

Recap

Basic Population Dynamics Eqn

$$dN/dt = B - D + I - E$$

Continuous Exponential growth

$$dN/dt = rN$$

Discrete Exponential growth

$$N(t) = N(t-1) + rN(t-1)$$

Discrete Logistic growth

$$N(t) = N(t-1) + rN(t-1)[(K-N(t-1))/K]$$

Digression: Why wait to reproduce?

Obviously, you will have more offspring faster if you reproduce sooner. Why doesn't everything reproduce as soon as its born?

R-selected species: reproduce at young age and small size or resources.

K-selected species: reproduce at older age and larger size or resources

Demographic Stochasticity

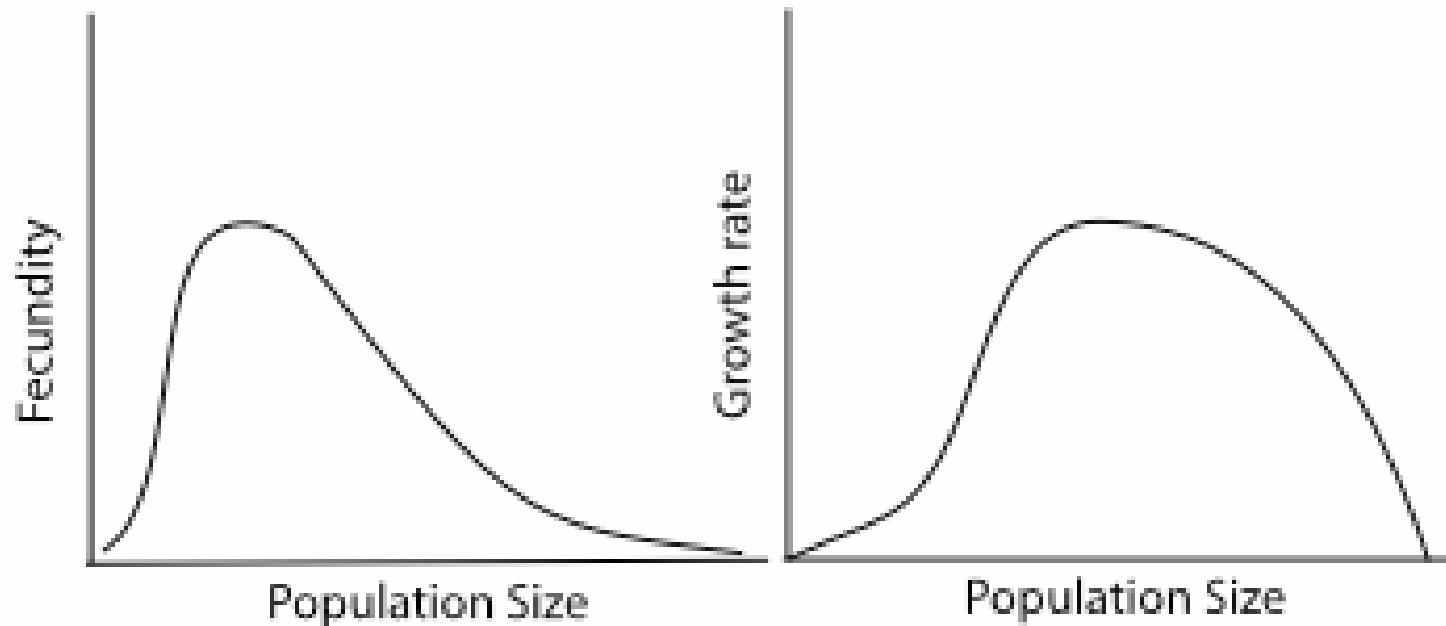
What happens when population is small?

Small numbers means that probability comes into play.

Allee effect

When population is small, some things may get harder (like finding mates)

If so, fecundity could actually decrease at low population size.



Estimating Population Size

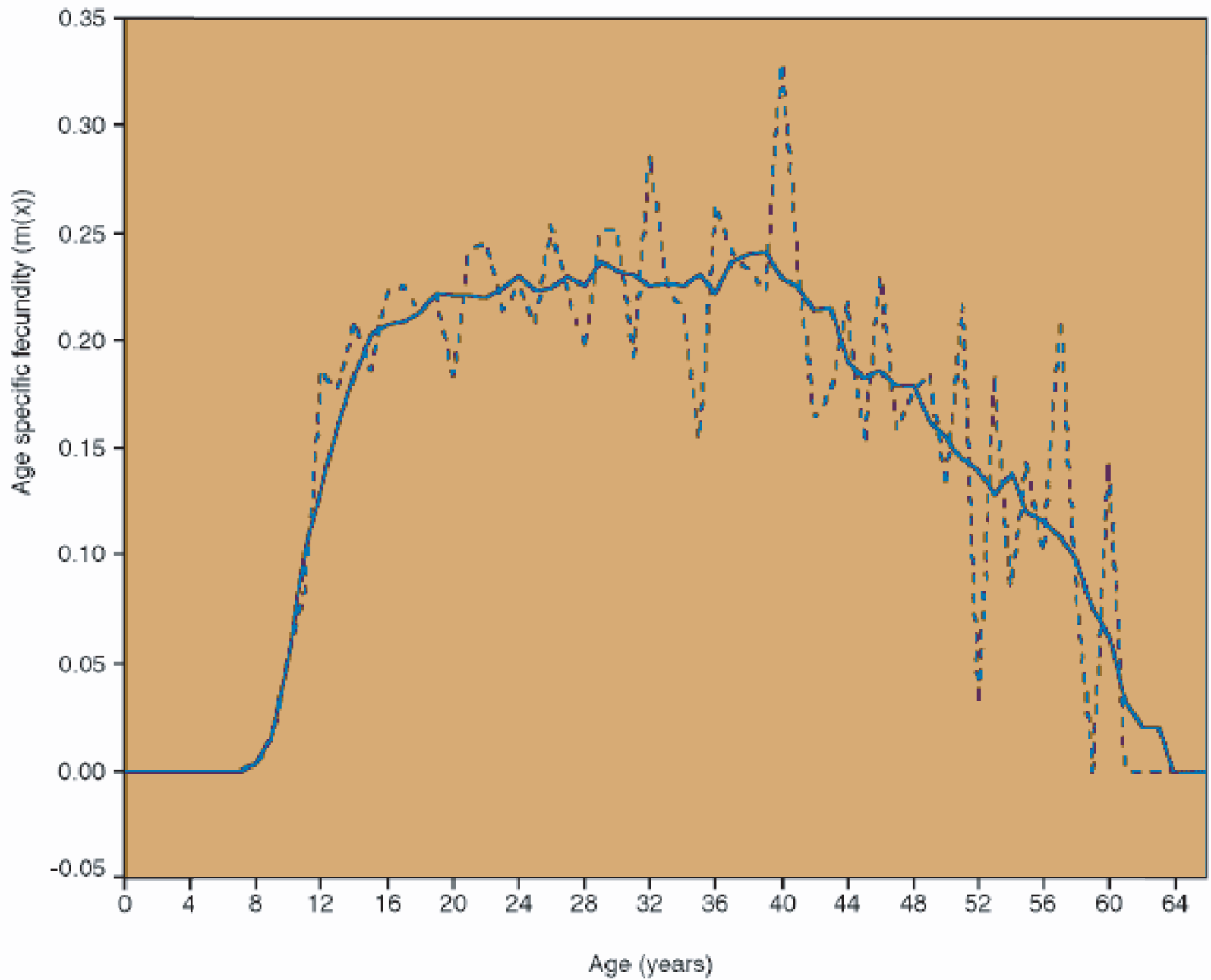
With luck, you can count (like elephants)

Normally, you must sample. Sampling, and analyzing samples, is 90% of most ecologists' job.

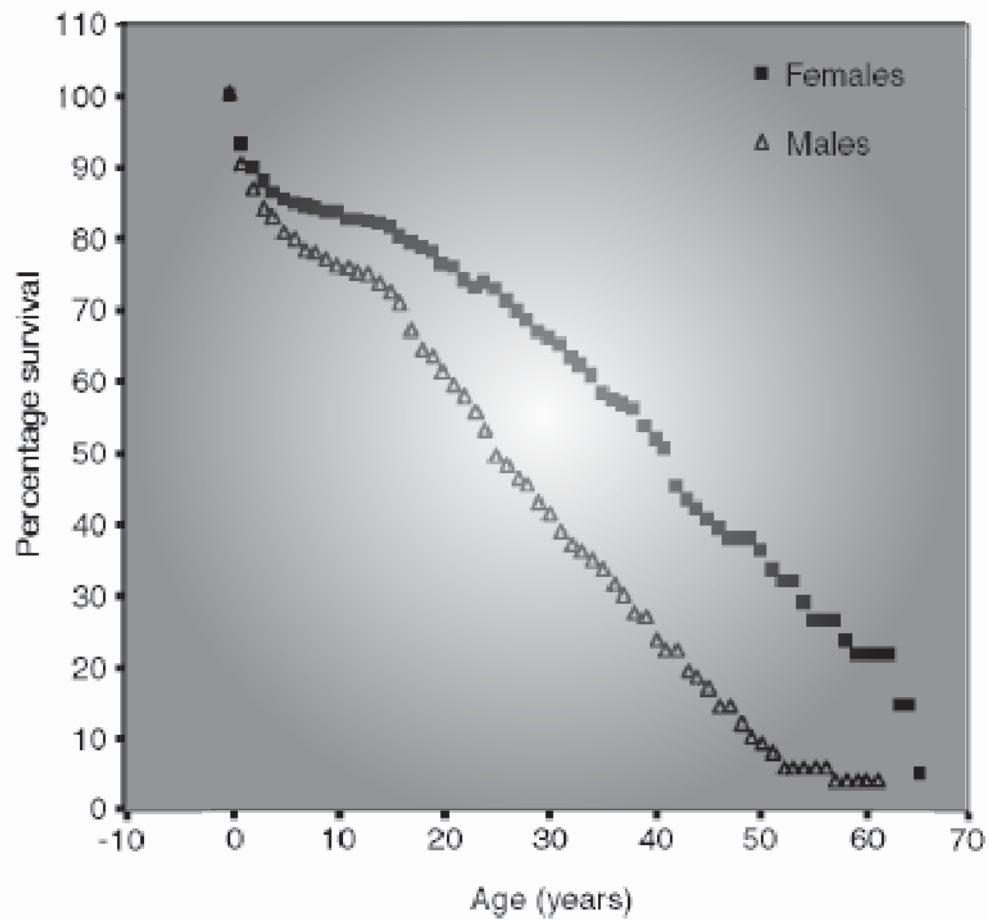
Some sampling techniques

Estimating Model Parameters

1. Plot data
2. Select a growth equation
3. Select parameters for that growth equation
4. Plot the equation over the data
5. Measure the distance of the equation plot from the data points
6. Change the parameters and repeat
7. Select the parameters that give the “best-fit” to the data
8. You can repeat this with a different equation and see which one fits better - if equations have different numbers of parameters, must take into account that its easier to fit data with more parameters.



Age-specific fecundity ($m(x)$) for female elephants. Both absolute values (dotted) and smoothed trends (solid) are shown.



 Age-specific survivorship for male and female elephants.

Split Data Into Ages or Stages

	birth rate	death rate
Juvenile	0	0.02
Adult	0.2	0.01
Ancient	0.05	0.05

$$N(\text{juvenile}, t) = 0.98 * N(\text{juvenile}, t-1) \\ + 0.2 * N(\text{adult}, t-1) + 0.05 * N(\text{ancient}, t-1)$$

$$N(\text{adult}, t) = 0.99 * N(\text{adult}, t-1) + \text{prop_age_14} * N(\text{juvenile}, t-1)$$

$$N(\text{ancient}, t) = 0.95 * N(\text{ancient}, t-1) + \text{prop_age_55} * N(\text{adult}, t-1)$$

Life Tables

Just using matrices to organize data on birth and death rates at different ages / stages.

$$N(\text{juvenile}, t) = 0.98 * N(\text{juvenile}, t-1) \\ + 0.2 * N(\text{adult}, t-1) + 0.05 * N(\text{ancient}, t-1)$$

$$N(\text{adult}, t) = 0.99 * N(\text{adult}, t-1) + \text{prop_age_14} * N(\text{juvenile}, t-1)$$

$$N(\text{ancient}, t) = 0.95 * N(\text{ancient}, t-1) + \text{prop_age_55} * N(\text{adult}, t-1)$$

juv			0.91	0.2	0.05		juv
adult	=		0.02	0.99	0		*
Ancient			0	0.06	0.95		ancient

Life Tables are just Matrices

Eigenvector = “Stable age distribution”

Eigenvalue = “Growth rate”

Sensitivity Analysis

In general, population dynamics is not useful for making accurate quantitative predictions.

It's useful for making qualitative predictions comparing different scenarios.

Individual-based Models

“EcoBeaker”-style

Follow individual creatures. Each creature can have its own
Variables

Pluses

- Can have infinite stages, ages, etc.
- Can account for space, interactions between individuals

Minuses

- Often lots of parameters
- Limits on number of creatures
- Hard to make general conclusions

Some Terms

- Intrinsic rate of growth: maximum offspring / individual / time
- Doubling time: Amount of time for population to double
- Carrying capacity: The maximum population that the environment can sustain
- Discrete vs. continuous: Do events happen continuously or once per some unit of time (such as once per year).
- Density-dependent/ independent: Are the parameters like b and d dependent on the density of the population
- Demographic stochasticity: When populations are low enough, chance events matter to the population size.
- Allee effect: Fecundity decreasing at low population size
- Stable age/stage distribution - the eigenvector for the life table matrix