MEASURING AND MODELLING POPULATION CHANGE

- Carrying capacity is the maximum number of organisms an ecosystem can sustain
- As populations increase the amount of available resources decreases.

Factors That Affect Population Growth

- Population dynamics are changes in population characteristics (such as natality, mortality, immigration and emigration)
- Fecundity is the potential number of offspring a species can produce in one lifetime (usually limited by the females)
- There are three types of survivorship curves (See Fig. 2 on pg. 661):
    - Type I have a low mortality until after reproductive years and have a long life expectancy.
    - Ex. Slow to reach sexual maturity and have a small number of offspring.
    - Type III has a high mortality rate when young and individuals that reach reproductive years have a reduced mortality.
    - Ex. Low average life expectancy and produce large number of offspring (green sea turtle)
    - Type II has a uniform risk of mortality throughout their life.
- Fertility (offsping that are actually produced in a lifetime) is often less than fecundity.
- Food availability, mating success and disease limits reproductive potential.

Calculating Changes in Population Size

$$\text{Popn. change} = \frac{[(\text{births} + \text{immigration})-(\text{deaths} + \text{emigration})]}{\text{Initial popn. Size (n)}} \times 100$$

- In an open population, changes are influenced by natality, mortality, and migration
- Closed populations are influenced by natality and mortality only.
- The biotic potential (r) is the maximum reproductive rate under ideal conditions.

Population Growth Models

- When birth rates and death rates remain constant, populations grow at a fixed rate in a fixed time interval
- For species that are restricted to a particular breeding season, they exhibit geometric growth
- For geometric growth, organisms reproduce at fixed intervals (like years) at a constant rate

$$\lambda = \frac{N(t+1)}{N(t)}$$

$$N(1) = N(0)\,\lambda$$
$$N(2) = N(0)\,\lambda \times \lambda$$
$$N(3) = N(0)\,\lambda \times \lambda \times \lambda$$
$$N(t) = N(0)\,\lambda^{t}$$

- The result is a graph with stepwise increments (see Fig.3, p. 663)

- Exponential Growth occurs when a population grows continuously at a constant rate (no fixed breeding season)

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

where r is the per capita birth rate and N is the popn. Size

popn. doubling time: $t_d = \frac{0.69}{r}$

- The result is a smooth J-shaped curve (see Fig.5 and 6, p. 663)

Modelling Logistic Growth

- population growth that levels off as the popn. size reaches the carrying capacity

$$\frac{dN}{dt} = r_{max}N \left[\frac{(K-N)}{K}\right]$$

where r_{max} is max. growth rate
N is popn. size and
K is the carrying capacity

Logistic Growth Curve

- results in a S-shaped curve.
- The lag phase occurs when the population is small and slowly increasing.
- The log phase occurs when the population is growing rapidly.
- The population experiences environmental resistance; where the available resources limit the biotic potential.
- The stationary phase occurs at or near carrying capacity.
- The population is said to be at dynamic equilibrium, since the number of births equals the number of deaths.

Seatwork

Pg. 669 # 1 – 9