The Ins and Outs of Population Ups and Downs

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2016 NCASI West Coast Regional Meeting

Population Trends

- When is a decline real?
- When is an outbreak happening?
- When can we open hunting on a species?

The Inference Problem

Population data over time not independent

Regression assumes they are

Null model: slope = 0

test H_o: b = 0

reject Ho

Inference for Autoregressive Series

A proper null for populations

Stochastic influences multiplicatively accumulate

Null is NOT slope = 0

Logistic model

Long-term stability

Fluctuations on short time scale

The Null

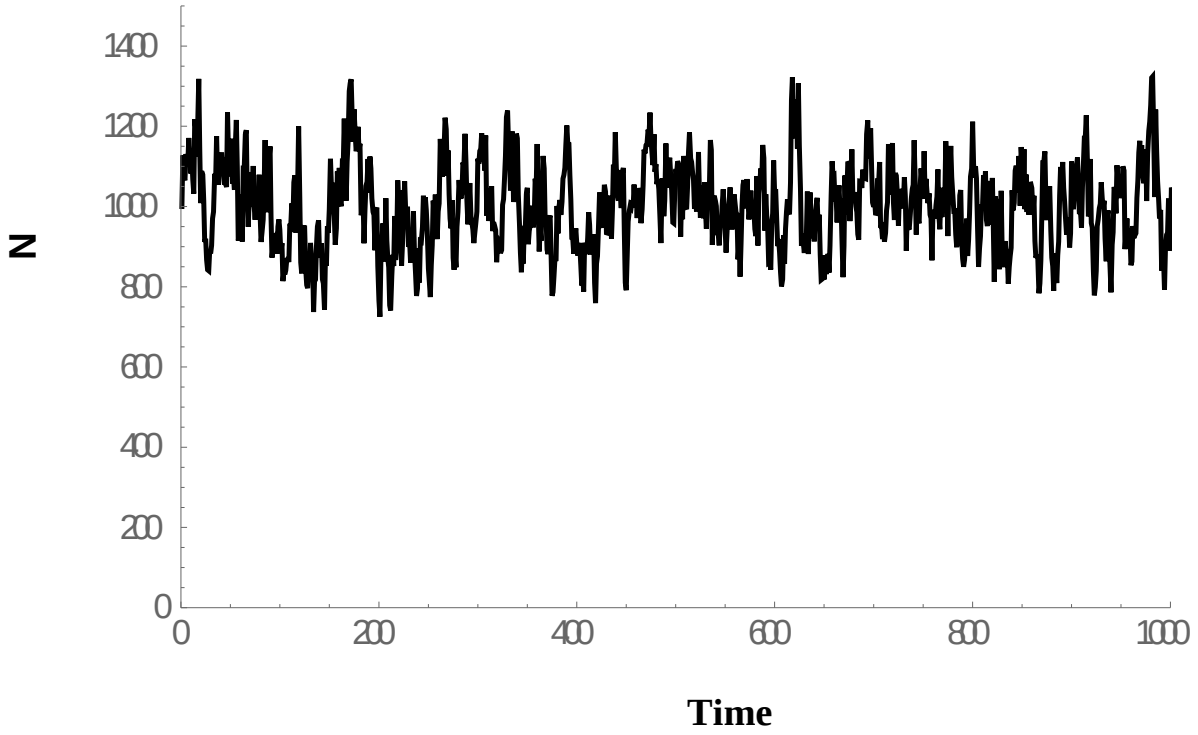
$$N_{t+1} = N_t \, e^{r_t}$$

$$r_t = Norm\left(\mu = r\left(1 - \frac{N_t}{K}\right), \sigma^2\right)$$

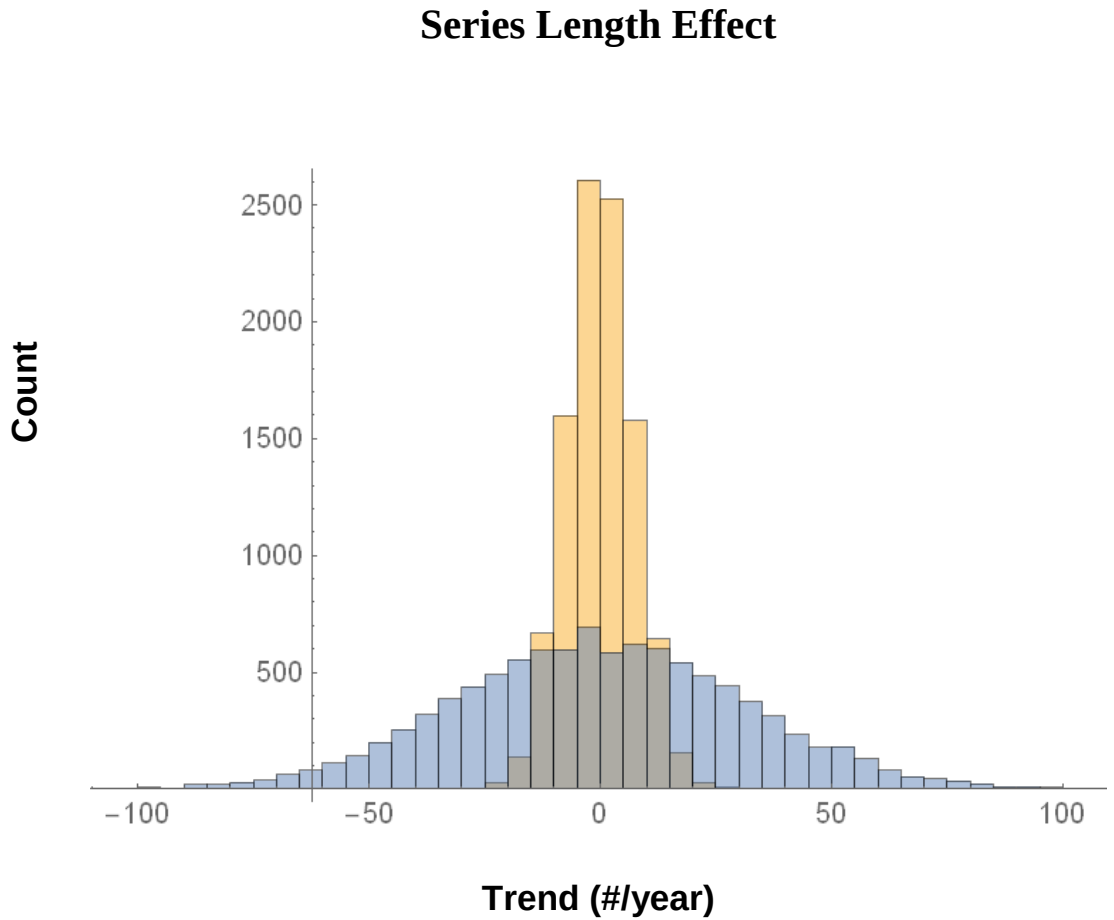
Bounded random walk (BRW)

Long-term stable but fluctuating

BRW Behavior



First 100 years of a 10,000 year run of a BRW model
using parameters K = 1000, r = 0.25, σ^2 = 0.005.
The model exhibits long-term stability.



Distribution of trends by linear regression for all 5 (blue) and 20 (orange) year subsets of the 10,000 year BRW simulation.

Null Implications

For given μ, σ, X% of series of length t will show > d% decline

This is our null expectation, not zero trend.

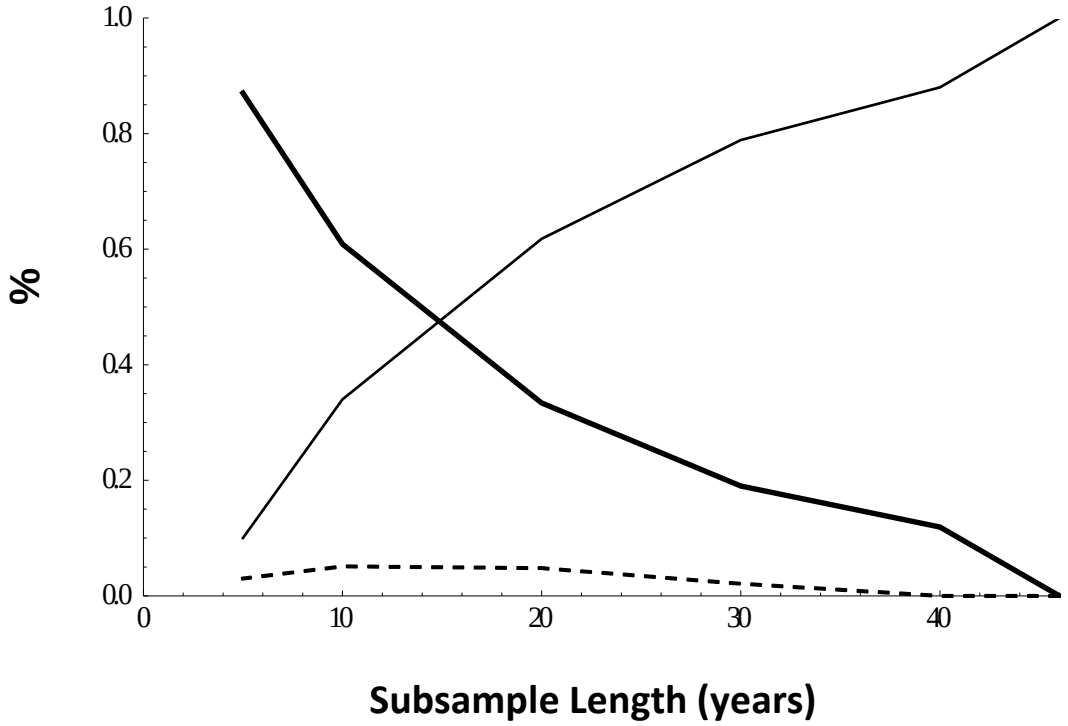
BBS Test Data

128 species

AL & GA

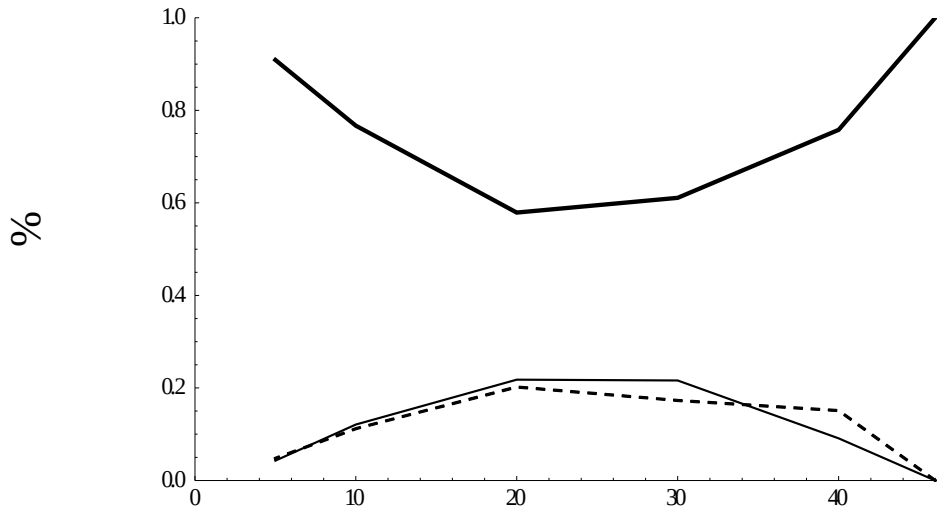
46 years data

BBS Sample Length



For all routes with statistically significant positive 46-year slope, more and more routes have statistically “0” slope for shorter series (thick line).

Statistical Power



For statistically 0 slope for 46 years, shorter series become more likely to appear positive or negative between 20-30 years, then back to neutral as power is lost with short series.

Metapopulation Effects

Consider a metapopulation

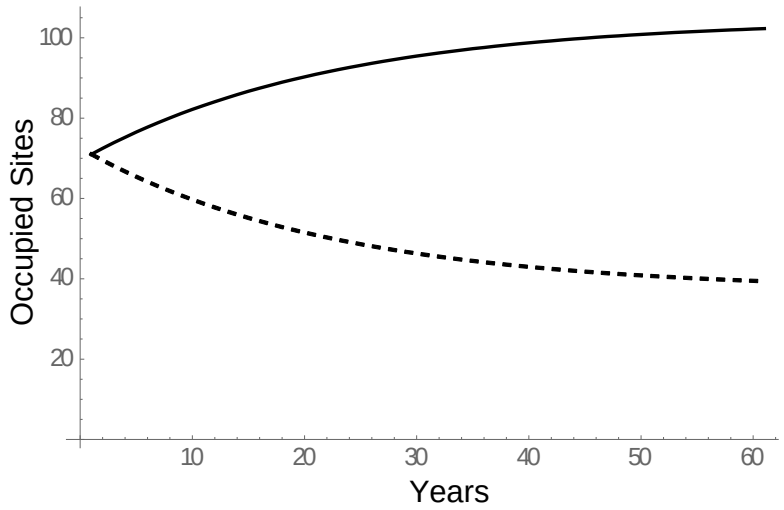
Of N sites sampled, p are occupied at year 0

Only these occupied sites are resampled t years later

Problem: over time, occupied sites revert to the mean occupancy

Metapopulations and Sampling

a



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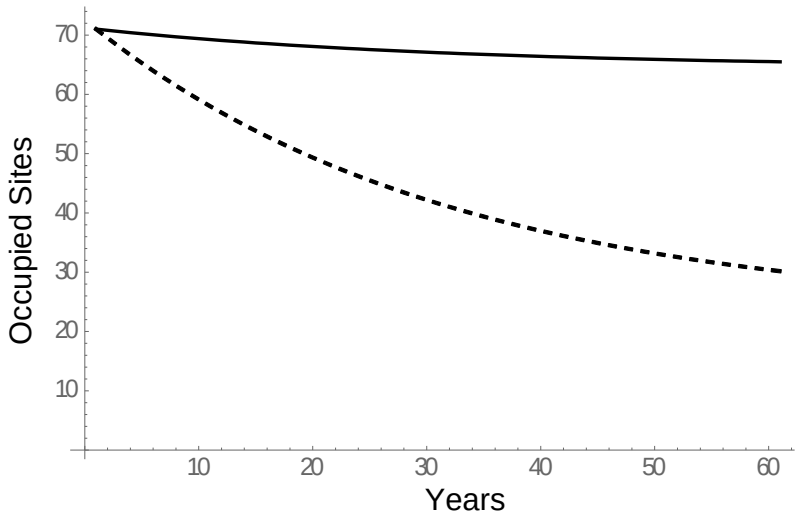

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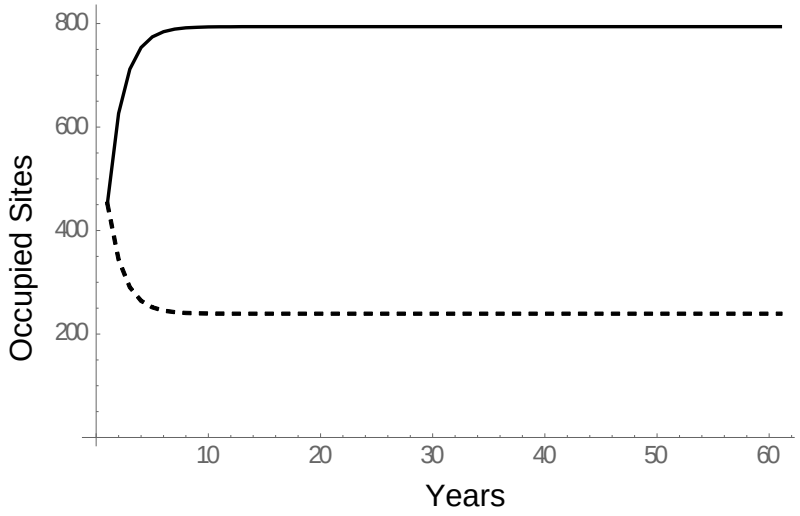


Detectability

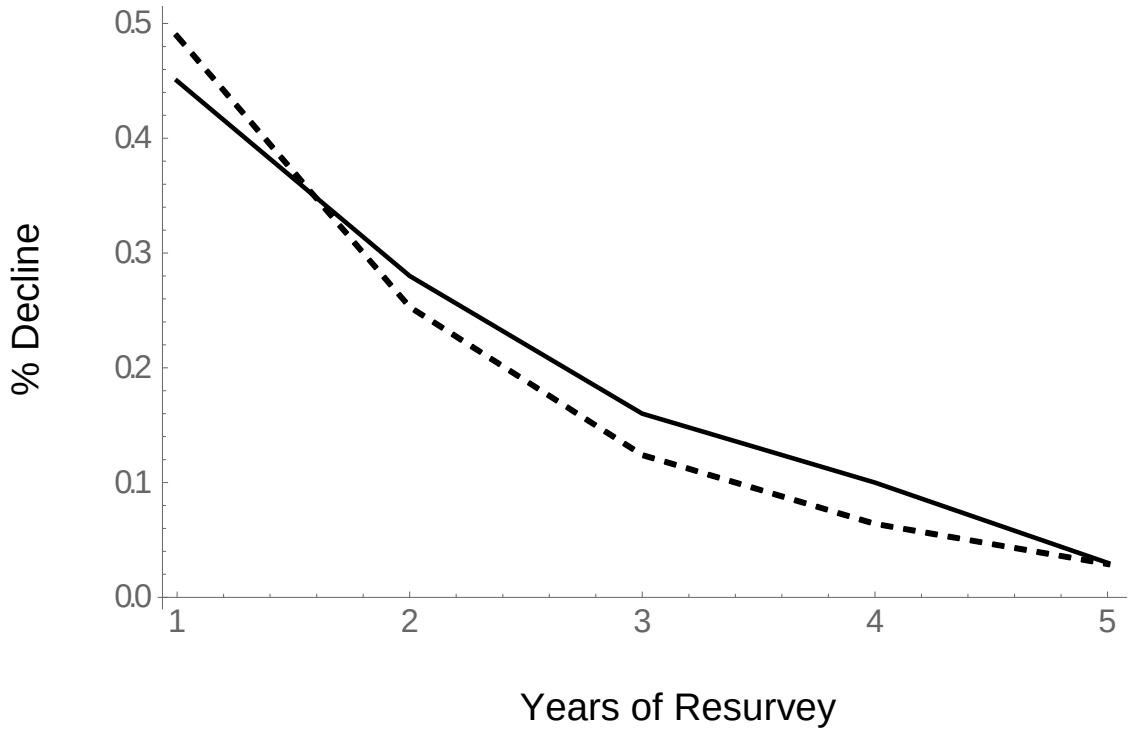
Consider N sites sampled in year 0, resampled later

Detectability is not high

OR populations fluctuate

Result: apparent decline on resampling

Detectability: multiple surveys reduce apparent decline



Skelly et al. (2003) resurvey of ponds in a reserve in Michigan (solid line) when all original ponds were resurveyed. Simulation (dashed line) of resurveys using detectability of 50%.

Summary

Null model for population time series

- BRW model
- Implies simple regression misleading
- Short series lose power
- 20 years reasonable length for inference

Metapopulations

- Can cause spurious declines if only resample original occupied sites

Detectability issues

- Need to resurvey for several years