J. S. Clark, S. La Deau, and I. Ibanez 2004

Fecundity of trees and the colonization-competition hypothesis

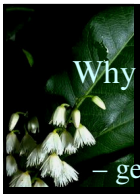
Ecological Monographs 74:415-442.

Stabilising Mechanisms of Species Co-existence

Colonisation-Competition trade-offs

Successional niche differentiation

– involve strict trade-offs in species-level traits



Why so hard to evaluate for forests?

– generation times >> experiments (or funds)

– complexity of processes of seed production and dispersal

– fecundity is never observed directly

Why read this paper then ?

– estimates unobserved fecundity by assimilating two different forms of data – tree observns & seed rain

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Objective:

Simultaneous estimation of key factors and sources of variation,

at individual & population levels

Bayesian framework

Likelihood of y given X and θ

$$p(y \mid X, \theta)$$

Probability distribution of θ given y

$$p(\theta \mid y) \propto p(y \mid X, \theta)\ p(X)p(\theta)$$

Likelihoods Priors

Hierarchical model

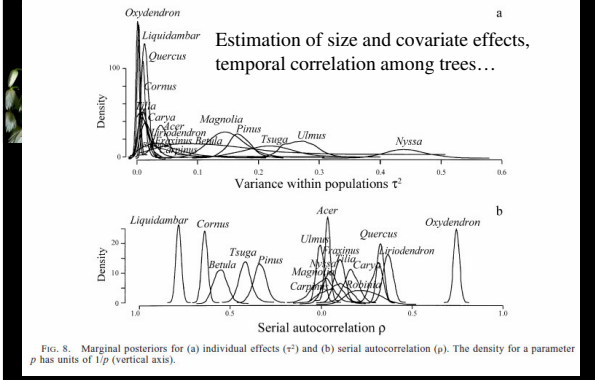
– Three process models

– Pr. of being reproductive, given canopy obs^{n}s,

– Seed production if reproductive, N seeds ~ size

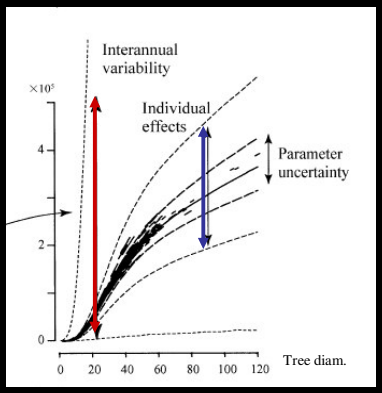
– individual effects on how fecundity changes with tree size

– Dispersal of (unobserved) seeds to seed traps

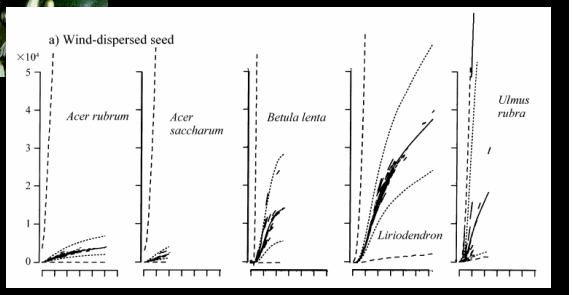


Estimation of size and covariate effects, temporal correlation among trees…

FIG. 8. Marginal posteriors for (a) individual effects (τ^2) and (b) serial autocorrelation (ρ). The density for a parameter p has units of $1/p$ (vertical axis).



Species examples



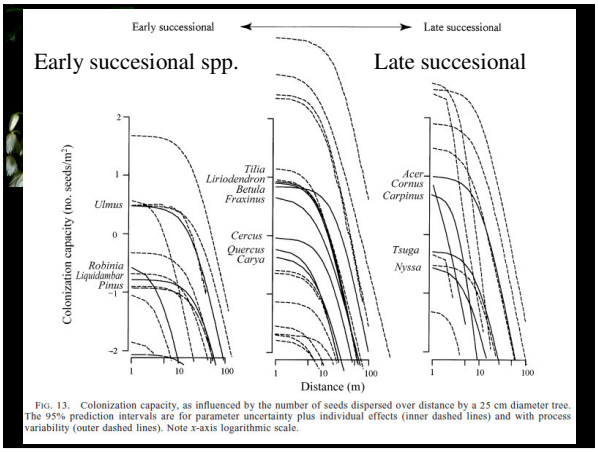


FIG. 13. Colonization capacity, as influenced by the number of seeds dispersed over distance by a 25 cm diameter tree. The 95% prediction intervals are for parameter uncertainty plus individual effects (inner dashed lines) and with process variability (outer dashed lines). Note x-axis logarithmic scale.

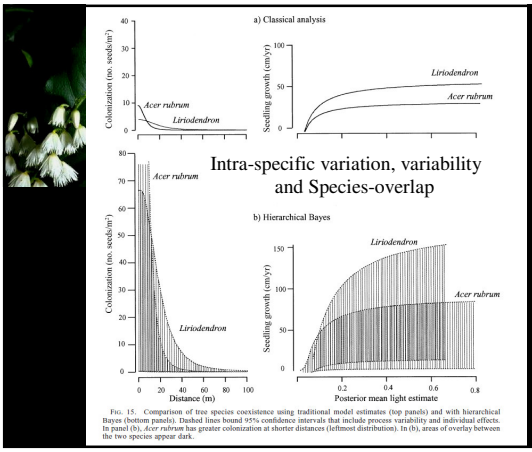


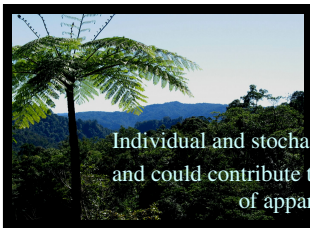
FIG. 15. Comparison of tree species coexistence using traditional model estimates (top panels) and with hierarchical Bayes (bottom panels). Dashed lines bound 95% confidence intervals that include process variability and individual effects. In panel (b), *Acer rubrum* has greater colonization at shorter distances (leftmost distribution). In (b), areas of overlay between the two species appear dark.

Stabilisation of co-existence ?

– Many sources of variability, plus intra-specific variation

– 'Storage Effect' of occasional recruitment success, and temporal persistence of adults

Requires some species differences, so that responses to spatial and/or temporal variation are not tightly correlated across species



Individual and stochastic variation can be immense and could contribute to stabilising the co-existence of apparently similar species.

Thanks

jwells@zen.uq.edu.au