IDX G9 Biology H
Study Guide Issue S1 Final
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Chapter 5

5.1 How Populations Grow

Study population from Geographic, density and distribution, growth, and age structure.

- **Geographic range**
    - range of area inhabited by a population
        - can vary over a wide range, for example a moose population could live across a whole continent, while a bacterial population may live only in one single cubic meter
- **Density and Distribution**
    - Density refers to the number of individuals per unit of area

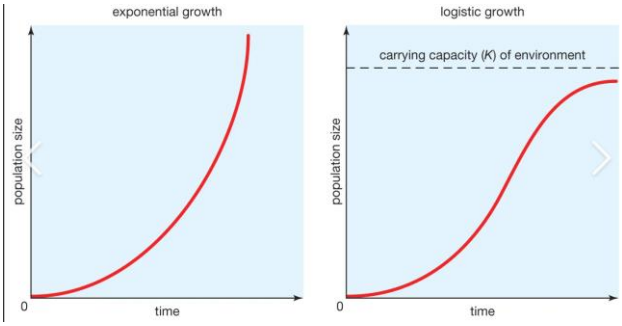
- Distribution refers to how populations are space out across the range of the population
  - this can be uniform, random or clustered distribution
  - Random distribution often depends on micro conditions of the environment
  - Clustered distribution can often be tied to resources or to avoid predation

- Methods of measuring population size:
  - **Quadrat Sampling Method**
    - population size = (avg number per quadrat * total area) divided by (area of one quadrat)
  - **Capture-Mark-Release-Recapture Method**
    - population size = (# individuals initially marked * # individuals second time caught) divided by (# marked individuals that is caught the second time)
    - In order for the captured/ total population and marked/recaptured ratio to maintain constant, we need an adequate mixing of the species, and make sure that markings don't affect mobility or survival

- **Growth Rate**
  - it determines wether a population will grow or not
  - R= B+I-D-E
    - B- D is the natural increase rate
    - I-E is the migration rate (Immigration & Emigration)

- **Age structure** — the distribution of males and females at each age a population contains (population pyramid)
  - **Use to identify the development of a country or citiy.**

- **Population Growth**



- **Exponential Growth**: J-shaped curve, consisting of a lag phase and an exponential growth phase
  - Limiting factor and carrying capacity slows it down
- **Logistics Growth**: S-shaped curve, growth slows down and stops at carrying capacity after a period of exponential growth
  - Modeled by the equation Nf=No(Kr)^t, where N stands for population initial and final, K is the carrying capacity, r is the growth rate while t is the time
- 3 Phases

1. Exponential growth phase: few predation and disease, resource plentiful
2. Transitional phase: growth slows due to increased predation, competition and disease
3. Plateau phase: growth stops, or oscillating around the carrying capacity line

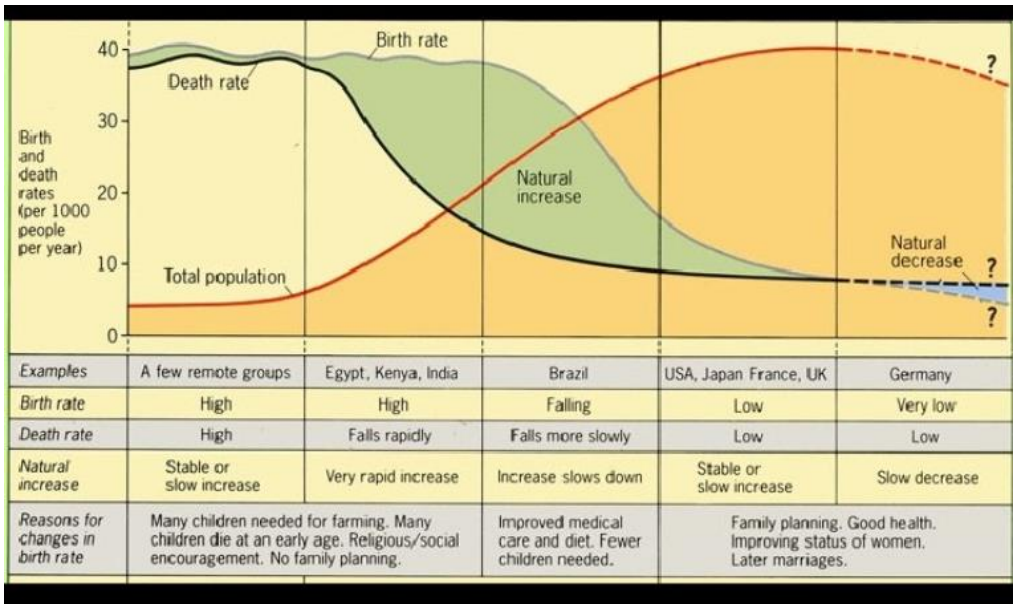
- **Carrying capacity**: maximum number of individuals of a species an environment can support for the long term

5.2 Limits to Growth

- **Limiting factor:** density dependent or density independent factor that controls the growth of a population and determines the carrying capacity
- Density dependent factor: affects more of larger populations
  - includes competition, predation, disease and stress from overcrowding
    - **stress from overcrowding**: weakens immunity, leading to higher mortality and emigration rates
- Density independent factor: affects all populations in similar ways (abiotic factors)
  - unusual weather, natural disasters etc.
- **Top-down or Bottom-up factors** (such as keystone species)
- **Endemic species — native species**
- **Alien Species — non-native species**
  - may become invasive and outcompete native species if not enough predators

5.3 Human Populations Growth

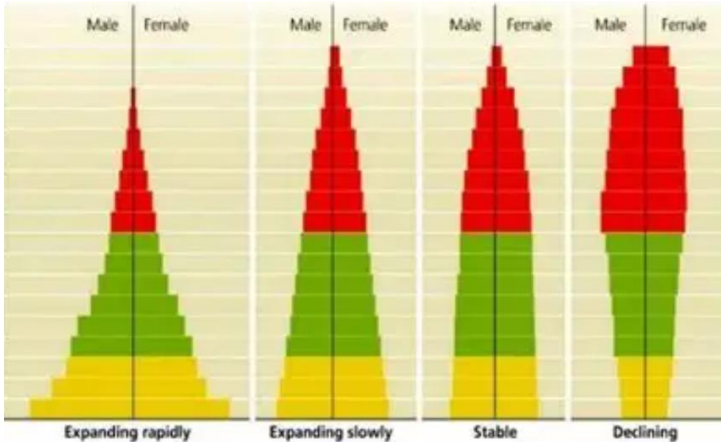
- **Overpopulation**
  - This will lead to safety, hygiene, limited space and psychological welfare problems

- **Urban sprawl leads to fragmentation of wildlife habitats,** because humans build up more suburbs as they expand outwards and interconnecting roads
- **Demography is the study of a population's growth, distribution, size and movement as well as birth and death rates**
    - **Historical overview:** starting with agricultural development, then onto the bubonic plague where the population drops suddenly, and the Industrial Revolution where the population rockets upward, reaching today's population of about 8 billion people
    - **Thomas Malthus**: proposed that populations will be limited by war and famine, graphically meaning that resource increases linearly, while population exponentially, and after the intersection point it will be a resource deficit for the global population
- **Demographic Transition Model**: from high B and D rates to low B and D rates (3 main stages)
    - note that on the graph birth rates are on top of death rates (always)
    - 

Examples	A few remote groups	Egypt, Kenya, India	Brazil	USA, Japan France, UK	Germany
Birth rate	High	High	Falling	Low	Very low
Death rate	High	Falls rapidly	Falls more slowly	Low	Low
Natural increase	Stable or slow increase	Very rapid increase	Increase slows down	Stable or slow increase	Slow decrease
Reasons for changes in birth rate	Many children needed for farming. Many children die at an early age. Religious/social encouragement. No family planning.		Improved medical care and diet. Fewer children needed.	Family planning. Good health. Improving status of women. Later marriages.	

1. **Pre-industrial stage** where both birth and death rates are high (horizontal lines)
2. **Transitional stage** where death rates start to decline while birth rates remains high (can be because of better sanitation and medics, or improved living standards)
3. **Industrial Stage** where following the fall of death rates, birth rates also start to decline, as people realize that they do not need that much children born to compensate for the lowered risks of infant mortality (living standards are improved a lot, and education increases as well)

- **Age structure and Population Pyramid**
    - There is the post-reproductive stage, reproductive stage and pre-reproductive stage

- 

- **Population Momentum** is how the population is expected to grow in the future based on the population pyramid
    - A bulge in the middle or the bottom will increase the population in the future, because there are/will be more women in their reproductive stages
    - An inverted pyramid shape will likely mean that the population is expected to decline, which fewer and fewer people born
    - A column shape means that the population is very stable, with no significant momentum to change

Chapter 6

6.1: A Changing Landscape

Human Activities

- Agriculture - Monoculture
    - Monoculture - Practice of clearing land to plant a single productive crop year after year
    - Benefits
        - Allows for efficient sowing and harvesting
    - Environmental Impacts
        - Deplete natural resources
        - Fertilizers consume fossil fuels
        - Increased use of pesticides & insecticides leak in rivers, cause ecologicla magnification
        - Imbalance of nutrients in the soil

        - Ecological Magnification: the pollution will move up and increase with the trophic level
- Development
    - Dense human communities produce large amount sof waste
    - Affect air, water, and soil resources
    - Consume farmland, divide natural habitats
- Industrial Growth
    - Requires a lot of energy to power
    - Burning fossil fuels pollute the environment
    - Waste discarded into soil, water, air

Sustainable Development

- Goods - Things that can be bought and sold for money
- Services - Processes & Actions that produce goods
- Ecosystem goods & services - Produced by ecosystems, benefit human economy
- Resources
    - Renewable - Produced & replaced by a healthy ecosystem
        - i.e. wind, sun, water, individual tree
    - Nonrenewable - Can't be replaced in a reasonable amount of time
        - i.e. Oil, Natural gas, Coal
- Sustainable Development
    - Provide for human needs while preserving the ecosystem
    - Use resources at rate where they can be replaced or recycled to preserve long-term environmental health
    - Increased use of renewables

6.2: Using Resources Wisely

Soil Resources

- Healthy soils support both agriculture & forestry
- Soil Erosion
    - Topsoil - Mineral and nutrient rich portion of soil
        - Absorb and retain moisture
        - Rich in organic matter
        - Can be renewable if used properly

        - Low in salts
    - Soil Erosion - Removal of topsoil by water and wind
    - Desertification - Combination of farming, overgrazing, seasonal drought and climate change
        - Turn farmland / forest into desert
    - Deforestation - Loss of forests
        - Lead to severe erosion
        - Grazing & Plowing especially
- Action on Soil Erosion
    - Management of agriculture - Leave the stem and roots of previous crop
    - Crop rotation: Different crop at different seasons
    - Contour plowing: Planting crop across the slope of the land

Freshwater Resources

- Humans depend on fresh water and freshwater ecosystems
    - Drinking water industry
    - Transportation
    - Energy Sector
    - Waste Disposal
- Pollutants - Harmful substances that can enter the biosphere
    - Industrial & Agricultural chemicals
        - Biological magnification of pollutants in ecosystems - Accumulation in tissues at higher trophic levels
        - PCBs: Organic echmicals
        - DDT: Pesticides used in agriculture
    - Residential Sewage
        - Lots of nitrogen & phosphorus
        - Bloom of bacteria and algae - Eutrophication
        - Can cause decrease in dissolved oxygen - oxygen-poor "Dead Zones"
    - Nonpoint sources
        - Single point: Pollutants from single sources
        - Nonpoint: Multiple sources, washed by rain / into air
- Water quality & Sustainability
    - Protect natural systems involved in the water cycle
        - Watershed - Area where water runs into the same lake / river

    - Pollution control
        - Sewage control
        - Integrated Pest Management (IPM) use predators instead of chemical
        - Pest predators, less poisonous sprays, crop rotation

Atmospheric Resources

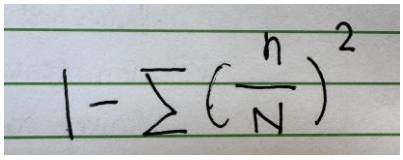
- Significance
    - Provide oxygen that we breath
    - Ozone layer protects skin from UV radiation
    - Regulate global temperatures
- Effects
    - Smog - Gray-brown haze release by industry or automobile
    - Acid Rain
        - Nitrogen & Sulfur compound released, form nitric / sulphuric acid
        - Effects
            - Kill plants by damaging leaves
            - Change chemistry of soil & water
            - Dissolves and release toxic heavy metals
    - Greenhouse gasses - CO2, Methane, etc.
    - Particulates - Microscopic dust & ash will cause global warming
- Protecting air quality
    - Automobile emission standards
    - Clean-air regulations

6.3: Biodiversity

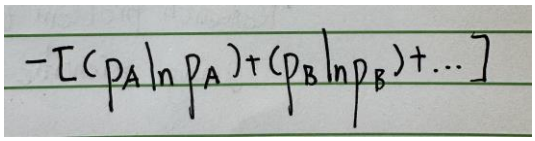
Types of Biodiversity

- Biodiversity - Total of all genetically based variations of organisms in the biosphere
- Types
    - Ecosystem - Variety of habitats & Ecologicla processes
    - Species - Total of different species in an area
    - Genetic - Total of all forms of genetic information carried by a particular species
- Richness: Number of different species
- Evenness: Same number of organisms in each specie
- Diversity Indexes

- Simpson's Biodiversity Index



  - n: Total number of a particular species
  - N: Total number of organisms
  - Maximum Diversity = 1, Minimum DIversity = 0
- Shannon's Biodiversity Index



  - A, B, C are species
  - P is their relative abundance
  - ln is the natural logarithm

Value

- Medical: Original source of medicine
  - i.e. Aspirin & Penicillin
- Agricultural: Wild plants can carry useful genes
- Ecosystem: Number and variety in an ecosystem promote stability

Threats to Biodiversity

- Altered habitats
  - Habitat Fragmentation - Splitting habitats into pieces
- Hunting Wildlife
  - Can push animal species to extinction
  - CITEs ban international trade of products from endangered animals
- Climate change
  - Can push vulnerable species to extinction

Protections

- Protecting individual species
  - Captive breeding - Breed & raise in protected environments
  - End goal: Release back into the wild
- Preserving Habitat
  - Ecological hotspot: Significant of species endangered
- Local Interests

- Tax credits & Ecotourism

6.4: Meeting Ecological Challenges

Ecological Footprint

- Ecological Footprint - Total area of functioning land & water ecosystems need to provide resources & deal with waste
- Limitations
  - Actual numbers complicated
  - No universally accepted definition
  - Snapshot of situation at a particular point
- Process
  - Identify a protein
  - Research problem to determine cause
  - Using scientific understanding to change behaviour