Unit 3 – Interactions Among Living Things

Ch. 7 – Population Dynamics

7.1 – Populations, Communities, and Ecosystems

(see Figure 7.1, p. 208)

- population – group of individuals of the same species living in the same geographical area
- community – all of the organisms of all the interacting populations in a given area

Communities are dynamic (always changing). As populations interact, they change the abiotic environment to make it more suitable for other living things, and these new living things take over and form new communities.

Ecological succession – process consisting of consecutive changes in species composition in a given area

Two types:

(1) primary succession – the development of a new community in a previously barren area, such as after a volcanic eruption, or on a bare rock mountain top

(2) secondary succession – the redevelopment of a previously existing community after a disturbance

In either case, the last stage of succession is called a climax community. A climax community is a self-perpetuating community in which populations remain stable and exist in balance with each other and the environment.

Ecosystem – community of living organisms, together with the biotic and abiotic factors that surround and affect the community.

Biomes – identifiable ecosystem found in a specific region on Earth that has a particular combination of biotic and abiotic factors

(see Fig 7.6, p. 211)

Biomes are determined by two major factors:

(1) The Earth is unequally heated because it is tilted on its axis. This means some areas of Earth receive more heat from the sun than others. As well, unequal heating sets up water and wind movements

(2) Rainfall varies in different areas of the world (due to water and wind movements). This influences climate and soil types, which affects what plants can grow in an area (and thus what animals)

Biosphere – all ecosystems and their interactions on Earth.

Ecological niche – the role that members of a population play in a community. The role includes the resources that members need and how members interact with other members of the population and the community.

The Structure of Ecosystems

Trophic level – the position of a species in a trophic structure of a community, according to what a species eats.

- 1st trophic level = producers
- 2nd level = primary consumers (herbivores)
- 3rd level = secondary consumers
- 4th level = tertiary consumers

decomposers – organisms that eat left-over dead or waste matter for energy

Energy Flow in Ecosystems

Primary productivity – the amount of light energy that autotrophs in an ecosystem convert to chemical energy during a specific period of time.

All of the energy that is captured by producers will get passed up a food chain; living things use up energy to live. As a result, as you go up in trophic level there is less energy, fewer organisms, and less biomass.

Biomass – the mass of all the same type of living organism in an area.

7.2 – Characteristics of Populations

demography – the study of populations, especially population size, density, age structure, and growth

density – the number of individuals per unit area or volume in a population

Measuring Population Density

There are several methods that can be used to measure population density:
(1) census – complete count of all the members of a given population
(2) Sampling methods (transect, quadrat sampling, mark-recapture)

Dispersion – the distribution of individuals of a population within its geographical boundaries
(see Fig. 7.18, p. 221)

7.3 – Describing the Growth of Populations

births – the number of individuals born during a given time period; increases population size

deaths – a factor that decreases population

emigration – movement of individuals away from a region, a factor that decreases a population

immigration – movement of individuals into a region from elsewhere, a factor that increases a population

In order for populations to grow, birth rate plus immigration must be greater than death rate and emigration.

In most species of living organisms, immigration and emigration rates are very low and can be ignored.

Biotic potential – the highest potential per capita growth rate possible for a given population (under ideal conditions)

Under ideal conditions, organisms could undergo exponential growth

Exponential growth – the growth of a population that occurs in an environment with unlimited resources

- organisms undergoing exponential growth quickly increase in population size, forming a J-shaped curve pattern (see Fig. 7.23, p. 226)

However, in the real world resources are limited so populations cannot grow exponentially forever. Instead, many populations grow exponentially for a while until resources become limited or other factors affect population growth.

Logistic growth – the type of population change that occurs in an environment in which resources are limited

- logistic growth tends to show a S-shaped curve pattern (see Fig. 7.25, p. 229)

carrying capacity – the maximum population size that can be sustained in a given environment over a long period of time.

7.4 – Factors Limiting Natural Population Growth

Two types of general factors affect population growth:

(1) Density-independent factors
- → Variables that affect the growth of a population regardless of the number of individuals in the population in a given area
- → Usually abiotic factors like floods, droughts, climate, forest fires, hurricanes

(2) Density-dependent factors
- → Variables that affect growth of populations when there is an increased number of individuals in an area
- → Usually caused by biotic factors
- → Examples
  i. Competition
  ii. Disease

Two types of competition:

(1) Intraspecific competiton – competition between or among members of the same species for resources
   i. ex. Two bears hunting salmon

(2) Interspecific competition – competition among or between members of different species for food
   i. ex. Hawks and foxes which both rabbits

Competitive exclusion principle – theory stating that species with niches that are exactly the same cannot co-exist

Ch. 8 – Population Change and Global Resources

8.1 – The Human Population: Past Meets Present

Although it is truly difficult to estimate populations before 1650, most demographers estimate that after the ice age (about 10, 000 years ago), the human population was approximately 5 million people.

Agricultural Revolution – time period during which humans started to plant and harvest crops and domesticate animals, resulting in a stable food supply and increasing human population growth.

Since 1850, population growth has been rapid, and it takes less and less time for the number to go up

(see fig 8.2, p. 257)

Demographic Transition

demographic transition – period of change in the growth rate (r) of a population

3 stages of demographic transition:

(1) Birth and death rates are both very high, so the population stayed low

- this corresponds to time before the Industrial Revolution. People were having a lot of children but mortality was high as well (poor medical treatments, cleanliness, etc.)

(2) Birth rates are high, but death rates are lower.

- Industrial Revolution – period of transition of lifestyle during the eighteenth century in which people shifted from working in traditional agriculture jobs and making goods by hand to working in factories and making mass-produced goods.
- medical technologies were being developed so there is less infant mortality and people were living longer. However, they were still having lots of children.

(3) Birth rate begins to decline because there is no need to compensate for high child and infant mortality. The death rate is low as well, so the population becomes stable.

8.2 – What is Earth's Carrying Capacity?

Scientists cannot currently predict (with any certainty) how many people Earth can support. There are, however, three general approaches to reduce the impact we humans have on environmental quality:

1. The Bigger Pie Theory
   - → theory suggests that Earth can be made to sustain any number of people if we grow more food, improve energy technology, and so on.
   - → Green Revolution – international effort, started in the 1950s, to transfer the farming methods and crop varieties used in the more developed nations to the less developed nations
   - → environmental damage has been done (pesticides, soil erosion, etc.), so it is perhaps unwise to assume technology can solve all the problems
2. The Fewer Forks Approach
   - → Involves slowing or reducing population growth
   - → Most strategies of this approach move a population into the 3rd stage of demographic transition
   - → Cultural reasons in particular areas may prevent this approach from being used
3. The Better Manners Approach
   - → Improving how people interact with each other; instead of competing with each other and using up resources they should work together

8.3 – Negative Effects on Carrying Capacity

perpetual resource – resource that is essentially inexhaustible, such as the energy from the sun, wind, or tides

renewable resource – natural resource, such as trees, that can be replenished when depleted

non-renewable resource – natural resource that cannot be replenished by Earth's natural processes or a resource that is replaced by processes that require very long periods of time (such as minerals and fossil fuels)

(see fig 8.15, p. 275)

suistainable development – the use of renewable resources in a way that meets the needs of the present without compromising the ability of future generations to meet their own needs

Negative effects on the Environment

1. Greenhouse effect
   - → Natural phenomenon that traps the Sun's heat in the atmosphere near the surface of Earth; produced by several of the gasses in the atmosphere
   - → Increased carbon dioxide levels have led to the temperature of the Earth rising slightly. This carbon dioxide rise is due to increased fossil fuel consumption and cutting down of trees (deforestation)
2. Ozone Depletion
   - → Reduction of the ozone layer; thought to be chiefly caused by chlorofluorocarbons (CFCs) released into the lower atmosphere moving upward and decomposing to produce chlorine atoms that react with the ozone to produce oxygen
   - → Ozone shields the Earth from harmful ultraviolet (UV) radation
3. Acid precipitation
   - → Rain or snow that has a pH of 5 to 5 as a result of interactions with atmospheric pollutants
   - → It corrodes metal, harms trees, kills marine life
4. Photochemical Smog
   - → Brown or grey haze of ozone and various nitrates formed by the reaction of nitrogen oxides and hydrocarbons in the atmosphere in the presence of sunlight and water vapour
   - → More common in larger centers
5. Drinking water
   - → The supply of fresh water on Earth is extremely limited (97% of water on Earth is ocean, 2% is frozen as icebergs)
   - → Water can be polluted by several things (sewage, oil spills, inorganic nutrients, etc.)

6. Desertification
   - → The transformation of marginal dry lands into near-deserts that are unsustainable for agriculture
   - → The Sahara desert in Africa is spreading due to overgrazing and overfarming
   - → Rainforests are being cut down for farming, but the farms don't last long and the area becomes unusable
7. Effects on Organisms
   - → Extinction – complete disappearance from Earth of all members of a species
   - → Extirpation – disappearance of a species from areas that were once its range