Joint analysis of survival and reproduction over 10 years in *Echinacea angustifolia* plants originating from 21 remnant prairies

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Evolution 2008, 2:45 PM Anderson 270

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A prairie remnant
Large population: many nearby plants. Avoid inbreeding with SI, great deal!
Echinacea: Model prairie species

- Asteraceae
- Herbaceous
- Long-lived
- Reproduces by seed
Common Garden Experiment

1301 plugs planted in 1999.

Randomized positions on 1/3 m x 2/3 m grid.

Old field with competition.

Biennial spring burns.

Annual measurements & harvests.
Survival, 1999 - 2006

Year

Living plants

0 20 40 60 80 100
Problems measuring fitness

1. Each fitness component for a given individual is conditional on the individual’s state for an earlier component of fitness.
Heads on flowering *Echinacea* plants

2002

fl plants 3

2003

fl plants 6

2004

fl plants 117

2005

fl plants 35

2006

fl plants 230

2007

fl plants 197
Histogram of fruit counts

- 303 dead plants
- 768 non-flowering plants
- max (1061)
Problems measuring fitness

1. Each fitness component for a given individual is conditional on the individual’s state for an earlier component of fitness.

2. No single probability distribution is suitable for modeling all components of fitness.
<table>
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<th>Year</th>
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<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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Survive to year? Binominal
Year 1 2 3 4 5 6

Flower? Binomial

Survive to year? Binomial

YES \rightarrow YES \rightarrow YES \rightarrow YES \rightarrow YES \rightarrow YES \rightarrow NO
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**Head count, Poisson**

- Year 1: 0
- Year 2: 1
- Year 3: 0
- Year 4: 2
- Year 5: 0

**Flower? Binomial**

- Year 1: NO
- Year 2: YES
- Year 3: NO
- Year 4: YES
- Year 5: NO

**Survive to year? Binomial**

- Year 1: YES
- Year 2: YES
- Year 3: YES
- Year 4: YES
- Year 5: YES
- Year 6: NO
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problem | solution
--- | ---
Measuring | *Echinacea* project
  | echinacea.umn.edu
Modeling | aster life history analysis
  | www.stat.umn.edu/geyer/aster/
  | Geyer 4:30 Anderson 230
Implementing | R statistical software
  | www.r-project.org
Echinacea Common Garden, Summer 2007
## Model Comparisons

### Analysis of Deviance Table

Model 1: \( \text{resp} \sim \text{varb} + \text{level:finalLoc} \)
Model 2: \( \text{resp} \sim \text{varb} + \text{level:finalLoc} + \text{achct} \times \text{pop} - \text{pop} \)
Model 3: \( \text{resp} \sim \text{varb} + \text{level:finalLoc} + \text{achct} \times \text{pop} \)

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Total fruit count per seedling planted vs. Population of origin, $n = 19$, $p = 0.00006$
Total fruit count per seedling planted vs. Isolation of maternal plant, $p = 0.03$
Conclusions

Population differences in total fruit count (fitness) are not related to population size.

Total fruit count (fitness) increases with isolation of maternal parent.

The “aster” statistical model jointly models composite sequential responses with predictors in a single analysis.
Large population: many nearby plants. Avoid inbreeding with SI, great deal!
Acknowledgements

Gretel Kiefer

Field assistants

Volunteers

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