Life history evolution

- Iteroparity (low reproduction, maximize growth) vs. semelparity (high reproduction, minimize growth)
- R and K selection (MacArthur and Wilson 1967; Pianka 1970)

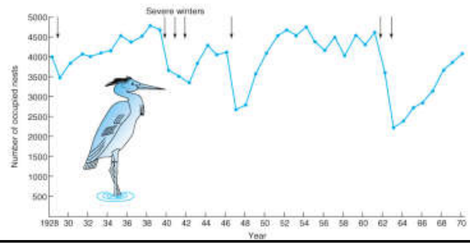
•r-selected
- •Unpredictable environment
- •Variable population size
- •Low competitive ability
- •Small body
- •Rapid maturation
- •Short life span
- •Many, small young (high fecundity)
- •Parental care rare
- •Type III survivorship

•K-selected
- •Predictable environment
- •Stable population size (near K)
- •High competitive ability
- •Large body
- •Slow maturation
- •Long life span
- •Few, large young (low fecundity)
- •Parental care common
- •Type I survivorship

Population Growth

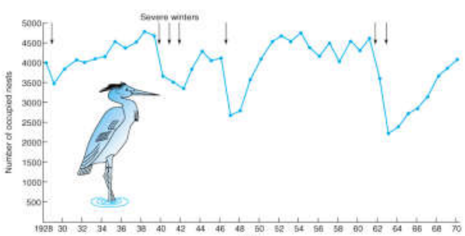
- Model predicts exponential growth of populations.
- We know that populations are limited but by what?

$$N_t = N_0 e^{rt}$$



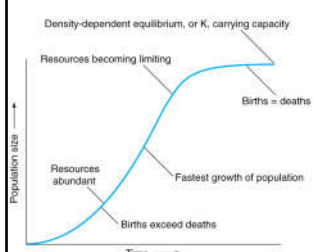
Density dependent vs. density independent

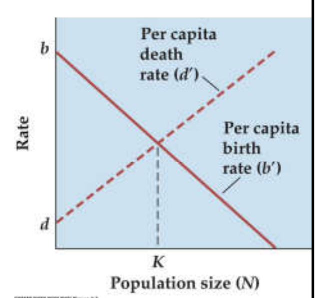
- Both negatively impact populations growth/size
- If the impact worsens with greater density it's **density dependent**
  - Disease
  - Competition
  - Famine
- If the impact does not vary with density it's **density independent**
  - Disturbance – fire, flood, etc.



Why don't we observe continuous exponential growth?

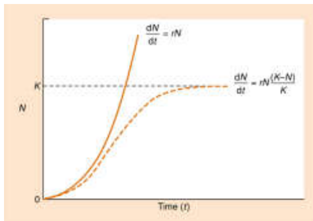
- If resources are limiting we expect competition.
- **Carrying capacity (K)** – the number of individuals of a species that can be supported by available resources in a habitat.
- As you approach K, R→1.0 and r→0.0





$$\frac{dN}{dt} = rN$$

$$\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$$



- K can be incorporated into our model by simply modifying the rate of increase (rN) by a measure of how close N is to K (Equation 4.7).

Intraspecific competition in discrete breeding

Modifying this equation:

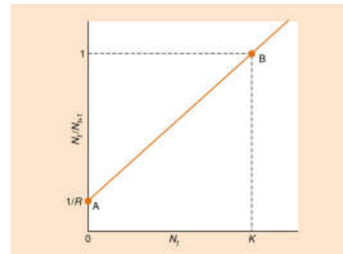
$$N_1 = R * N_0$$

To include modifications of population growth due to K, gives you:

$$\frac{N_t}{N_{t+1}} = \frac{1-\frac{1}{R}}{K} * N_t + \frac{1}{R}$$

Rate of change — Slope * N — +1/R

Simplifying - $a = \frac{R-1}{K}$



$$N_{t+1} = \frac{N_t R}{(1+aN_t)}$$

Showing population increase is limited by intraspecific competition.

a – per capita susceptibility to dens. dep. effects

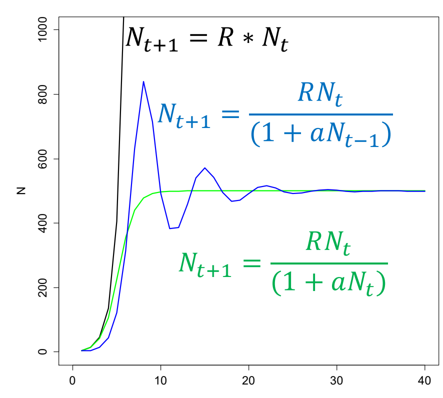
Time Lags

- A problem with this model is that K (which is incorporated into *a*) is assessed along with N_t
- Biologically, we know that competition in time t is most likely to affect populations in time t+1
- Thus, we modify this to include a time lag

$$N_{t+1} = \frac{N_t R}{(1+aN_t)}$$

$$N_{t+1} = \frac{N_t R}{(1+aN_{t-1})}$$

Dampened Oscillations

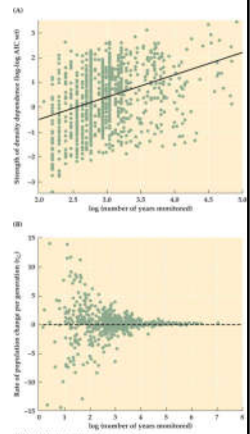


Density Dependent Effects

- Surprisingly difficult to quantify in nature.
- What is K based on?
- Are there density dependent effects that may not be related to resources?
- Equilibrium vs. non-equilibrium dynamics
  - Populations in equilibrium (birth and death rate) should remain near K.
  - Most natural populations are not in equilibrium, does not mean there is no density dependence.
  - Strongly debated up until the 1980's, in part due to difficulty in quantifying density dependent effects.

Density Dependent Effects

- Using long term population data, there are significant signals of density dependence.
  - Higher population growth at lower density
- In longer term datasets, there is also a trend towards the overall rate of population trend approaching 0. This implies equilibrium when viewed on large enough scale.



COMMUNITY ECOLOGY, Figure 4.5
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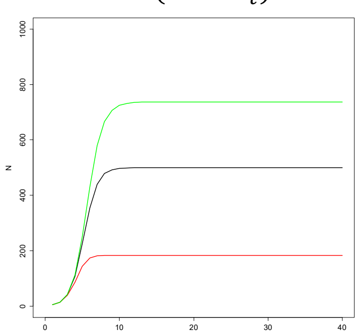
Strength of Competition

- What if competition is not as intense?
  - b can be used to modify the intensity of competition
  - K=500
  - b=1.0
  - B>1.0 increases intensity (2.0)
  - B<1.0 decreases intensity (0.8)

$$N_{t+1} = \frac{RN_t}{(1 + aN_t)^b}$$



Stochasticity

- Typical to have "good" and "bad" years due to other biotic and abiotic factors
- Model this as random variation in R
  - K=500
  - b=1.0

$$N_{t+1} = \frac{RN_t}{(1 + aN_t)^b}$$