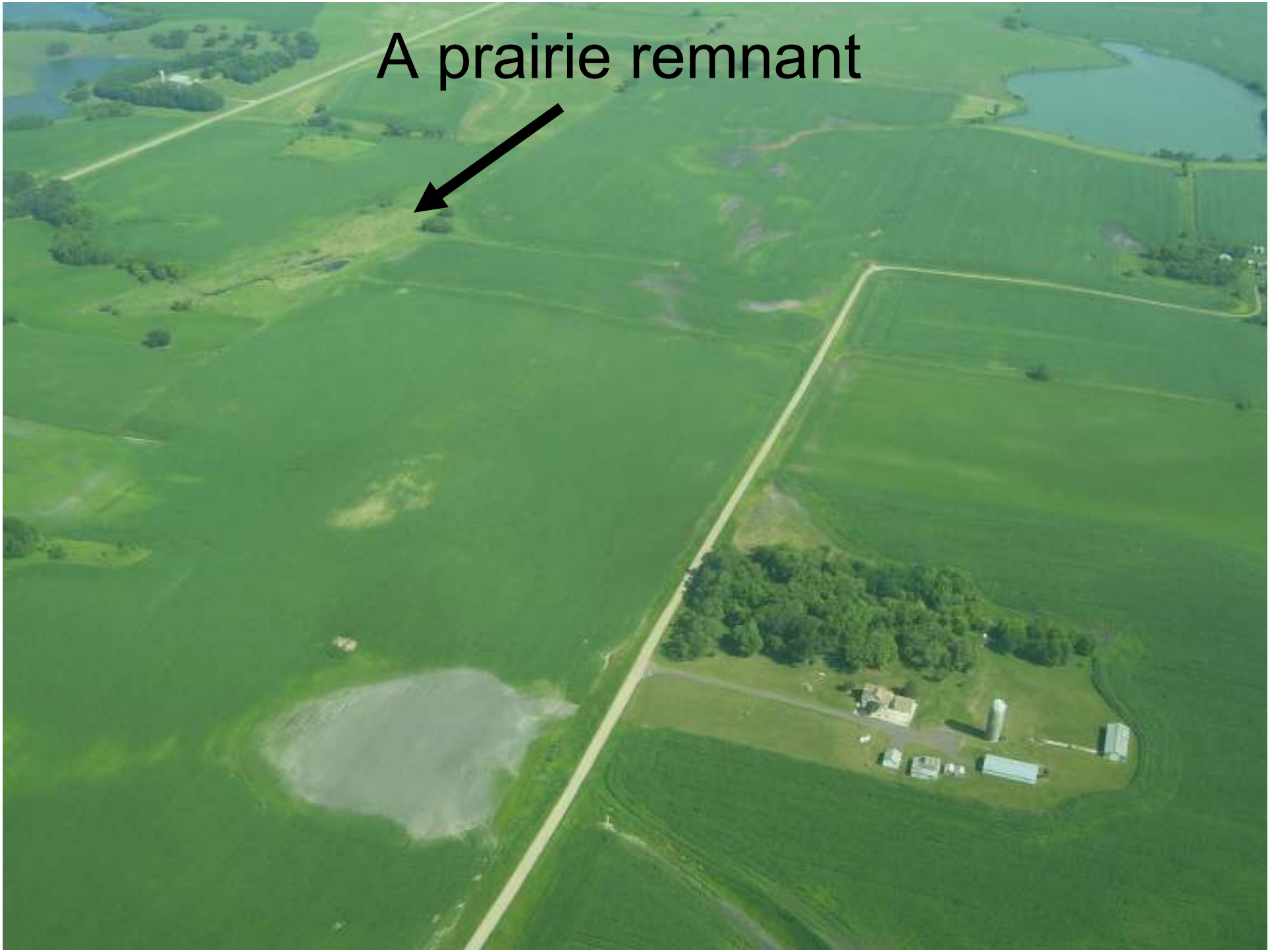
Joint analysis of survival and reproduction over 10 years in *Echinacea angustifolia* plants originating from 21 remnant prairies

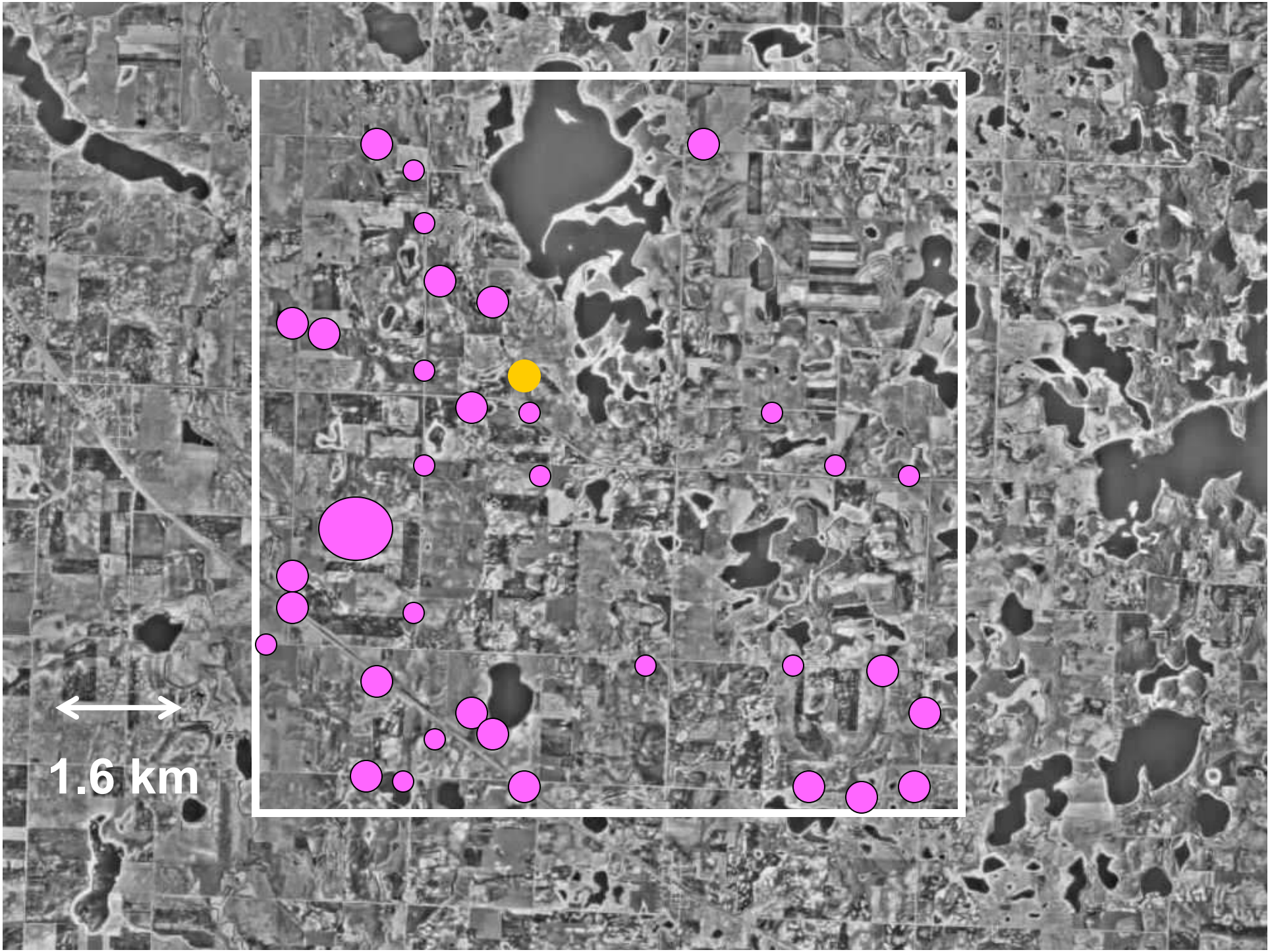
Stuart Wagenius[1], Ruth G. Shaw[2], Charles Geyer[2]
Evolution 2008, 2:45 PM Anderson 270

[1]Chicago Botanic Garden, [2]University of Minnesota


A prairie remnant

Echinacea: Model prairie species

- Asteraceae
- Herbaceous
- Long-lived
- Reproduces by seed


1.6 km

Common Garden Experiment

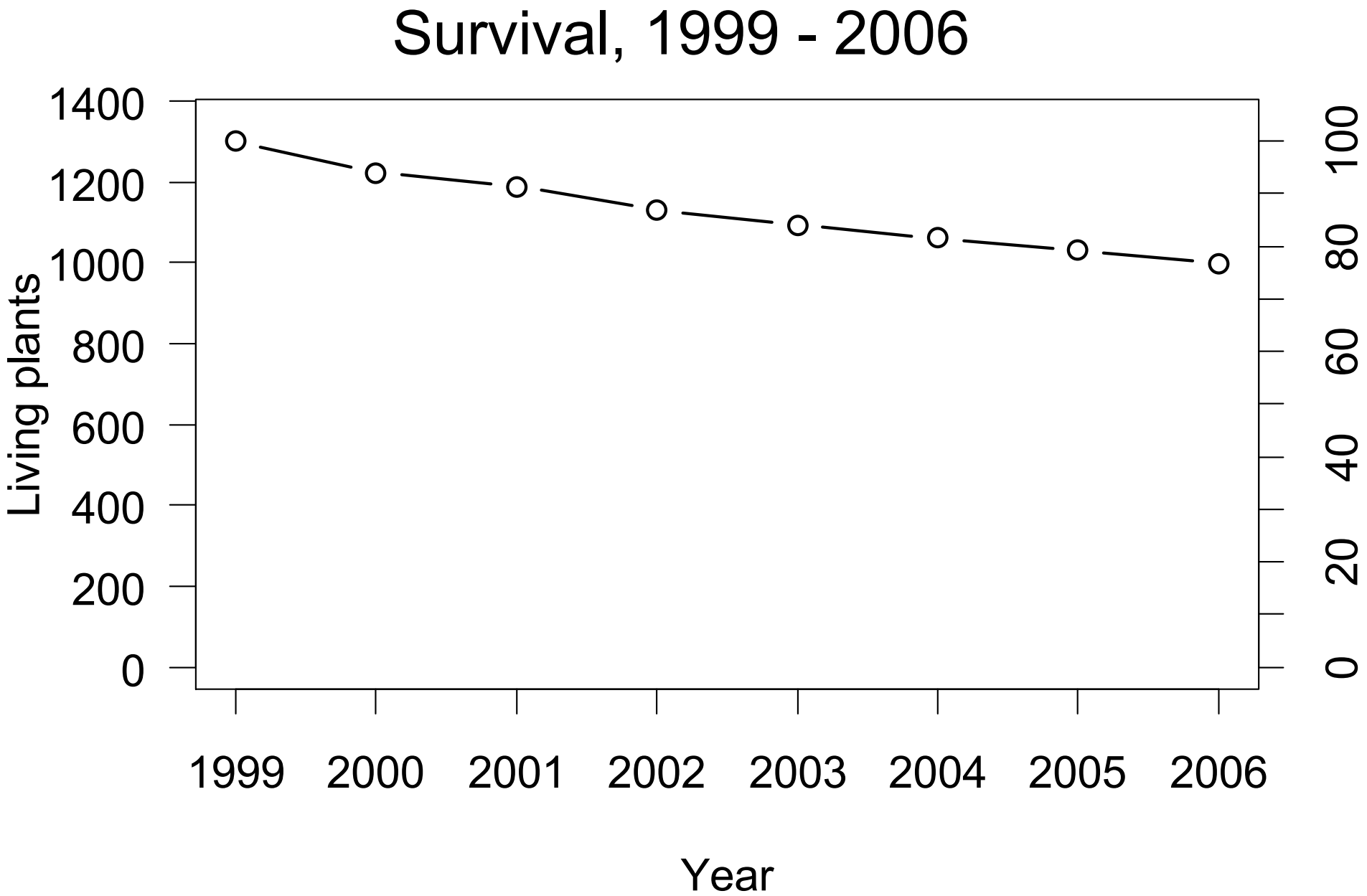
1301 plugs planted in 1999.

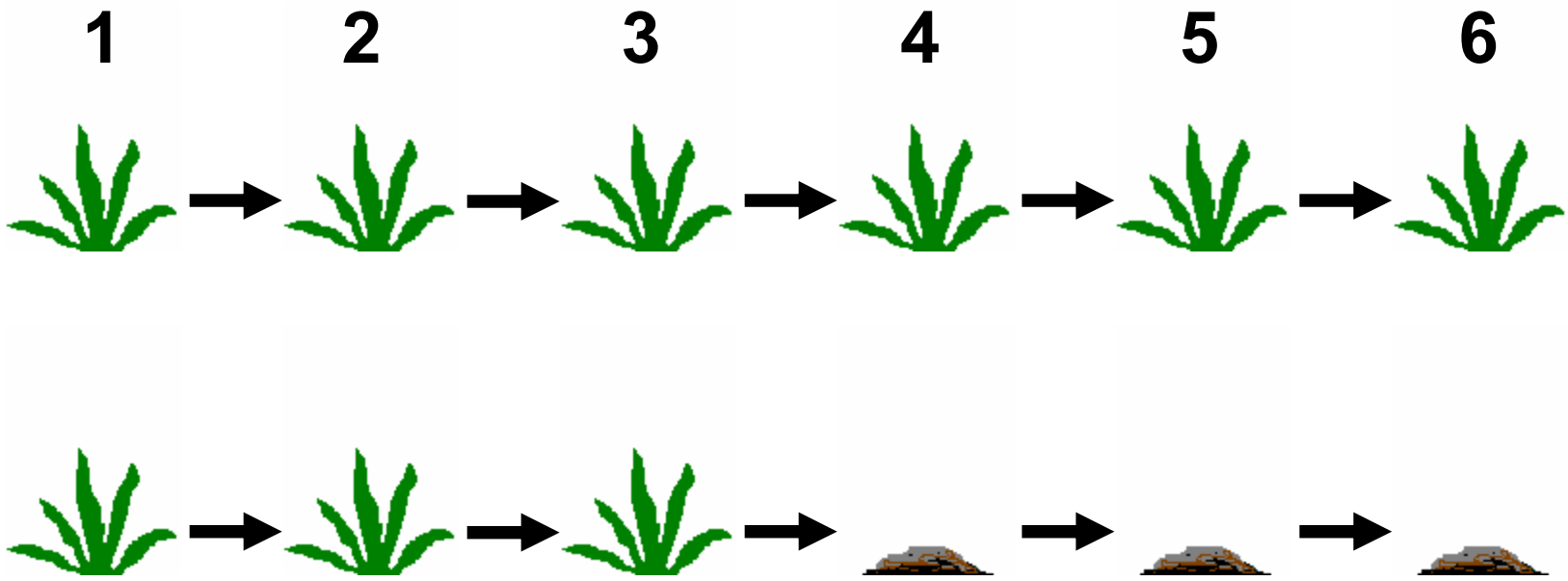
Randomized positions on 1/3 m x 2/3 m grid.

Old field with competition.

Biennial spring burns.

Annual measurements & harvests.

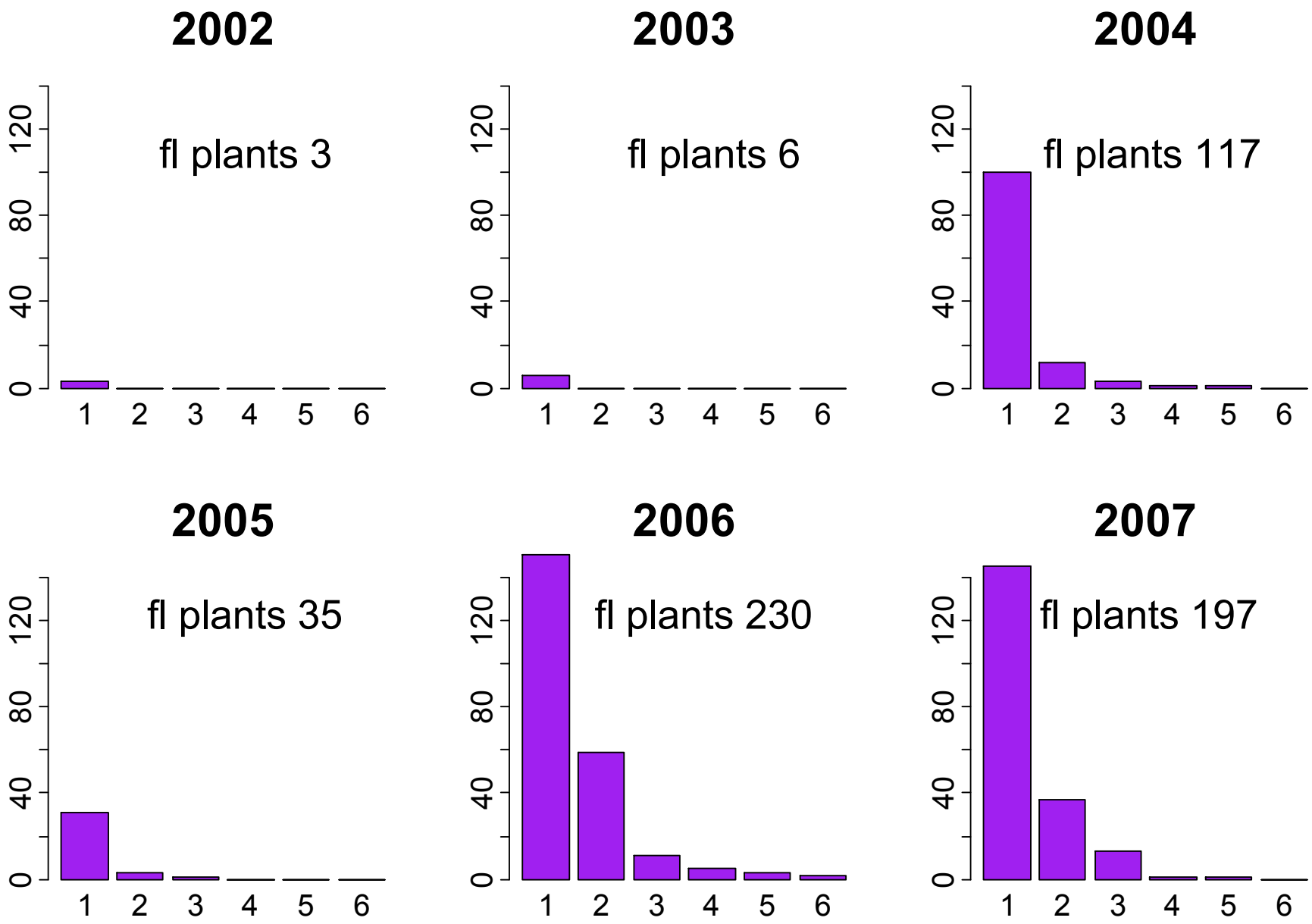

Survival, 1999 - 2006
Living plants
1400
1200
1000
800
600
400
200
0
100
80
60
40
20
0
1999
2000
2001
2002
2003
2004
2005
2006
Year

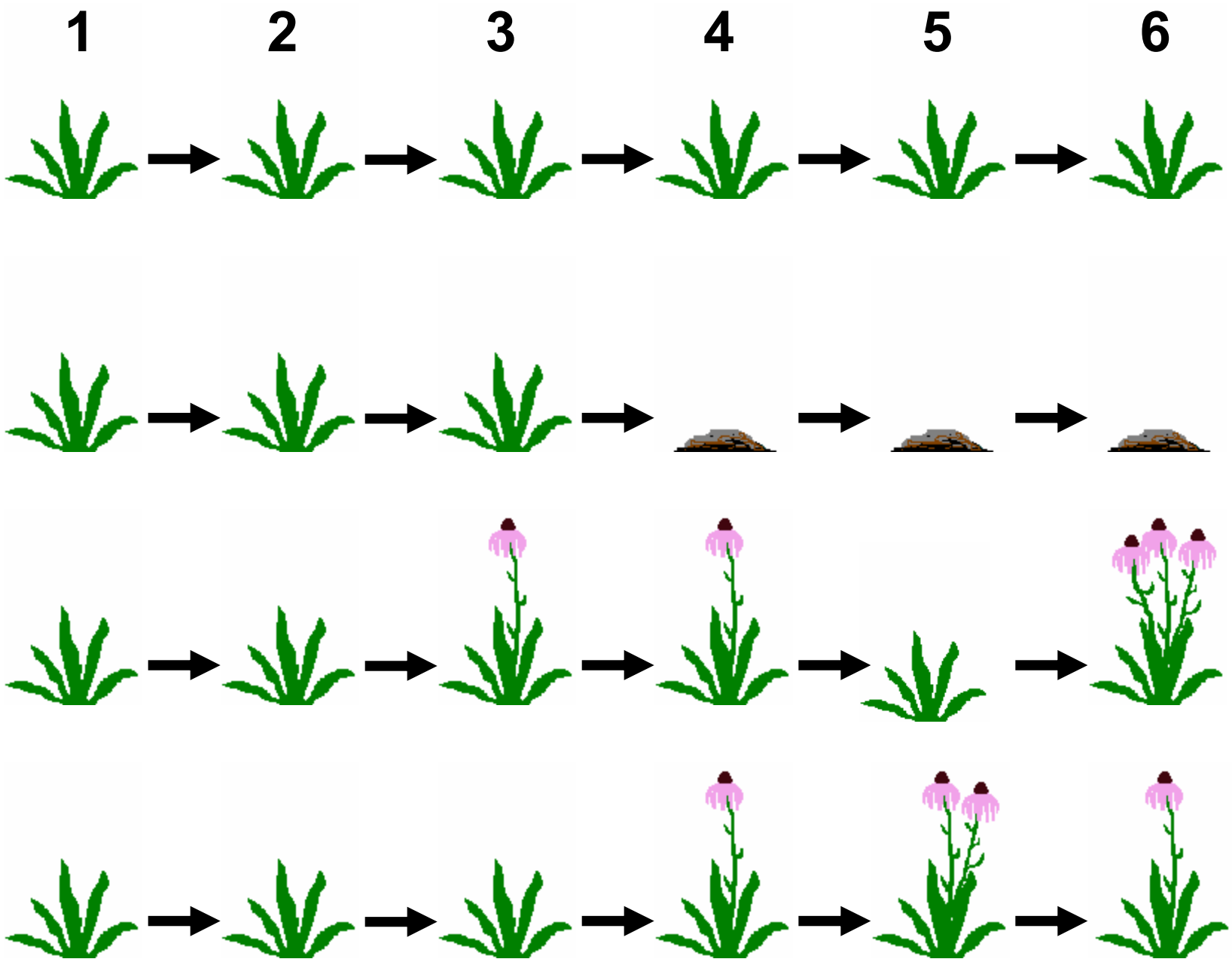

1
2
3
4
5
6

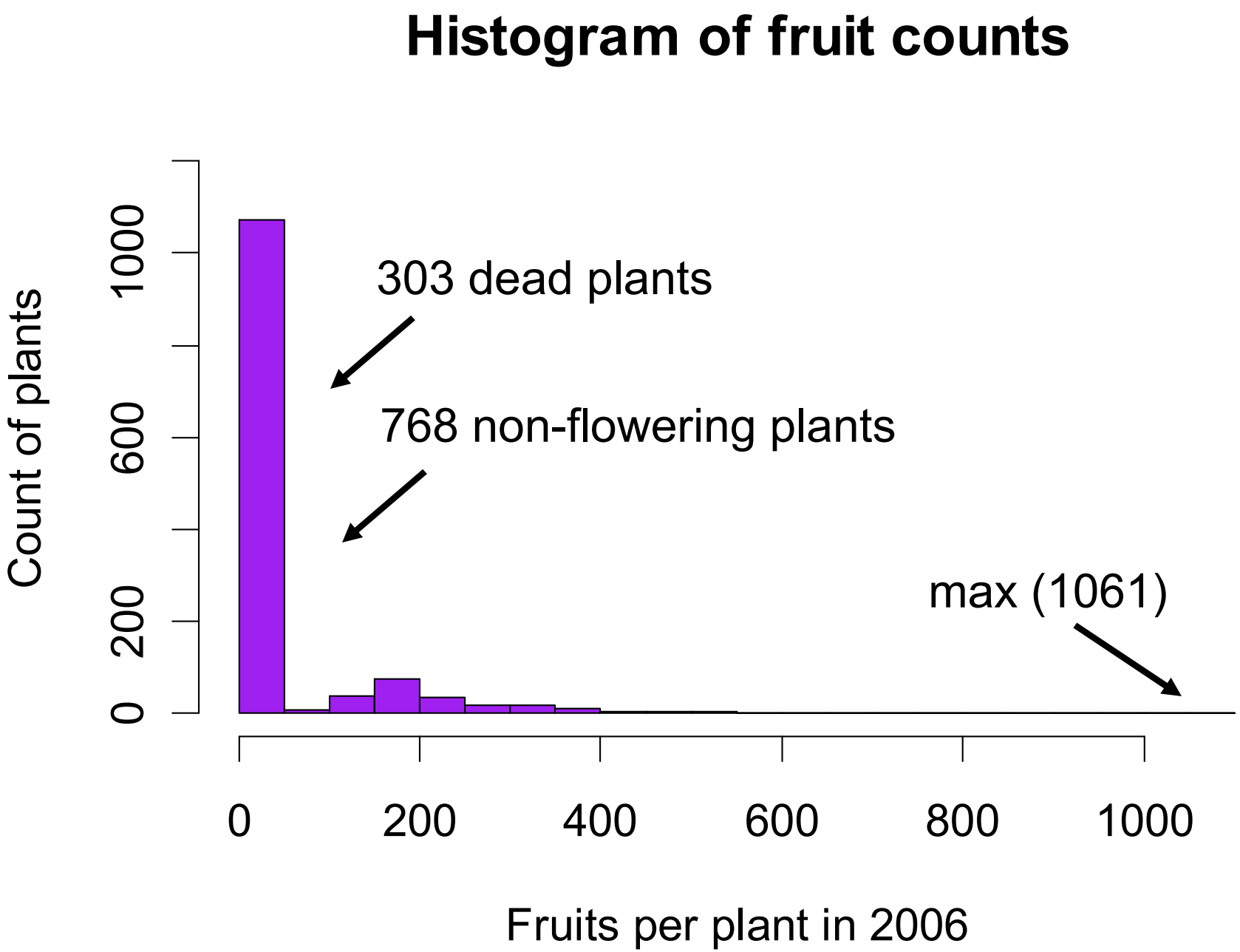
Problems measuring fitness

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




1
2
3
4
5
6


Histogram of fruit counts
Count of plants
0
200
600
1000
303 dead plants
768 non-flowering plants
max (1061)
0
200
400
600
800
1000
Fruits per plant in 2006

Problems measuring fitness

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

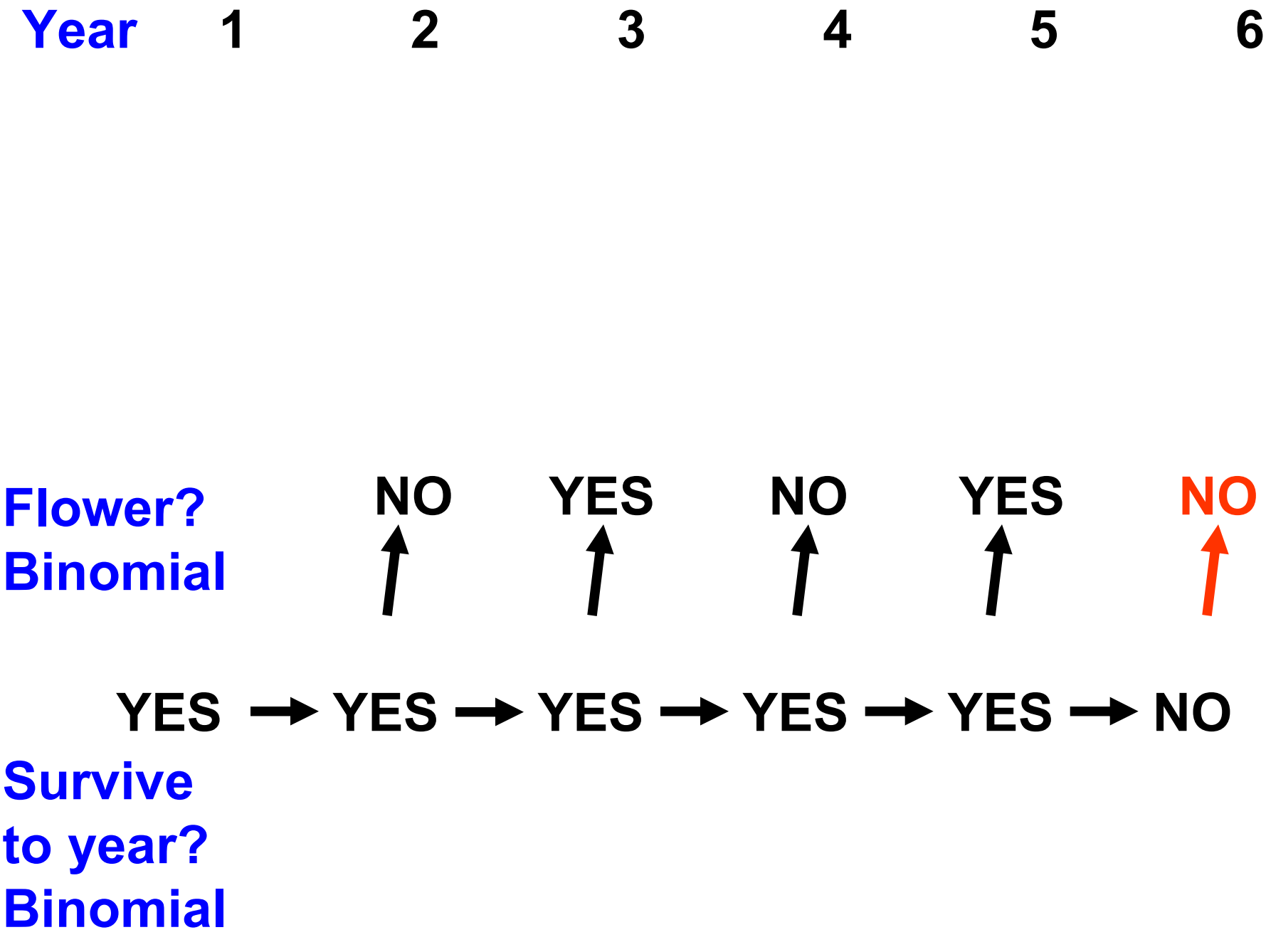
2. No single probability distribution is suitable for modeling all components of fitness.

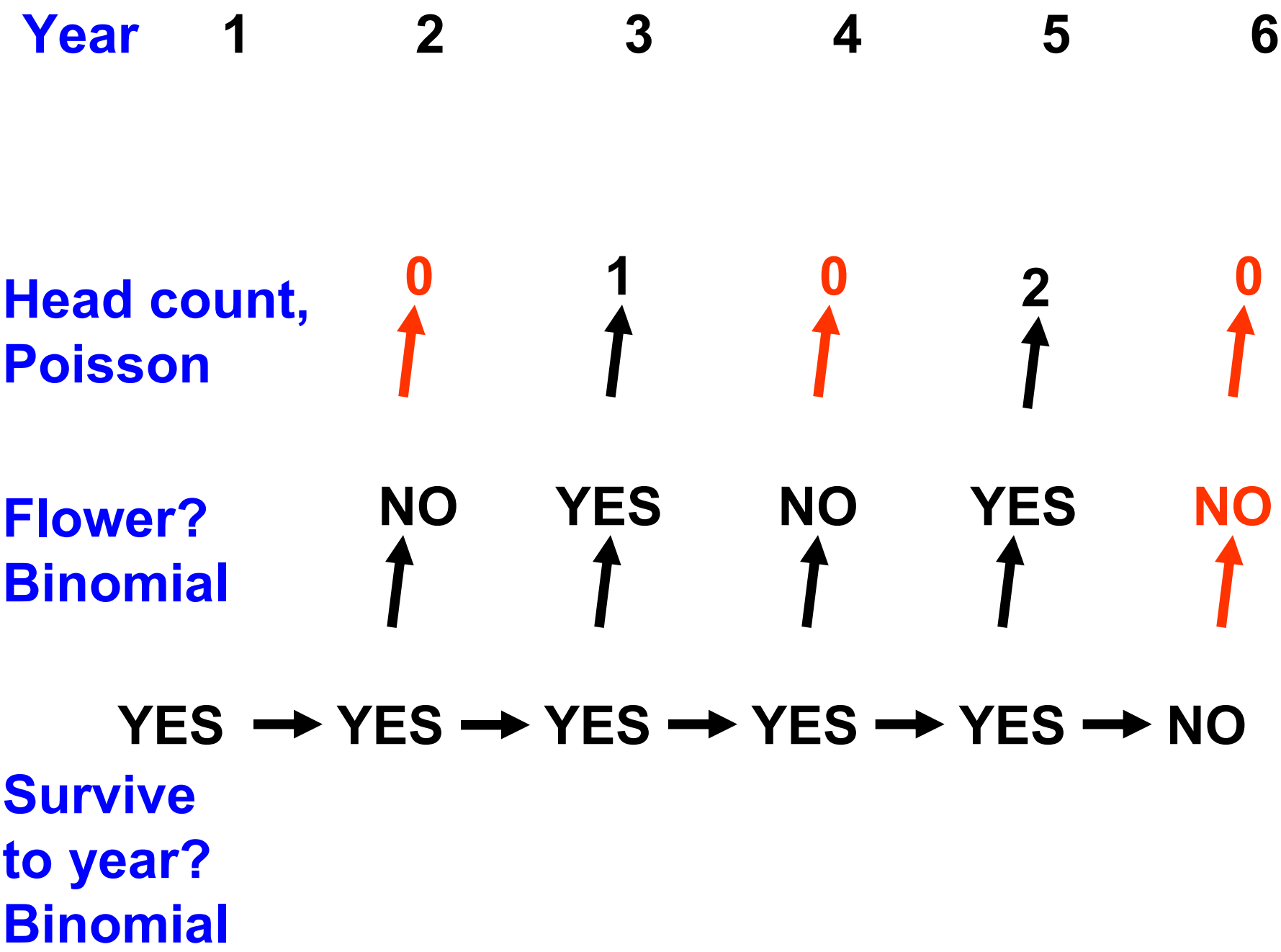
Year	1	2	3	4	5	6

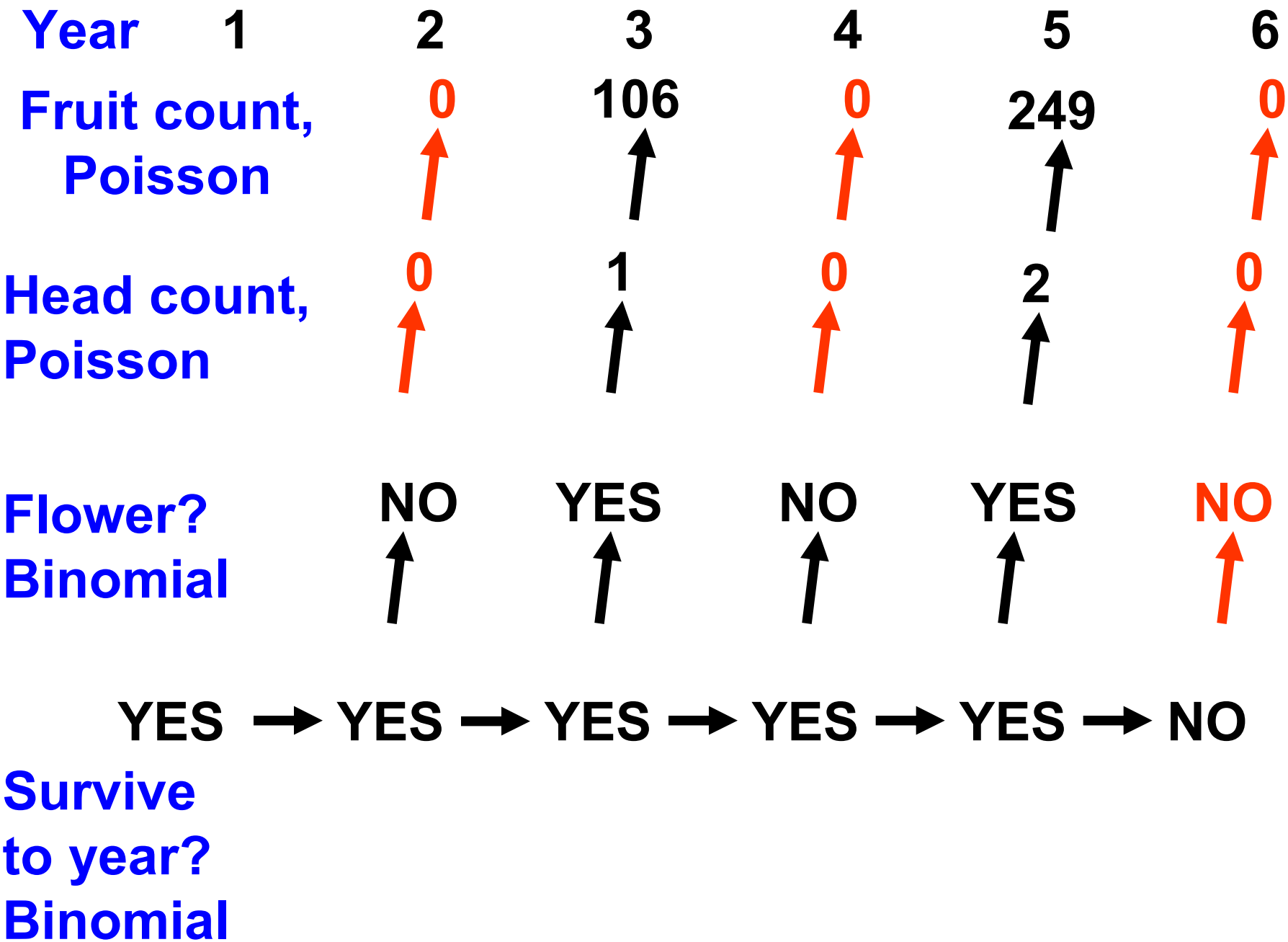
YES → YES → YES → YES → YES → NO

Survive to year?

Binomial


Year
1
2
3
4
5
6
Flower?
Binomial
NO
YES
NO
YES
NO
YES → YES → YES → YES → YES → NO
Survive
to year?
Binomial


Year
1
2
3
4
5
6
Head count, Poisson
0
1
0
2
0
Flower? Binomial
NO
YES
NO
YES
NO
YES → YES → YES → YES → YES → NO
Survive to year? Binomial


Year
1
2
3
4
5
6
Fruit count, Poisson
0
106
0
249
0
Head count, Poisson
0
1
0
2
0
Flower? Binomial
NO
YES
NO
YES
NO
YES → YES → YES → YES → YES → NO
Survive to year? Binomial

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

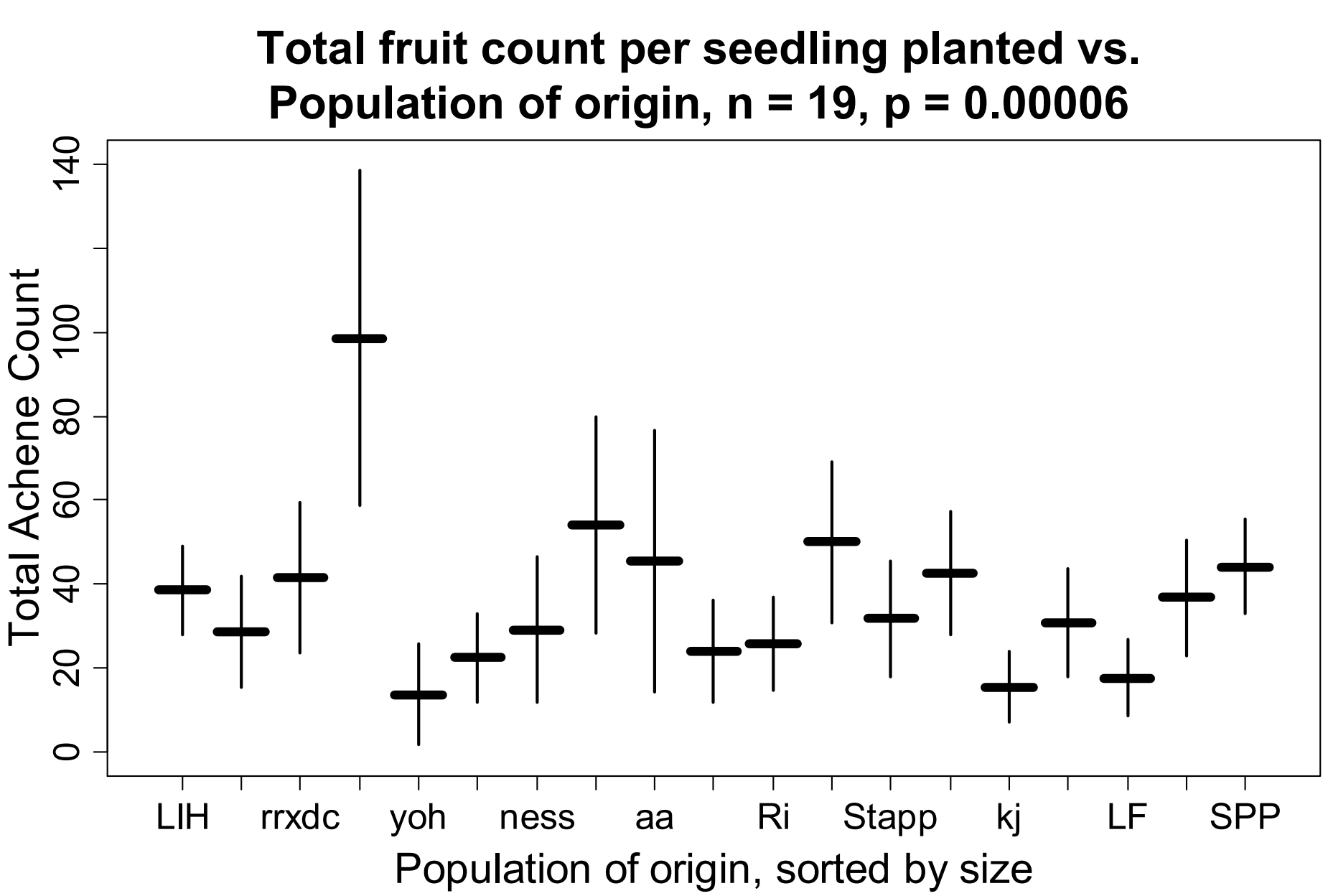

Echinacea Common Garden, Summer 2007

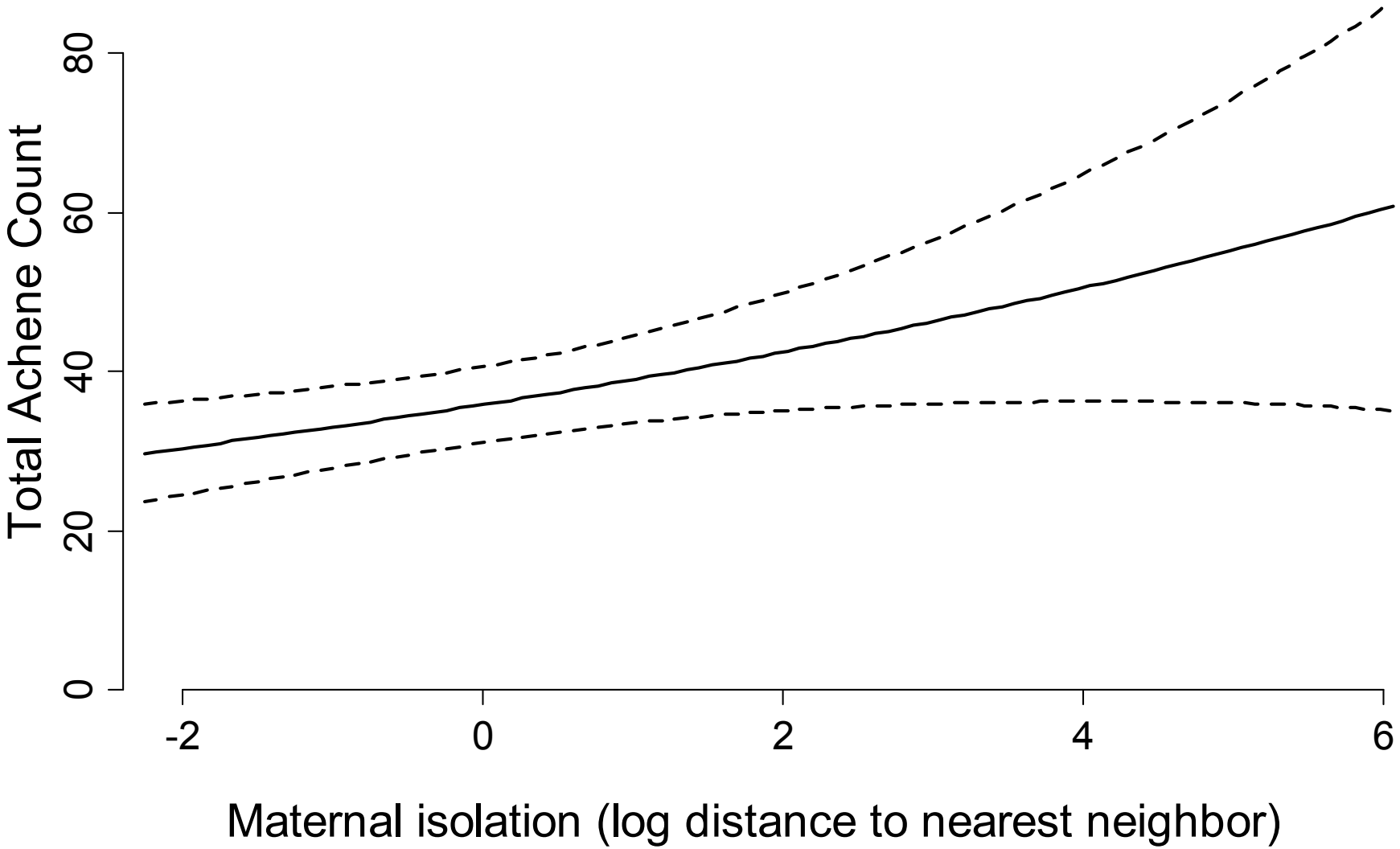
Model Comparisons

Analysis of Deviance Table

Model 1: resp ~ varb + level:finalLoc
Model 2: resp ~ varb + level:finalLoc + achct * pop - pop
Model 3: resp ~ varb + level:finalLoc + achct * pop

Model No.	Model d.f.	Model Deviance	Test d.f.	Test Deviance	Test *p*-value
1	24	686849			
2	42	686899	18	51	0.00006
3	60	686929	18	29	0.04


Total fruit count per seedling planted vs.
Population of origin, n = 19, p = 0.00006
Total Achene Count
0
20
40
60
80
100
140
LIH
rrxdc
yoh
ness
aa
Ri
Stapp
kj
LF
SPP
Population of origin, sorted by size


Total fruit count per seedling planted vs.
Isolation of maternal plant , p = 0.03
Total Achene Count
0
20
40
60
80
-2
0
2
4
6
Maternal isolation (log distance to nearest neighbor)

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.

Acknowledgements

Gretel Kiefer

Field assistants

Volunteers

NSF: DMS-0083468
& DEB-0545072