How much are wild vertebrate populations evolving right now?

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The big problem: We do not know how much wild organisms are currently evolving!

Fisher's fundamental theorem of natural selection states that **additive genetic variation in fitness measures evolution across all traits and all the genome**. That is just what we need*! Yet, there are few estimates in free-ranging populations, and most may be unreliable. Indeed, it is difficult to measure fitness, difficult to estimate genetic variance, statistical models tend not to fit the data, and it is unclear how to interpret estimates from generalized linear models. We use a dozen long-term monitored populations with high quality fitness (measured as lifetime breeding success) and relatedness measurements to tackle these issues. How to make the most of these data? Are birds and mammals currently evolving?
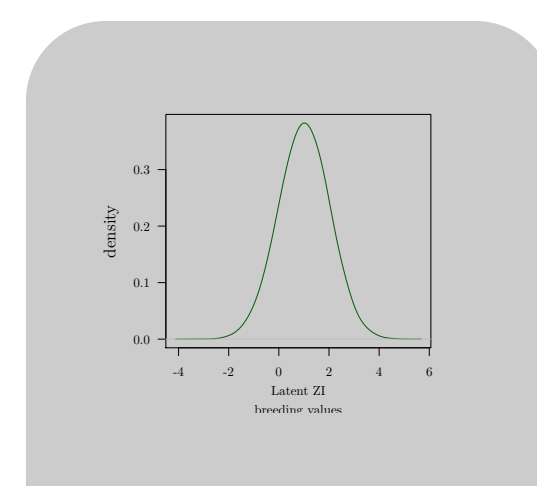
Theory: How to estimate additive genetic variance in relative fitness ($V_A(\omega)$) ?

Model distributions for fitness
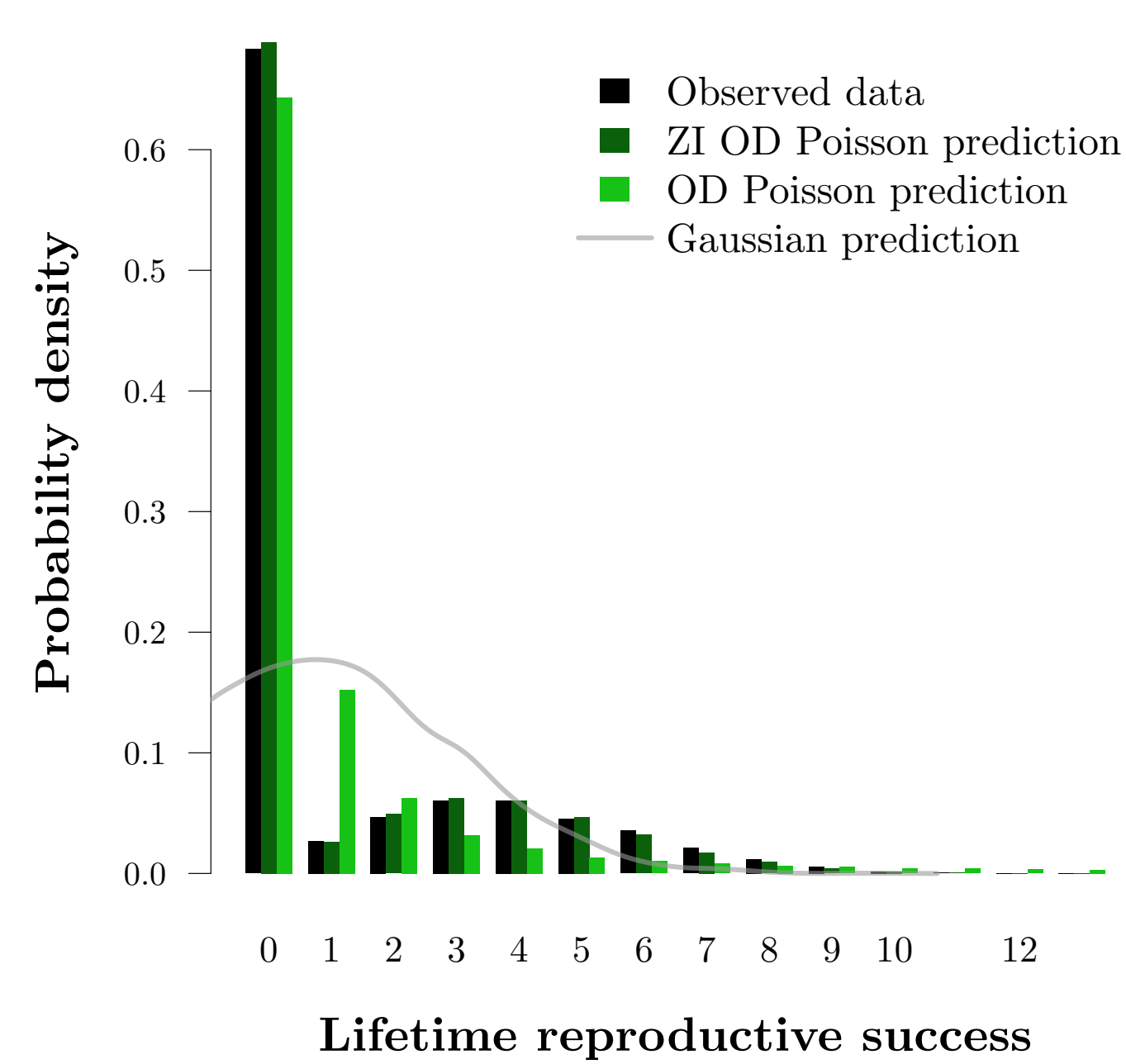
Zero-Inflated Over-Dispersed Poisson models tend to fit well lifetime fitness data. Quantitative genetic estimates may be more precise than with Gaussian or Poisson models.

Estimate latent genetic variation

Quantitative genetic ANIMAL MODELS use relatedness matrix to estimate G-matrix for the zero-inflation and the over-dispersed Poisson processes on two latent scales (log and logit).
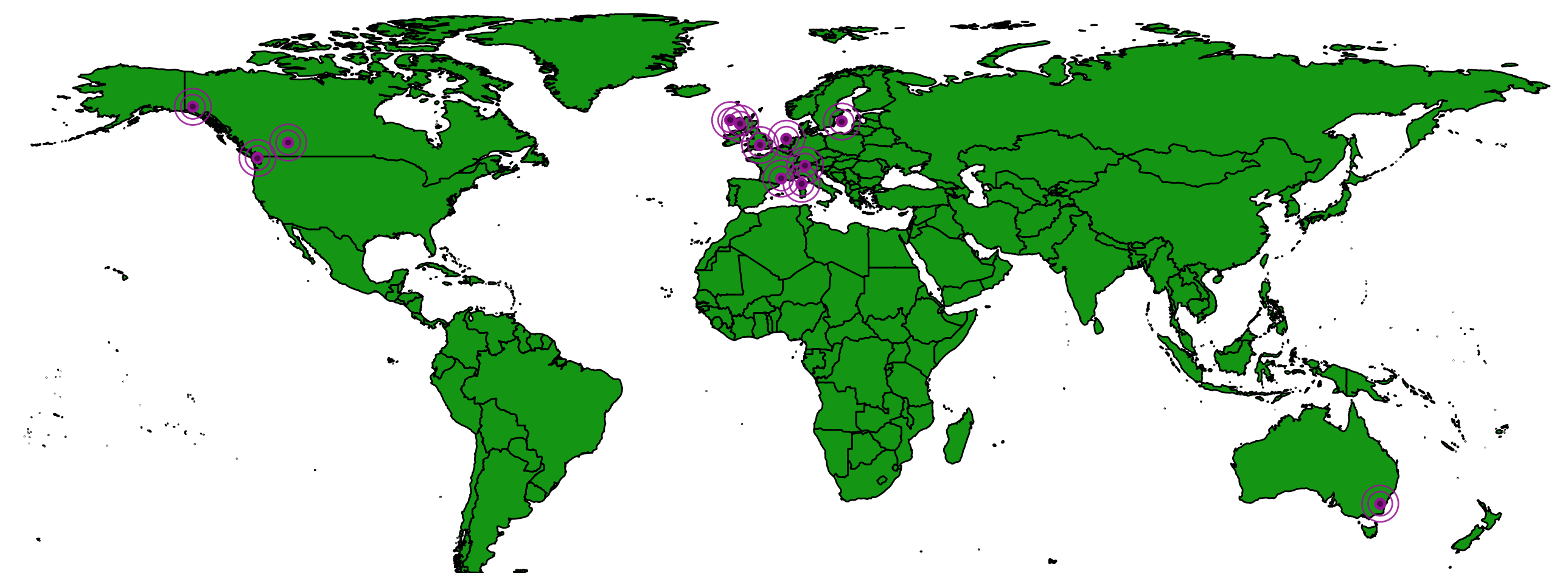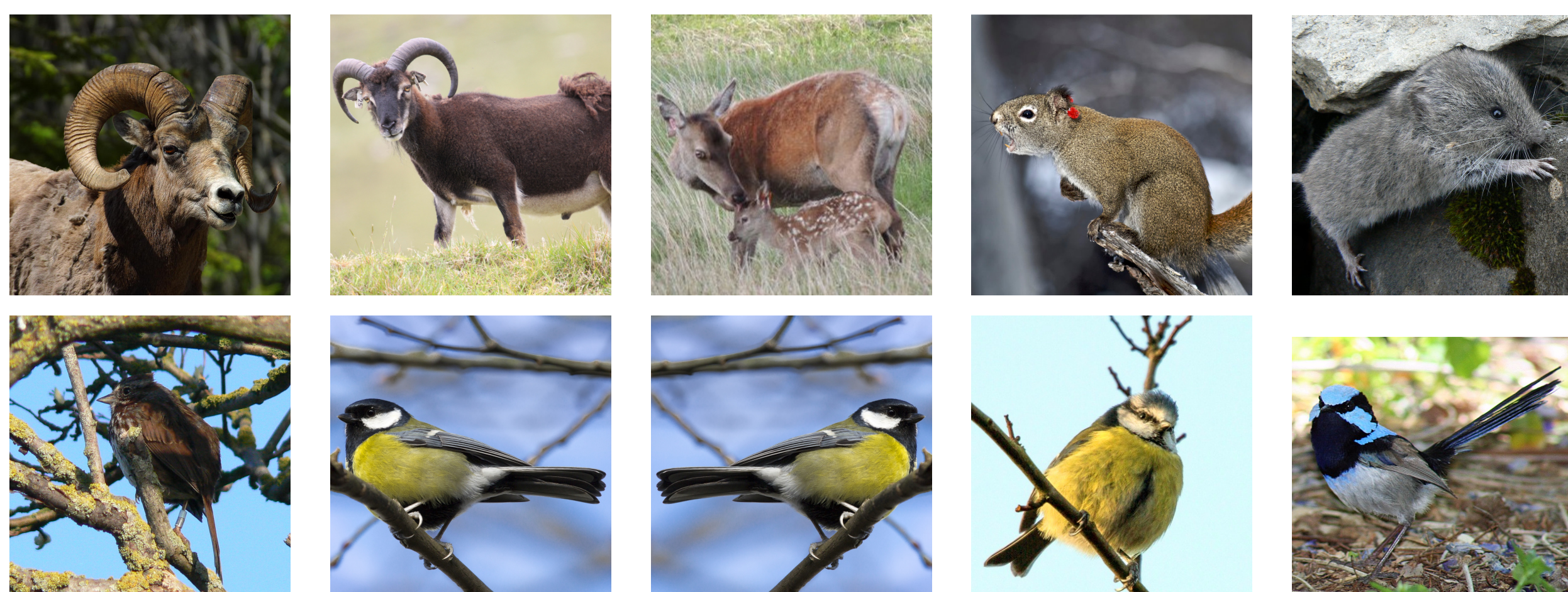
### Convert latent parameters to $V_A(\omega)$
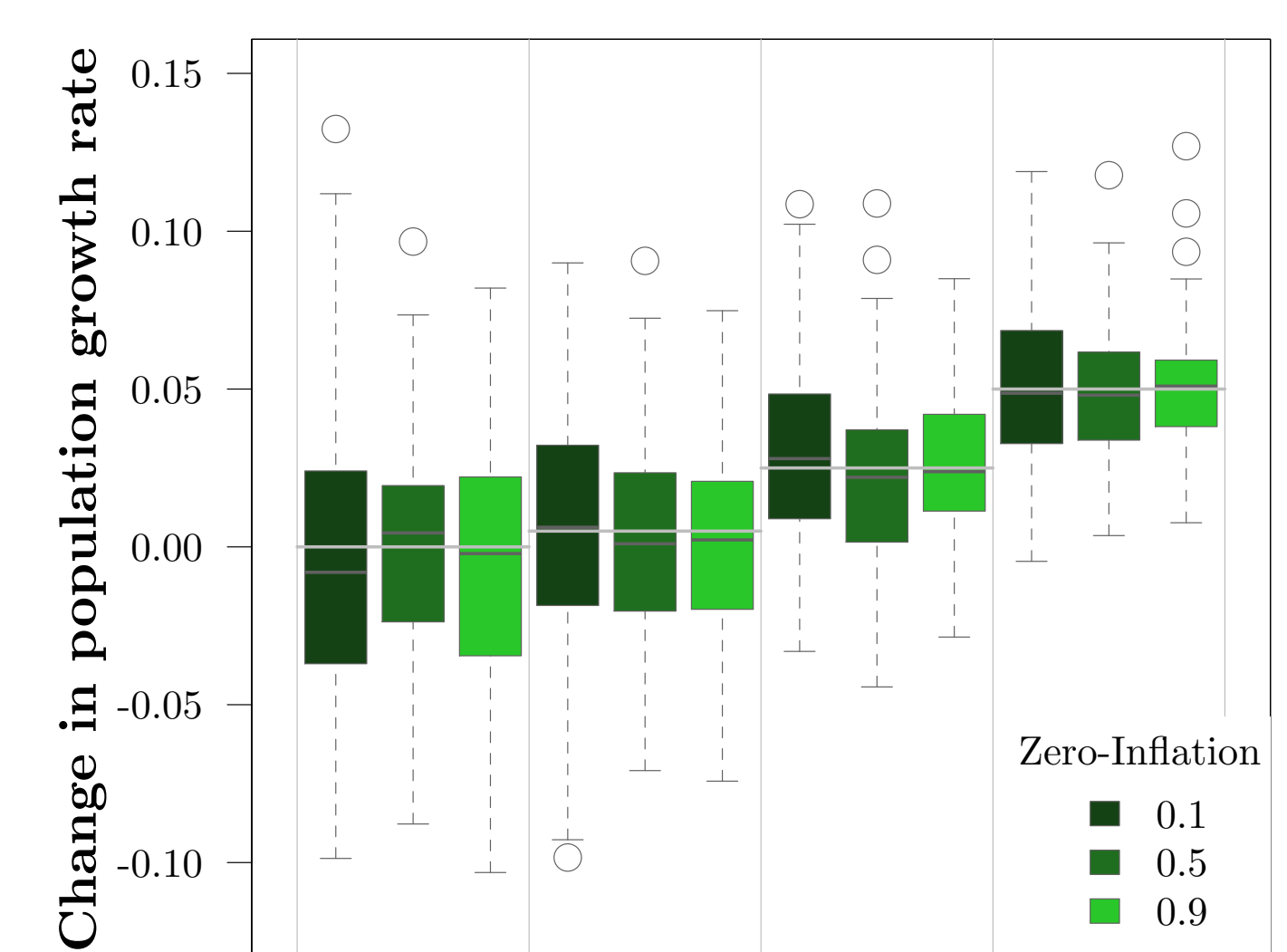
Monte-Carlo integration of latent breeding values to the data scale. Back-transformation works for individual-based simulations: $V_A(\omega)$ equals the increase in population growth rate.

## Empirical results: Additive genetic variation in fitness detectable in most populations

Preliminary models suggest small heritabilities of fitness on the data-scale (average 2.4%). Cohort effects, maternal effects and stochasticity dominate variation. However, credibility intervals of $V_A(\omega)$ exclude 0 in 5 out of 10 populations, and the posterior mode exceeds 0.1% in all of them, suggesting widespread on-going evolution.
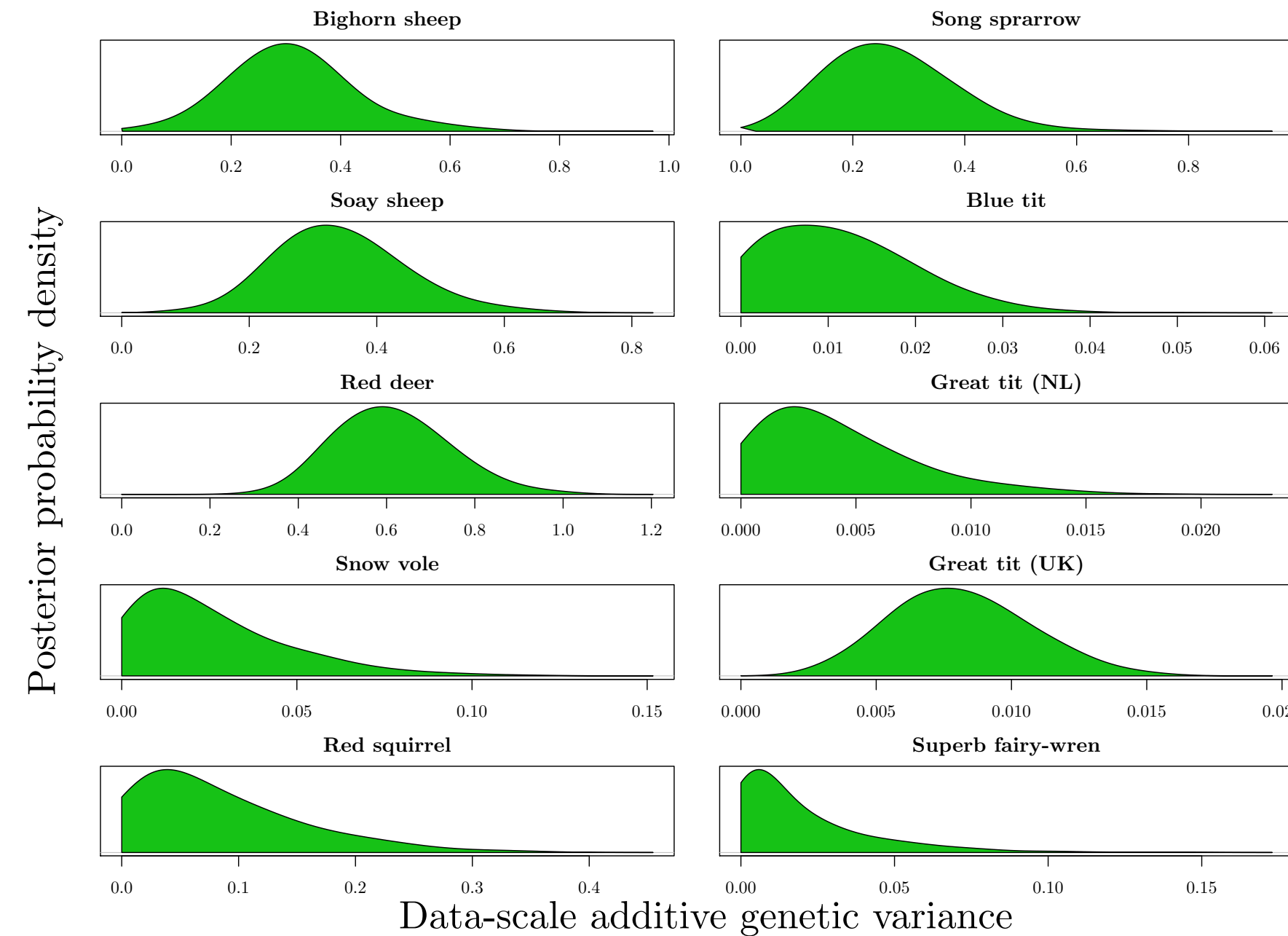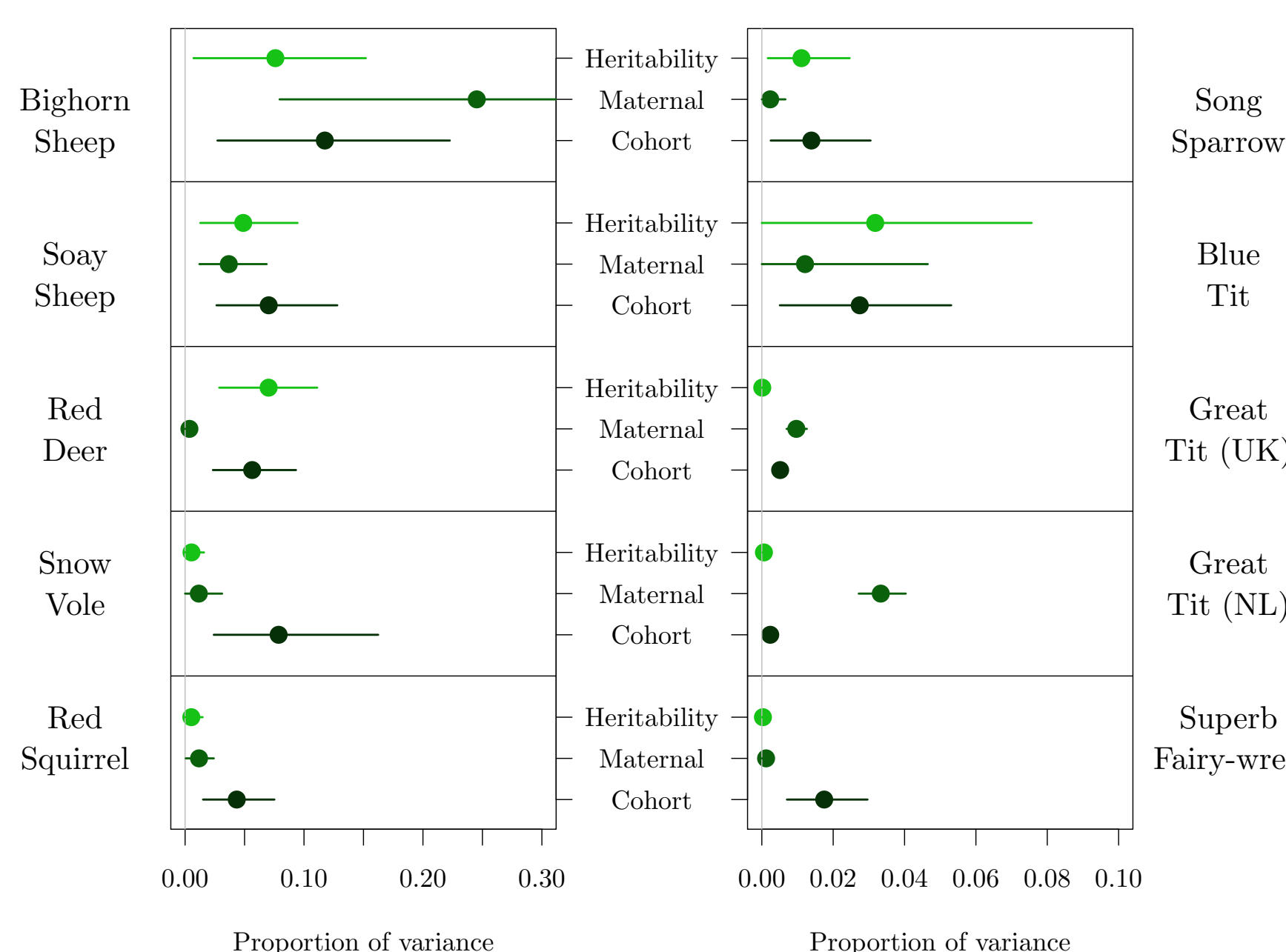
Next, we will explore:
- Influence of priors on estimation
- Influence of missing data and imigration
- Sex-specific fitness. Does cross-sex genetic correlation constrain or enhance evolution?
- Relative importance of ZI, Poisson and their covariance
- Significance for population dynamics

Website
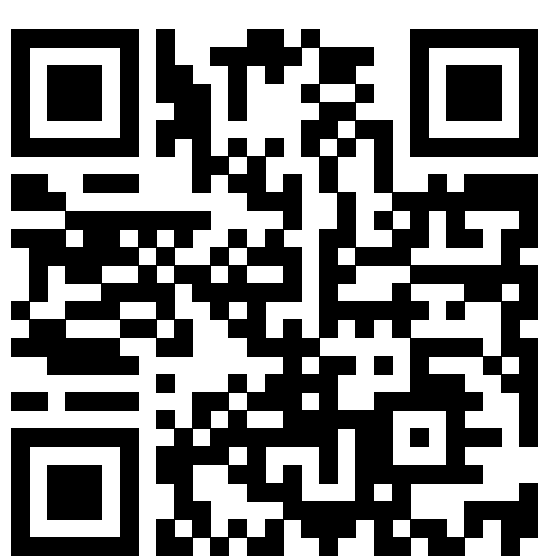
timotheenivalis.github.io

R and LaTeXcode

github.com/timotheenivalis/VAWisWOW

* Fisher's theorem relies on stringent assumptions, or alternatively on a specific meaning of evolution. In the absence of competition and gene-by-environment interactions, $V_A(\omega)$ is the increase in expected population growth rate. This clean link between evolution and demography probably doesn't apply (for long) in nature.