A framework for optimally predictive population models: identifying climate drivers for integral projection models

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Abstract

Linking variation in weather to population dynamics is an integral step toward predicting the impactes of climate change on plant and animal populations. However, fitting demographic population models with climate drivers is deceptively complex. Just deciding how to, and whether to, aggregate weather variables into a set of candidate covariates is non-trivial. Here, we describe and compare three possible methods for including climate covariates: (1) use expert knowledge to *a priori* define a tractable set of climate covariates, (2) use functional linear models (splines) to avoid aggregation altogether, and (3) use functional linear models to identify time periods over which to aggregate climate variables followed by statistical regularization to manage covariate collinearity. To test the three methods we build stochastic integral projection models using the all three methods for climate covariate inclusion for 15 species across five semi-arid grasslands and compare their predictive ability. We find...

Key words: population model, climate change, forecasting, integral projection model, ridge regression, functional linear model, model selection

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Plan of Work

Research Question

What is the best way to link demography to climate drivers when prediction is the goal: data-driven approaches or expert knowledge? (*This is a placeholder, and a crappy one at that.*)

Research Approach

1. Fit vital rate statistical models

- Functional linear models (Britta and Andrew) – `mgcv`
- Ridge regression on *a priori* climate covariates (Andrew) – `Stan` (has to be Bayesian, no packages for frequentist GLMM with mixture of penalized and non-penalized coefficients)
- Ridge regression on climate covariates aggregated according to FLM results (Andrew and Britta) – `Stan`. This will also require coming up with an algorithm to identify months over which to aggregate (and, do we sum, average??).

2. Build IPMs for each statistical approach above (Andrew and Peter)

- Leave-one-year-out validation
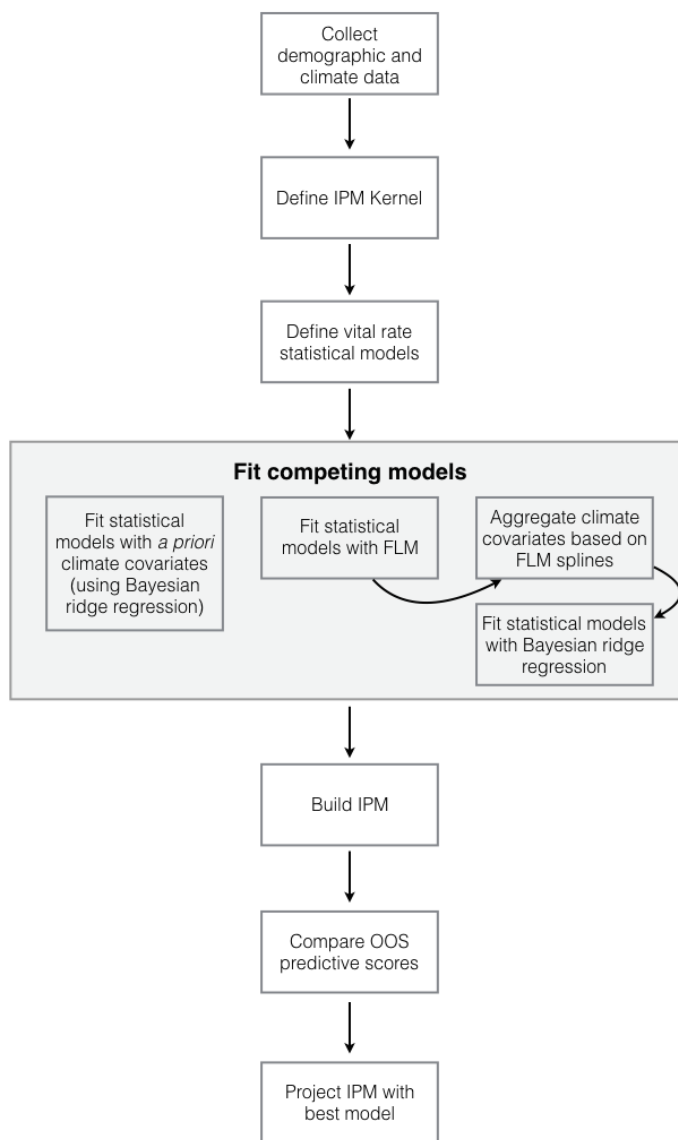- Compare validation scores among three approaches

Figures

Figure 1: Flowchart diagram of the steps in our analysis.