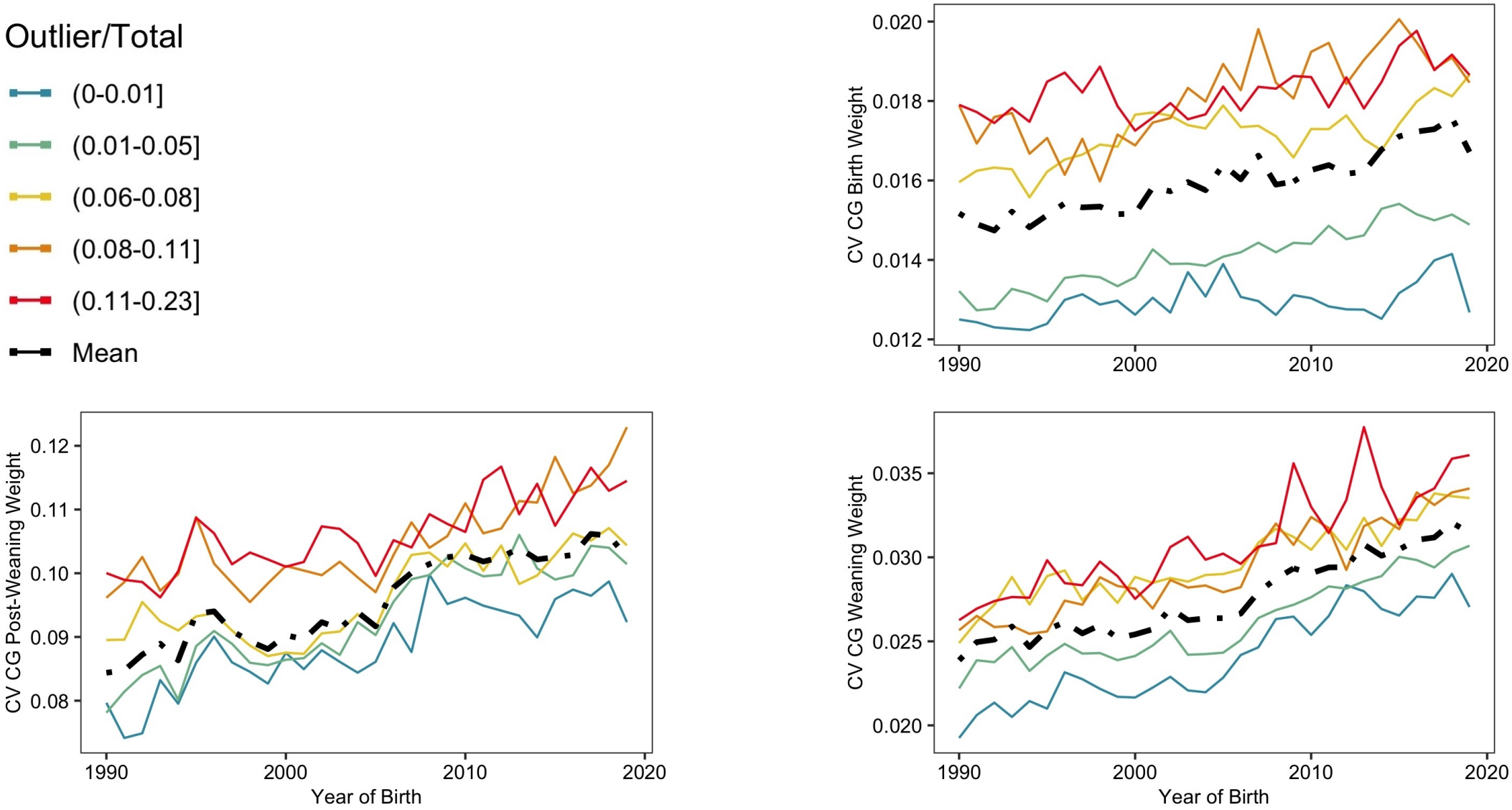








Contemporary Group Trends – Coefficient of Variation



Conclusions

1. Phenotypic trends are in the same direction; however, in locations with frequent heat stress outliers, were slower and more variable.

2. No differences in the estimated genetic trends.

3. All contemporary group (CG) effects tend to decrease along years; but locations with more heat stress outliers had worse mean and highest variability in the three traits.

4. An indication that long term changes in the local climate has a detrimental effect on animal performance.

Thank you for your attention!

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