2nd stage analyses: Test heterogeneity in population trends and fluctuations

Prior structure 1:
Hierarchical models in a Bayesian framework with weakly informative (flat) priors

$$Pr(\mu) \sim N(0, 10^8)$$
$$Pr(\sigma^2) \sim Inverse\ Wishart\ (V = 0,\ nu = 0)$$

Prior structure 2:
Hierarchical models in a Bayesian framework with weakly informative (parameter expanded) priors and a variance-covariance structure that allows the slopes of population trends and fluctuations to covary for each random effect.

$$Pr(\mu) \sim N(0, 10^8)$$
$$Pr(\sigma^2) \sim Inverse\ Wishart\ (V = 1,\ nu = 1)$$

INPUT

Population trend (μ), population fluctuations (σ^2) and observation error (τ^2) estimates for each population

GEOGRAPHIC PATTERNS

QUESTIONS | How do vertebrate population trends and fluctuations vary across latitudes, realms and biomes?

MODELS
$\mu \sim latitude,\ random = species$
$\mu \sim 1 + realm,\ random = species$
$\mu \sim 1 + biome,\ random = species$
$\sigma^2 \sim latitude,\ random = species$
$\sigma^2 \sim 1 + realm,\ random = species$
$\sigma^2 \sim 1 + biome,\ random = species$

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Bird, amphibian and reptile phylogenies

TAXONOMIC PATTERNS

QUESTIONS | How do vertebrate population trends and fluctuations vary across taxa and phylogenies?

MODELS
$\mu \sim 1 + taxa,\ random = species$
$\sigma^2 \sim 1 + taxa,\ random = species$
$\mu \sim 1,\ random = species + phylogeny$
$\sigma^2 \sim 1,\ random = species + phylogeny$

Prior structure 2

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Bird and mammal geographic range, species' mean population size, species' habitat specificity

RARITY PATTERNS

QUESTIONS | How do vertebrate population trends and fluctuations vary across rarity metrics?

MODELS
$\mu \sim log(geographic\ range),\ random = species$
$\mu \sim log(mean\ population\ size),\ random = species$
$\mu \sim habitat\ specificity,\ random = species$
$\sigma^2 \sim log(geographic\ range),\ random = species$
$\sigma^2 \sim log(mean\ population\ size),\ random = species$
$\sigma^2 \sim habitat\ specificity,\ random = species$

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Species' IUCN conservation status and IUCN threats categories

IUCN CONSERVATION STATUS AND TREATS

QUESTIONS | How do vertebrate population trends and fluctuations vary across species' IUCN conservation status and type and number of IUCN threats?

$\mu \sim 1 + Red\ List\ status,\ random = species$
$\mu \sim 1 + threat\ type,\ random = species$
$\mu \sim number\ of\ threats,\ random = species$
$\sigma^2 \sim 1 + Red\ List\ status,\ random = species$
$\sigma^2 \sim 1 + threat\ type,\ random = species$
$\sigma^2 \sim number\ of\ threats,\ random = species$

Prior structure 1

OUTPUT

Effect sizes for each tested metric