Populations, Communities and Species Interactions

I. Populations: group of individuals of the same species occupying a given area
   a. When studying populations, ecologists consider the genetic make up as well as the reproductive modes and reproductive behavior of the individuals.
      i. Demographics: vital statistics of the population
   b. Population size: number of individuals that contribute to a population's gene pool
   c. Population density: number of individuals per unit space
      i. Ex. People per sq. mile, number of guppies per liter of water in a stream
   d. Population distribution
      i. General pattern in which individuals of the population are dispersed
      ii. Crude density is a measured number of individuals in a specified area
         1. Three theoretical distribution patterns
         2. Patchy: Each species is adapted to a limited set of ecological conditions, which usually are patchy through a habitat
         3. Nearly uniform: usually unrealistic, but can occur when there is an optimum distance between individuals
         4. Random: only when habitat conditions are nearly uniform, resource availability is fairly steady and individuals of the population neither attract nor avoid one another.
   e. Gains and losses in Population size
      i. Populations can increase by
         1. Births
         2. Immigration
      ii. Can decrease by
         1. Deaths
         2. Emigration
      iii. If we assume the birth rate and death rate remain constant, we combine them into a single variable net reproduction per individual per unit time (r)
         1. Growth = r * (N)number of individuals
         2. If growth goes unchecked, the population will experience exponential growth and get really big really fast.
            a. Doubling Time: length of time it takes for a population to double in size
               i. Biotic Potential: maximum rate of increase per individual under ideal conditions
               ii. Ex: bacteria = 100% per 1/2 h, humans = 2 to 5%/ yr
         3. What limits population growth?
a. Must be limited, otherwise the world would be only 1 organism
   i. Limiting Factors
      1. Food
      2. Space
      3. Predators
      4. Polluted environment

4. Carrying Capacity (K)
   a. Maximum number of individuals of a population that a given environment can sustain
   b. Between the concept of biotic potential and carrying capacity we get logistic growth
      i. Growth =r*(K-N)/K
      ii. This plot of growth gives an S shaped curve

5. r vs. K adapted species
   a. r adapted species persist by relying on a high rate of reproduction and growth (rN)
      i. They tend to have rapid reproduction and high mortality of offspring
      ii. They frequently overshoot their carrying capacity and then die back.
      iii. Tend to occupy lower trophic levels
         1. Ex: Mice, rabbits, many insects
   b. K adapted species reproduce more slowly as they approach the carrying capacity of their environment
      i. Tend to occupy higher trophic levels
      ii. Delayed reproduction
         1. Ex: Humans, elephants, whales
   c. Many species don’t fit neatly into either category.

II. Communities: Several different populations existing in the same ecosystem
   a. Community ecology: study of interactions of all populations living in the ecosystem of a given area
   b. Productivity
      i. Primary productivity- the rate of biomass production of the conversion of solar energy into chemical energy stored in organisms.
         1. Net-primary productivity- amount of biomass stored after respiration, which means that it is available for consumption by other organisms.
   c. Abundance and diversity
      i. Abundance: the number of individuals of a species in an area
      ii. Diversity: the number of different species in an area
         1. Communities with high diversity often have low abundances.
         2. Both abundance and diversity vary greatly with environmental conditions
a. Latitude
b. Altitude
c. Precipitation
d. **Complexity, Resilience and Stability**
   i. **Complexity**: the number of species at each trophic level and the number of trophic levels in the community.
      1. A diverse community may not be very complex if all of its species are clustered in only a few trophic levels
   ii. **Stability** comes in three forms
      1. **Constancy**: lack of fluctuations in composition
      2. **Inertia**: resistance to perturbations
      3. **Renewal**: ability to repair damage after disturbance

e. **Community Structure**: patterns of individuals and populations within a community, as well as the relation of a particular community to its surroundings.
   i. **Spacing**
      1. Random- common
      2. Clustered or patchy-more common
      3. Ordered-uncommon

f. **Edges and Boundaries**
   i. **Ecotones** are the boundaries between habitats
      1. Often rich in diversity because they have species from two separate habitats
   ii. **Edge effects**, environmental and biotic conditions on the edges may extend hundreds of meters into the forest
      1. Because edges or ecotones, the habitat may be altered enough to no longer be hospitable for certain community members.
         a. New species
         b. Increased temperature

g. **Ecological Succession**: process by which organisms occupy a site and gradually change environmental conditions by creating soil, shade, shelter or increasing humidity.
   i. **Primary succession**: when a community begins to develop on a site previously unoccupied by living organisms
      1. **Examples**
         a. Island
         b. Volcanic flow
      2. Often first colonized by **pioneer species** a few hardy species, such as microbes, that can withstand harsh conditions.
         a. These species alter the habitat, called **ecological development** or **facilitation** and make the area more habitable for other species
   ii. **Secondary Succession**: when an existing community is disrupted and a new one subsequently develops at the site
1. Examples
   a. Deforestation
   b. Flooding
   c. Fire

iii. Climax Communities: appear to be the culmination of the successional process and are deterministic
   1. However, communities are comprised of individuals and disturbances are important factors in the life histories of many of these individuals