Data from: Improving structured population models with more realistic representations of non-normal growth

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Abstract

1. Structured population models are among the most widely used tools in ecology and evolution. Integral projection models (IPMs) use continuous representations of how survival, reproduction, and growth change as functions of state variables such as size, requiring fewer parameters to be estimated than projection matrix models (PPMs). Yet almost all published IPMs make an important assumption: that size-dependent growth transitions are or can be transformed to be normally distributed. In fact, many organisms exhibit highly skewed size transitions. Small individuals can grow more than they can shrink, and large individuals may often shrink more dramatically than they can grow. Yet the implications of such skew for inference from IPMs has not been explored, nor have general methods been developed to incorporate skewed size transitions into IPMs, or deal with other aspects of real growth rates, including bounds on possible growth or shrinkage. 2. Here we develop a flexible approach to modeling skewed growth data using a modified beta regression model. We propose that sizes

first be converted to a (0,1) interval by estimating size-dependent minimum and maximum sizes through quantile regression. Transformed data can then be modeled using beta regression with widely available statistical tools. We demonstrate the utility of this approach using demographic data for a long-lived plant, gorgonians, and an epiphytic lichen. Specifically, we compare inferences of population parameters from discrete PPMs to those from IPMs that either assume normality or incorporate skew using beta regression or, alternatively, a skewed normal model. 3. The beta and skewed normal distributions accurately capture the mean, variance, and skew of real growth distributions. Incorporating skewed growth into IPMs decreases population growth and estimated lifespan relative to IPMs that assume normally-distributed growth, and more closely approximate the parameters of PPMs that do not assume a particular growth distribution. A bounded distribution, such as the beta, also avoids the eviction problem caused by predicting some growth outside the modeled size range. 4. Incorporating biologically relevant skew in growth data has important consequences for inference from IPMs. The approaches we outline here are flexible and easy to implement with existing statistical tools.

Usage Notes

Bistort raw data

Demographic data for Polygonum viviparum collected at Niwot Ridge, CO from 2001-2011. szs0 = size at time t, szs1 = size at time t+1, bulbs0 = number of bulbils produced at time t. Details of data collection given in the supporting information.

Gorgonian raw data

Demographic data for Paramuricea clavata collected in the NW Mediterranean Sea from 1999-2004. Mortality = source of mortality, Site = site, Plot = plot, Year = annual transition from time t to time t+1, Ncol = colony id, Size = size at time t, Sizenext = size at time t+1, Survnext = dead (0) or alive (1) at time t+1. Details of data collection and reproduction given in supporting information.

Vulpicida raw data

Demographic data for Vulpicida pinastri collected in Kennicott Valley, AK from 2004-2009. Year = year at time t, site = site, t0 = size at time t, t1 = size at time t+1, repro = number of offspring assigned based on thallus circumference, survival = dead (0) or alive (1) at time t+1. Details of data collection and reproduction are given in supporting information.

Appendix 1

R script for analyses in Figure 2

Appendix 2

R script for analyses of coral

Appendix 3
R script to simultaneously fit the minimum, maximum, mean, and precision parameters of the beta approach using maximum likelihood

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References

This dataset is supplement to https://doi.org/10.1111/2041-210x.13240

Location

NW Mediterranean Sea
USA
Colorado
Alaska
Kennicott Valley
Niwot Ridge

Keywords

Bistorta vivipara, Vulpicida pinastri, skewed normal, Polygonum viviparum, matrix model, Asymmetry, Beta regression, integral projection model, quantile regression, population model, Growth, skew, Paramuricea clavata

Files

6 files for this dataset

Appendix 1.R	19.81 kB	text/plain
Appendix 2.R	20.88 kB	text/plain
Appendix 3.R	6.62 kB	text/plain
Bistort raw data.csv	330.89 kB	text/csv
Gorgonian raw data.csv	233.76 kB	text/csv
Vulpicida raw data.csv	74.07 kB	text/csv

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