Population Balance in an Ecosystem

Population balance is an equilibrium between births and death. Otherwise, the population would change and the ecosystem would not be in balance, in other words, not sustainable.

Population Growth Depends on:

1. **Biotic Potential** - the number of offspring that an organism can produce under ideal conditions
2. **Recruitment**
    a. the number of young which survive to reproduce.
    b. in order to affect the size of a population, the young must survive
    c. this leads to two different reproductive strategies
        i. many young with no parental care
        ii. few young with high parental care
3. **Other factors** - migration, ability to adapt, invade new habitats, defense, disease resistance

Population explosions occur when conditions are ideal, resulting in exponential growth of the population.

4. **Environmental Resistance**
    a. the combination of all factors that tend to resist population growth.
    b. usually prevents a population explosion.
    c. examples include an increase or decrease in temperature, moisture, food supply, predation, disease, competition, space.
    d. the population dynamic (*i.e.* whether or not it grows) depends on the interplay between biotic potential and environmental resistance (especially environmental resistance).
    e. many environmental resistance factors are density dependant. This means that they become more and more limiting as the population density gets larger.

Consider the human case. Our technology has increased biotic potential and decreased environmental resistance. As a result, we are in a population explosion.

What Factors Maintain Population Balance?

1. Predator-prey - an increase in the predator population would generally decrease the prey population. As the prey population decreases, it would cause a decrease in the predator population.
2. Host-parasite - an increase in the host population can increase the parasite population. The increased parasite population could decrease the host population.
3. Plant-herbivore - similar to the predator-prey relationship.
4. Territoriality
    a. this is an individual defending a territory against the encroachment of others of the same species
    b. each individual needs a certain amount of space to live
    c. usually this behaviour is to ensure sufficient food and shelter to raise young
    d. only the strongest are able to compete successfully for the limited resources
5. Carrying capacity - the concept of carrying capacity suggests that there is a maximum population size for each species that an ecosystem can support

Population Growth Curves

1. S curve
    a. in an S curve, the size of the population fluctuates up and down but generally stays below the carrying capacity
    b. increases and decreases can be in response to changes in factors such as those which keep a population in balance (see above)
2. J curve
    a. a J curve usually happens after an unusual disturbance of some kind
    b. every J curve eventually ends in a J curve crash after which one of a few things may happen
        i. producers may recover
        ii. natural predators may enter the ecosystem and restore the S curve
        iii. if too much damage has been done the ecosystem may not recover
        iv. the species may become extinct

Carrying Capacity of Earth for Humans

Our forest, fish, soil, water, and atmosphere are all declining. These are the primary resources on which our survival depends. Currently only about 20% of the world population lives at the North American standard of living. Environmental problems will become steadily worse as more of the population begins to move toward that standard. If all the world lived as we do, the carrying capacity of Earth is estimated to be about 2B. If all the world lived as the Chinese do, the carrying capacity is estimated to be 12B. These estimates do not consider the possibility of new technology for alternative energy, total product and waste recycling, crop production, or soil conservation.

Changes in Population Size

Four factors determine if a population will increase or decrease in size

1. Natality - the number of births
2. Mortality - the number of deaths
3. Immigration - the number of individuals entering the population from other areas
4. Emigration - the number of individuals leaving the population to go to other areas

The change in size can be calculated as follows:

$$\text{population growth (\%)} = \frac{(\text{births} + \text{immigration}) - (\text{deaths} + \text{emigration})}{\text{initial size}} \times 100$$

Generally, natural populations tend to stay in a state of equilibrium with minor fluctuations up and down (remember the S curve).

Changes in population density (the number individuals in a given area) can be calculated as follows:

$$\text{rate of change} = \frac{\text{change in density}}{\text{change in time}}$$