Population Viability Analysis= PVA

A. Alternative method
   i. A **Count** based method
   ii. An **Individual** base method
      1. Data collection
      2. Amalgamation of data
      3. Data Analysis
      4. Limitation of the methods
      5. Demographic Stochasticity
      6. Temporal y Spatial Stochasticity

Count vs. Demographic Data

Count Data : Dennis *et al.*, 1991

Census Series

Demographic Data: Leslie 1945 and Leftkovitch 1965

Describes the rates of survival, reproduction and growth of individuals of different age or size category across time.

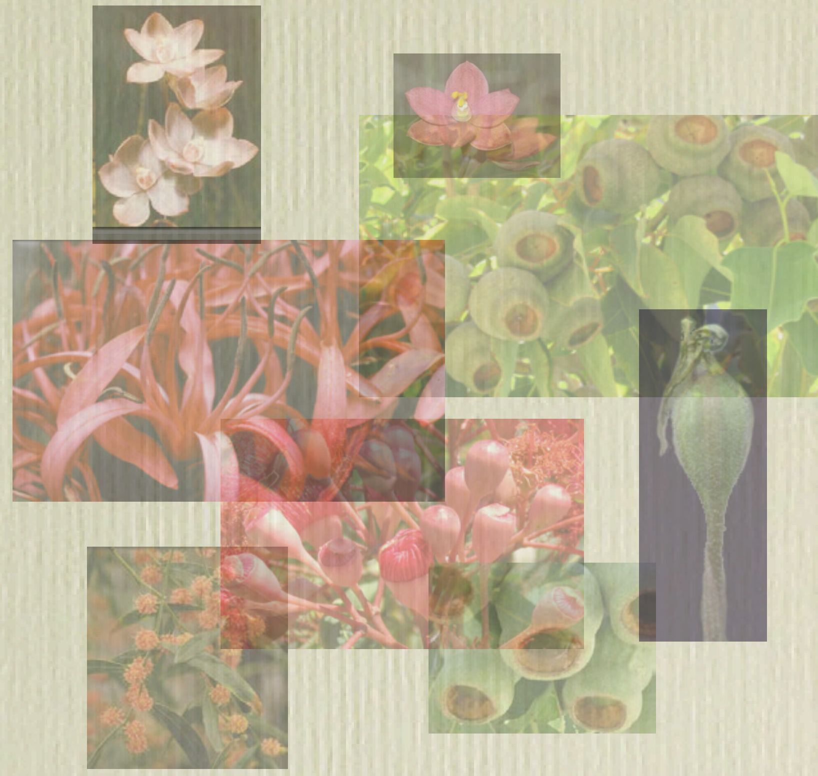
How frequent are count data?

Morris *et al.*, 1999
  14 Count
  5 Demographic

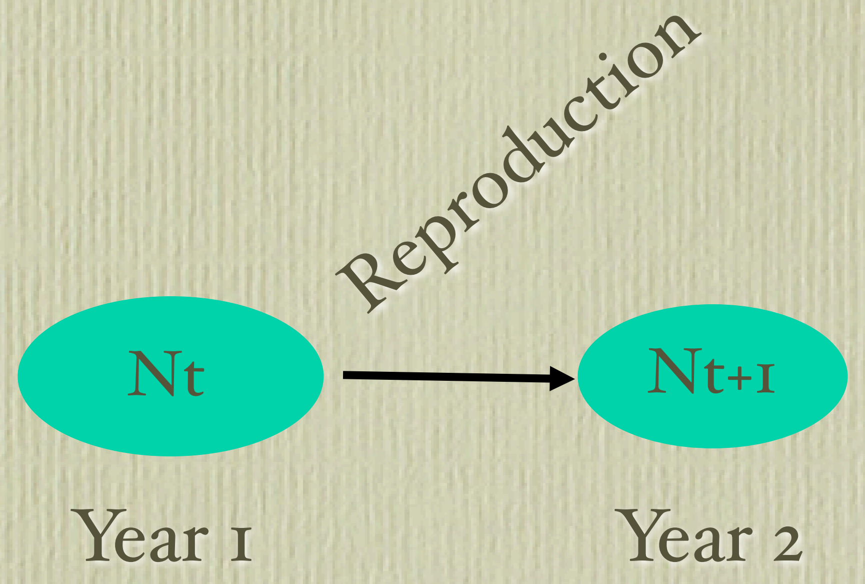
Range of survey period
1 - 12 years (mean of 6 years),
mostly animals surveys

Orchids from the state of Victoria, Australia
  7 Counts
  35 Demographic (10 new surveys)

Range of survey period
1 - 20 years (mean 5 years)



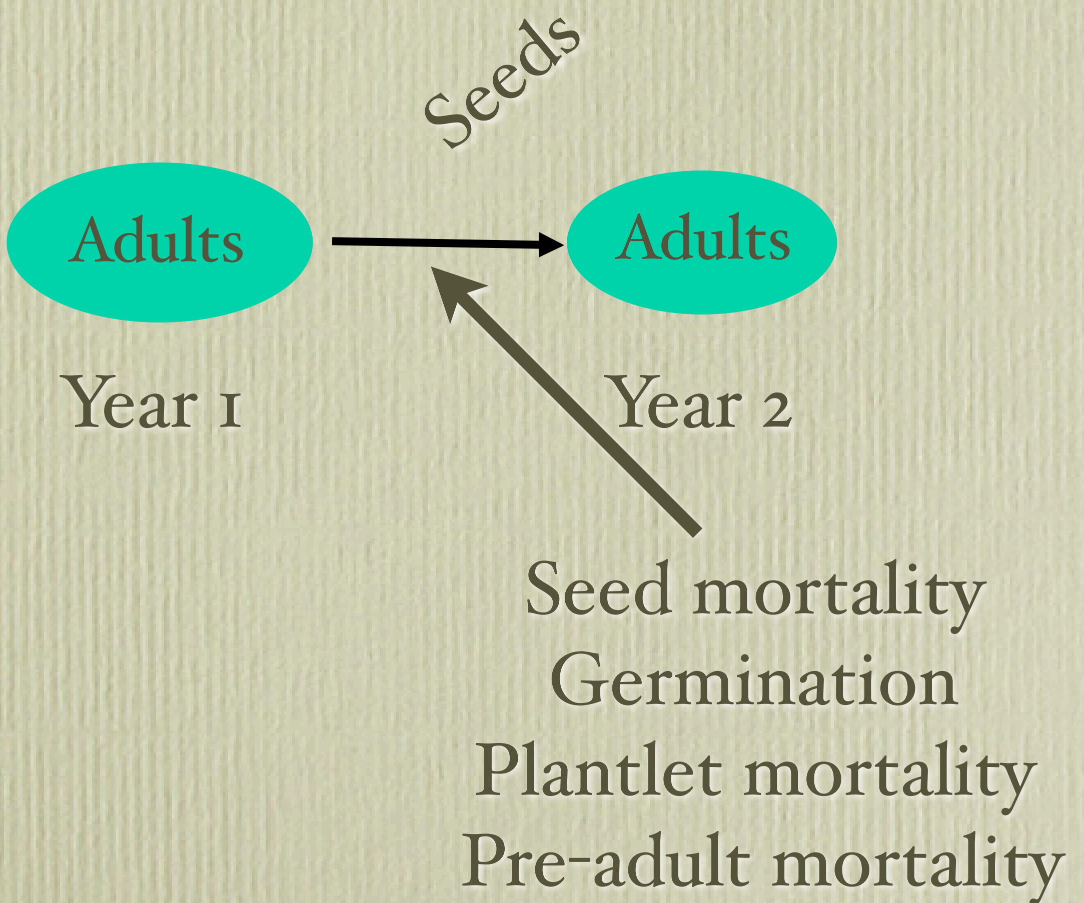
Population dynamics of an annual plant



The most simple system

The population size is directly proportional to the effective success of reproduction and environmental influences

Population dynamics of an annual plant



Mathematical formula

$$N(t+1)=\lambda N(t)$$

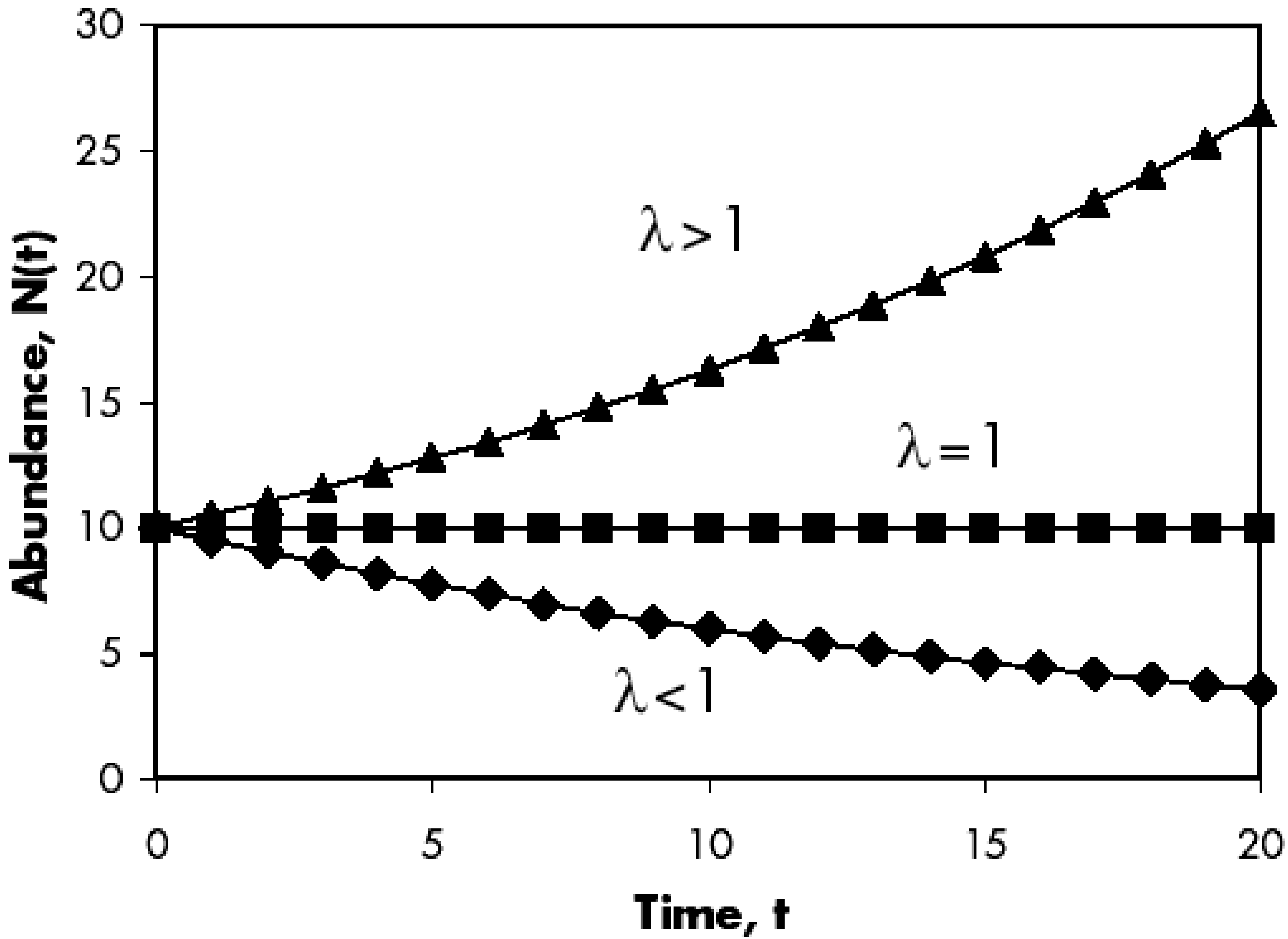
λ (lambda) = Rate of growth

$\lambda < 1$; Reduction

$\lambda = 1$; Stable

$\lambda > 1$; Increase

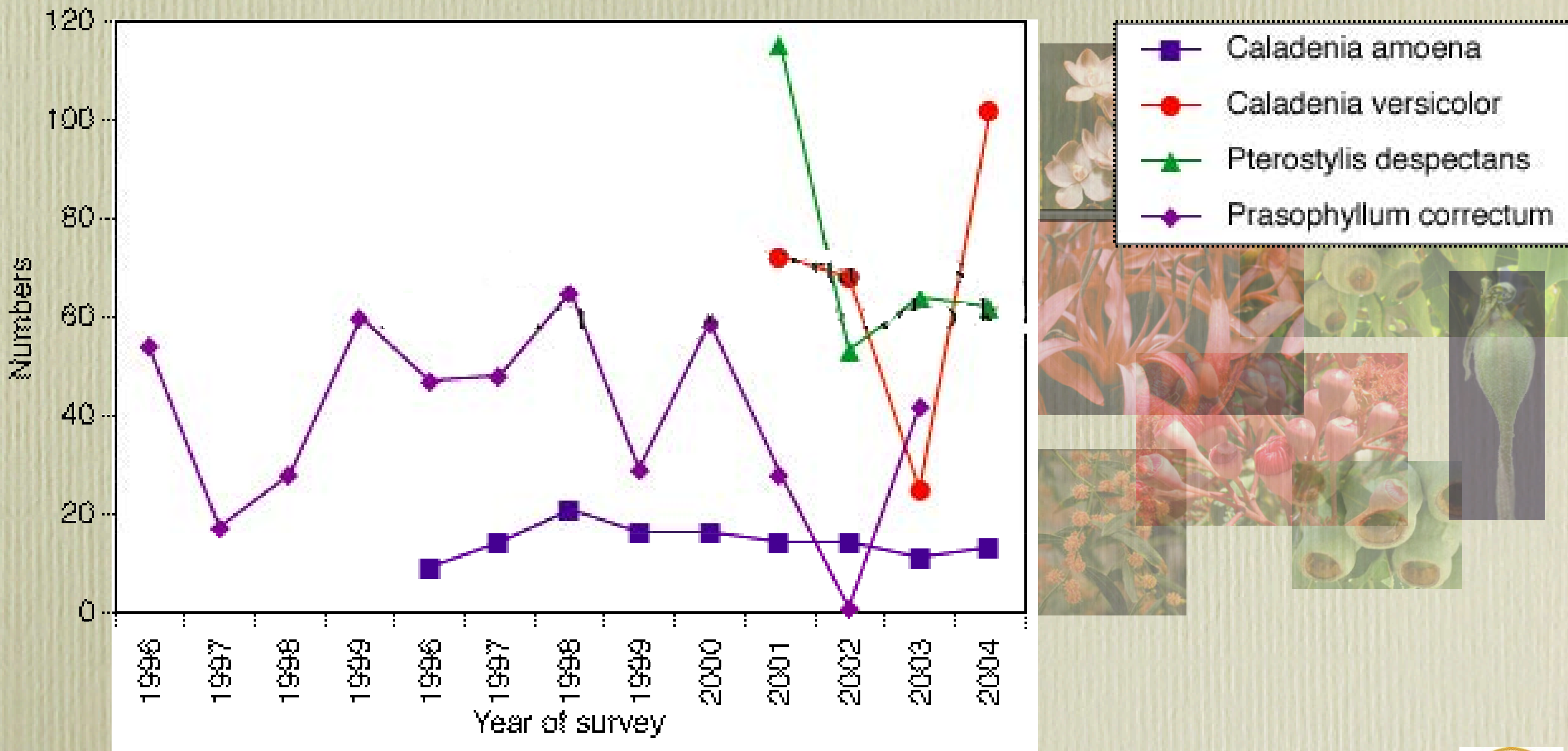
No Environmentally-Driven Variability



Populations in a stochastic environment

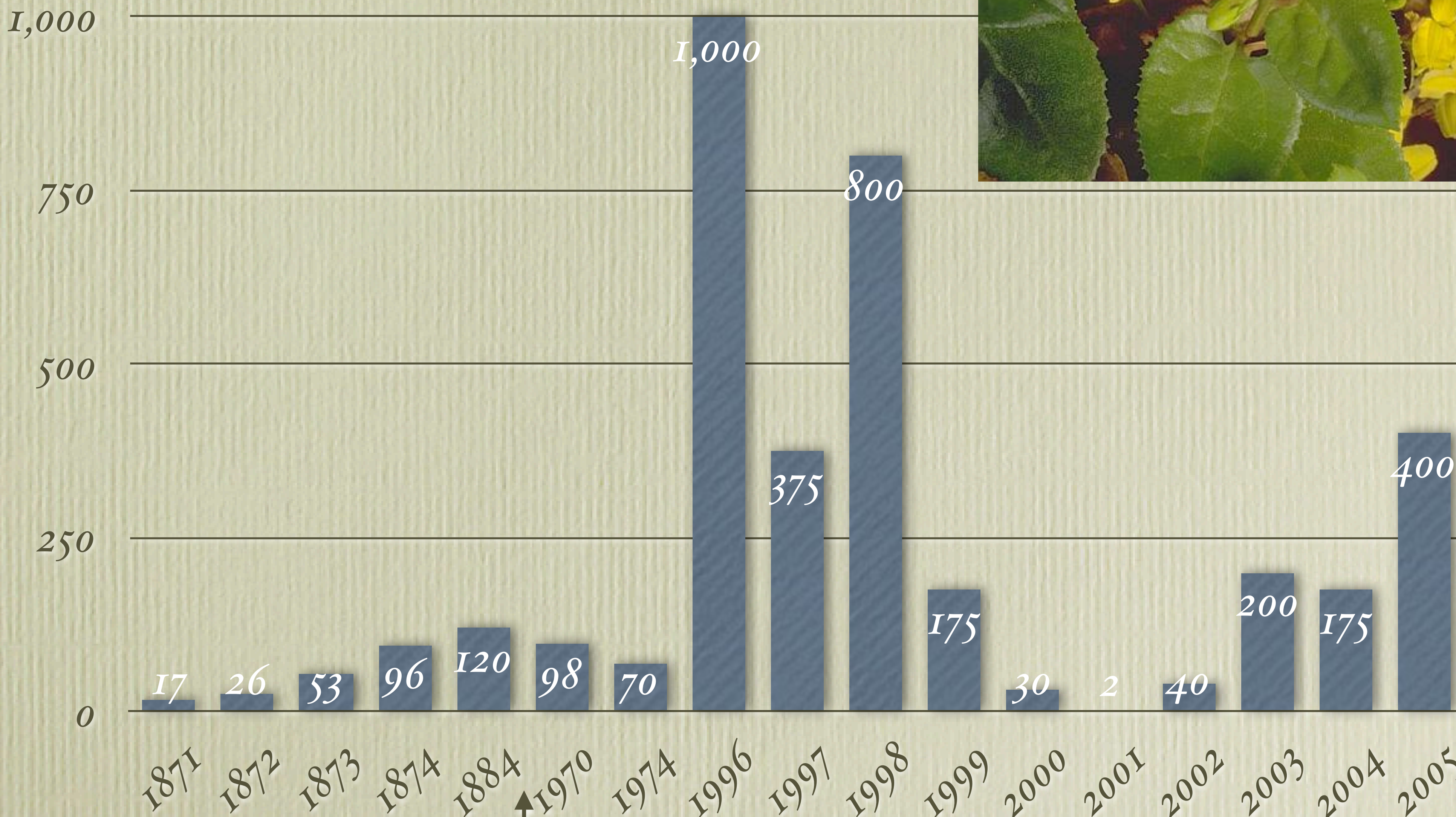
Inter annual variation

Rain, temperature, fire, resource, etc.



Goodenia macbarronii

Fictitious site, Argentina



Note years missing

Count data: How to calculate population growth rate

1. Transform the data and years
2. Perform a linear regression analysis to estimate the mean μ, and

the variance, σ^2 in growth rate

Subsequently, calculate $\bar{\lambda}$

= the mean and the variance in growth rate.

Because $\bar{\lambda}$ does not predict with <***exactitud***> what's going to happen in a population, we calculate:

a) the average time to extinction, and
b) the probability of a future extinction in a given time

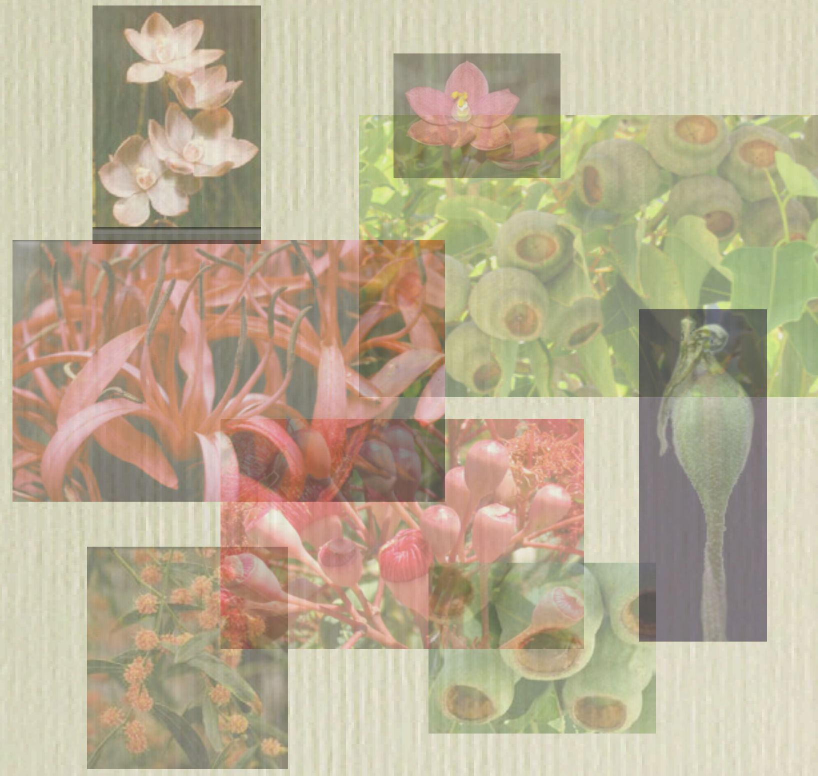
Goodenia macbarronii

Year	N
1871	17
1872	26
1873	53
1874	96
1884	120
1970	98
1974	70
1996	1000
1997	375
1998	800
1999	175
2000	30
2001	2
2002	40
2003	200
2004	175
2005	400

Year	N	X
1871	17	
1872	26	=SQRT(yr2-yr1) =1
1873	53	1
1874	96	1
1884	120	3.162
1970	98	9.274
1974	70	2
1996	1000	4.69
1997	375	1
1998	800	1
1999	175	1
2000	30	1
2001	2	1
2002	40	1
2003	200	1
2004	175	1
2005	400	1

Sqrt of the difference between sequential number of years

=SQRT(yr 2-yr 1)



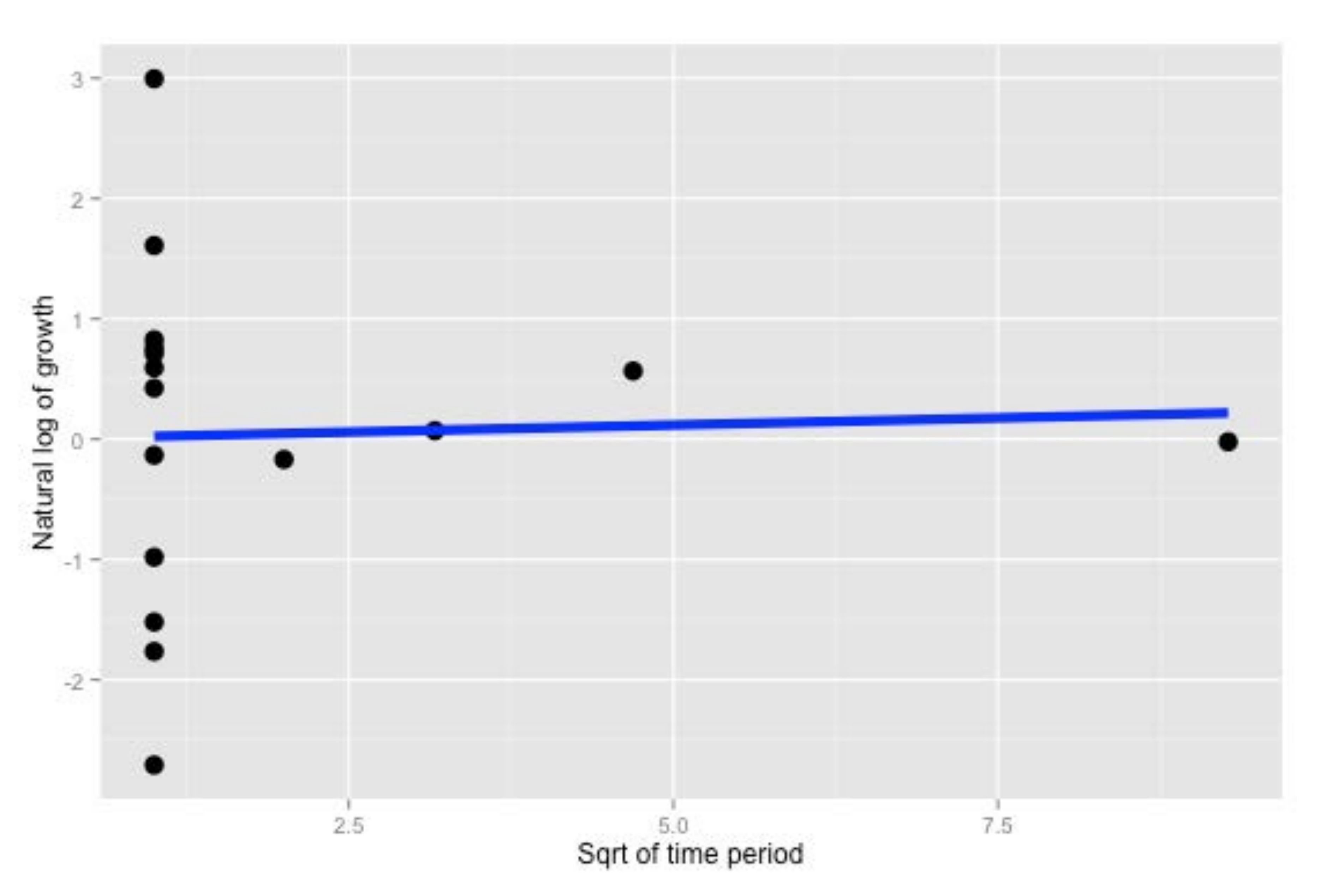
Year	N	X	Y
1871	17		
1872	26	=SQRT(A	0.4249
1873	53	1	0.7122
1874	96	1	0.5941
1884	120	3.162	0.0706
1970	98	9.274	-0.0218
1974	70	2	-0.1682
1996	1000	4.69	0.567
1997	375	1	-0.9808
1998	800	1	0.7577
1999	175	1	-1.519
2000	30	1	-1.764
2001	2	1	-2.708
2002	40	1	2.996
2003	200	1	1.609
2004	175	1	-0.1335
2005	400	1	0.8267

Growth rate by time period

$$Y = \frac{\ln\left(\frac{N_{t+1}}{N_t}\right)}{X}$$

$$Y = \frac{\ln\left(\frac{26}{17}\right)}{1} = 0.4249$$

Change in population size in time



Análisis de regresión, poner intercepto a “0”

ANOVA	df	SS	MS	F	Significante F
Regresión	1	0.074437	0.074437	0.040053	0.84425
Residual	15	27.87711	**1.85847**		
Total	16	27.95154			
Regresión	Coeficientes	Standard Error	t Stat	valor P	Intervalo de confianza 95%
Intercepto	**0**	#N/A	#N/A	#N/A	#N/A
X Variable	**0.023569**	0.117768	0.200132	0.844066	-.22745 0.274585

σ^2

Must be “0”

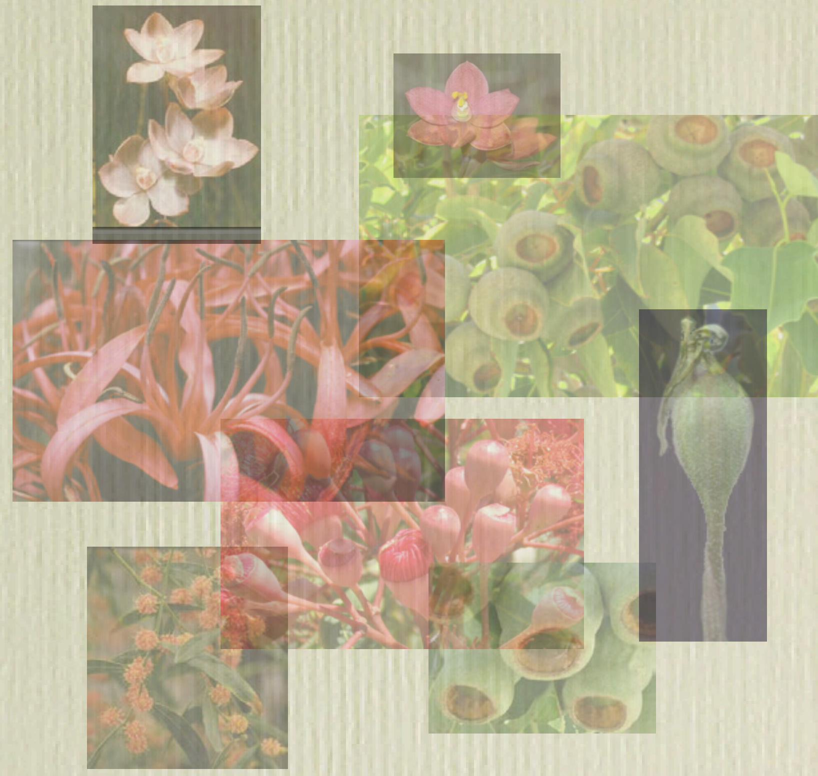
μ

	Mean	95% Confidence Interval
μ	0.02369	-.2274 0.2745
σ^2	1.858474	1.01414 4.4517
λ	3.739	1.2825 5.2423

A function for the cumulative distribution function (CDF) for time to extinction.

CDF is the probability that the population will fall below some critical point (number of individuals) and likely to go extinct.

The critical level is determined as the population size with the species/population is no longer viable and likely to persist.



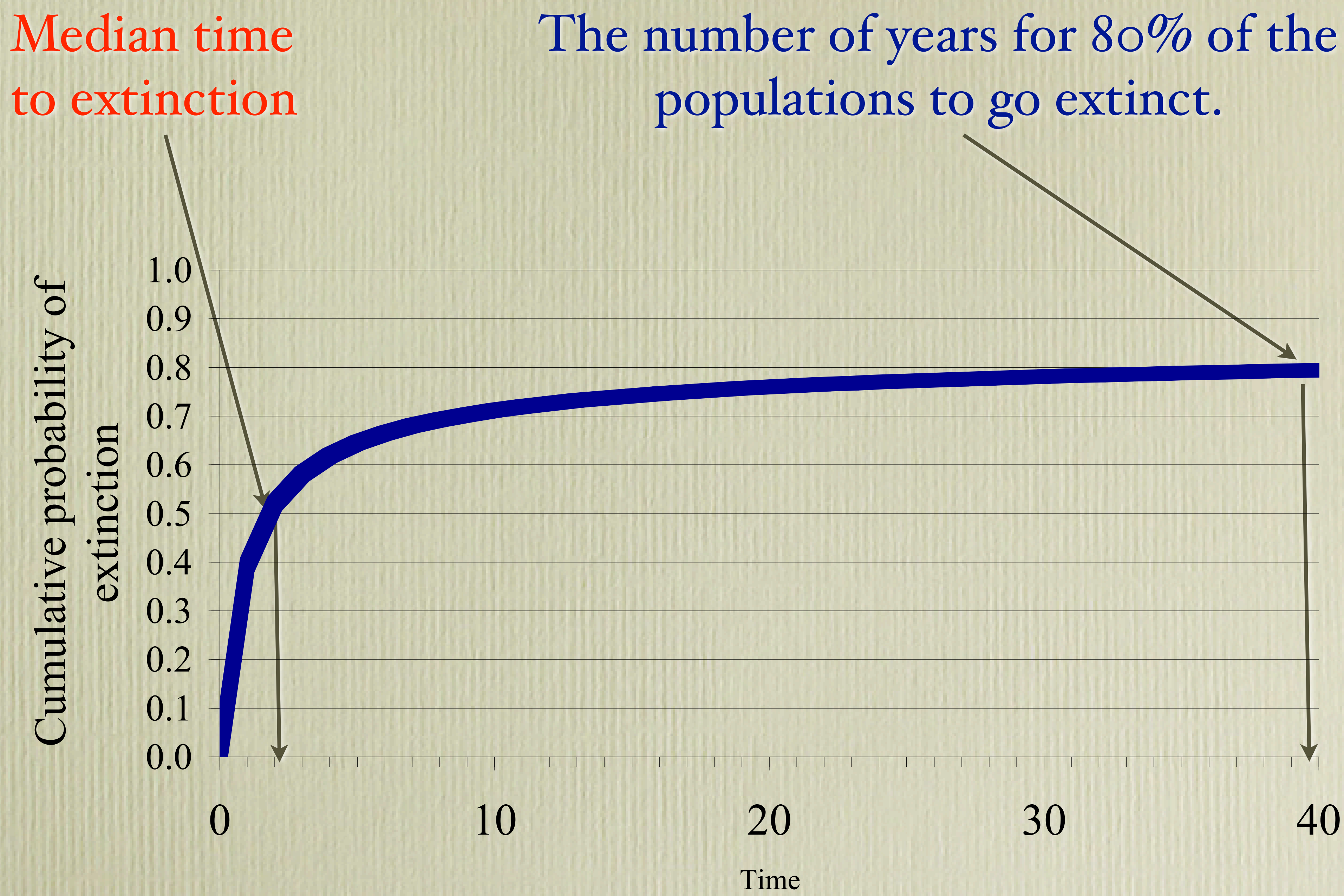
Mean Time for extinction

Is an index of the time critical level to extinction (not exact if μ is larger than zero; if μ is larger than zero, the population will never go extinct).

If the critical level is of one individual (1), then the average time to extinction is 233yrs (range: 0–23,000yrs).

<u>This index can only be used when μ is negative.</u>

If μ is positive, it may be posible that the population will never go extinct, so we need an alternative.



Median time to extinction
The number of years for 80% of the populations to go extinct.
Cumulative probability of extinction
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
10
20
30
40
Time

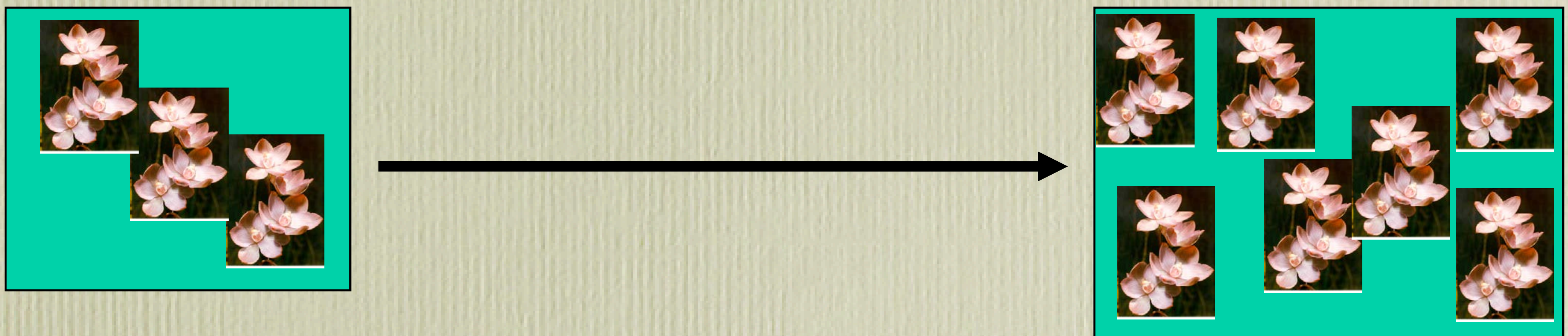
Assumptions: Careful with the assumptions!

Count data for PVA

Presupuestos simples:

1. The data represents an extensive count of the population or sample (fraction of the whole population), that doesn't change in time.
2. Year to year variation reflects the true magnitude of the effect of the environment on "N". The year to year variation is not dominated by observer error.
3. The annual variation caused by the environment is not extreme.
4. Population growth is density-independent.
5. Life history traits allow for proper count of individuals.

Predicting population growth rate



$N_i(t)$ $N_i(t+1)$

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      6. Temporal y spatial stochasticity

Count vs. Demographic data

Count data: Dennis et al., 1991

A series of counts

Demographic data: Leslie 1945 and Leftkovitch 1965

Describes the survival rate, reproduction, and growth in individuals of different ages, sizes or another characteristics.

Stage 1

Decide whether the population is best described by age, **size, or life-stage**:

In orchids is usually a mixture of size and stage

- A population with Age structure (humans)
- A population with Size structure
- A population with a Stage-structure

Age

- Age-structured population
  - All individuals with the same age are considered to have the same life stage characteristics.
    - Bird, humans or mammals.

Size

- Size-structured population
  - Individual's size has an effect on the vital characteristics, influencing survival and reproduction
    - E.g. plants, trees, fishes
    - The classification in size classes is determined by drastic changes in the vital characteristics
- Stage-structured population

Stage

- Stage-structured population
  - Organisms where life-stage influences the vital parameters.
    - Humans (infant, juvenile, adult)
    - Insects (larvae, pupae, adult)
    - Flowering plants (seedling, juvenile/sapling, adult)

Stage 2

Build the projection matrix

From stage i

To stage i

To class

From class

$$
\begin{array}{c|cccc|}
 & 1 & 2 & 3 & 4 \\
\hline
1 & a_{11} & a_{12} & a_{13} & a_{14} \\
2 & a_{21} & a_{22} & a_{23} & a_{24} \\
3 & a_{31} & a_{32} & a_{33} & a_{34} \\
4 & a_{41} & a_{42} & a_{43} & a_{44}
\end{array}
$$

*As a convention, stage 1 is the youngest or smallest stage