Population Ecology

- Characteristics of individuals and populations
- Life histories
- Population growth
- Population-limiting factors
- Population interactions
- Human Population growth

It is at the level of populations that most ecological work is done. Ecologists are rarely interested in the individual in terms of the questions being asked.

The Origins of Population Ecology

- Thomas Malthus
  - 1798 published his Essay on the Principle of Population. Malthus introduced the concept that at some point in time an expanding population must exceed supply of prerequisite natural resources, i.e., population increases exponentially resulting in increasing competition for means of subsistence, food, shelter, etc. This concept has been termed the “Struggle for Existence”.
  - Influenced many thinkers...among them?

Characteristics of Populations

- What is a Population?
  - A group of individuals of a species that occupy the same area
    - Two parts:
      - It must be same species
      - Spatial delineation
  - So, what are individuals? Do you know them when you see them?
Once we are clear on what is an individual, we can talk about populations

- Some Characteristics of populations:
  - Distribution: the area in which it occurs
  - Abundance: # or size of population
    - Density: # / unit space
      - Various ways to estimate; most are difficult
  - Rates of birth, growth, death, etc.
  - Spacing/Dispersion
- Organisms, and therefore populations, respond to a variety of environmental factors.
- Only when all are within tolerance can it live in an area, its Habitat

Spacing options:

- (A) Uniform
- (B) Clumped
- (C) Random
- (D) Regular

What about over larger areas?
Sea Otter Distributions

Moving from Individuals to Populations

Demography
- Factors affecting growth and decline of populations
  - Birth
  - Immigration
  - Death
  - Emigration
- Survivorship curves and Life Tables

Survivorship Curves

What about vertically… or in 3-D?

What does ‘random’ or ‘normal’ mean? Why do thing live where they do?
Reproduction strategies

- **Semelparity (big-bang)**
  - One time reproductive events
  - Examples?
- **Iteroparity (multiple)**
  - Repeated reproduction
  - Examples?

What factors drive the evolution of these strategies?
How many eggs do you put into one basket?

Reproductive trade-offs

- **Survival of offspring**
  - Few or Many
    - Limited resources and environment pose major restrictions
- **Survival of parent**
  - Reproducing has a cost
  - Kids will kill ya!

Rates of Growth

- **Some examples…**

Exponential Growth

- **Exponential growth (geometric)**
  - Intrinsic rate of increase under ideal conditions (not limited by anything) = $r_{max}$

Logistic Growth

- **Real world growth is usually not exponential…for long.**
- **Limited resources put many pressures on growing populations**
- **Carrying capacity**
  - “K”
  - Maximum population size that a particular environment can support at a particular time, with no harm to the habitat.
Carrying capacity and growth rates

\[ \frac{dN}{dt} = r \left[ \frac{K-N}{K} \right] \]

Examples of real growth

Logistic growth breakdown

- Assumptions of logistic model
  - Every individual has a negative effect
  - Populations adjust instantaneously
  - Limiting factor is always population size
- Useful starting point in understanding very complex systems

\( K \) and \( r \) selected Species

- At high population densities (close to ‘\( K \)’)
  - Selection favors adaptations that help organisms survive and reproduce with few resources
  - Efficiency and Competition
- At low population densities
  - Selection favors rapid reproduction and shorter lifespans
  - Dispersal and Growth
- \( K \)-selection - density dependent
- \( r \)-selection - density independent

\[ \frac{dN}{dt} = r \left[ \frac{K-N}{K} \right] \]

Population limiting factors

- Negative feedback
  - Difficult to study (often need long-term data)
  - Resource limitation (food, shelter, etc)
  - Predation pressure, toxic wastes, disease

Density-dependent changes
Species interactions
• Classic example of lynx and hare
• Other Non-consumptive effects…
  – Reduced physiological condition, behaviors, etc
  – 50% drop in fecundity for years after crash…

Siphonophore Abundance

Human Populations
Why talk about humans in ecology section?

Human population
➢ Earth’s population reached 6 billion in September, 1999
➢ Increase to 7 billion by end of this decade
➢ Exponential growth of human population since early 1800s
➢ 40,000 years for 1st billion, 100 years for 2nd billion, 30 for 3rd billion, 15 for 4th billion, 12 for 5th billion and 9 for 6th billion…
➢ Population growth is slowing but still ~50 years the population should double…how?

Age Structure
Human growth rates