Unit 6: Ecology
Content Outline: Population Ecology (6.2) – Part 1

I.   **Population Ecology**
- A.   This field of Biology deals with species populations and the population's environment.
- B.   A **Population** is the *same species, same time, same place, and showing signs of reproduction*.
- C.   The human population will soon be over 8 BILLION people on Earth.
- D.   It mainly focuses on **Density** (number of organisms in a given area) and boundaries.
   - 1.   Man made boundaries or natural boundaries exist.
- E.   **Dispersion** –This term refers to *where within the boundaries* are the organisms located.

II.   Patterns of Dispersion
- A.   **Clumped** – This usually results from a need for nutrients, mating, or employment.
- B.   **Uniform** (evenly) – This usually results from territoriality or favorable environment.
- C.   **Random** – There is no apparent reason seen in the dispersion pattern.
      Please have students provide examples of species that exhibit each type.

III.   **Demography** – The study of population sizes and distribution.
- A.   **Growth** – This occurs by birth or **immigration** (to enter into a new area).
- B.   **Decline** – This occurs by death or **emigration** (to exit an area).
- C.   **Life Tables**
   - 1.   Provides Age Specific Traits for cohorts (individuals of the same age or demographic).
   - 2.   These are expensive and time consuming to produce. (Like the U.S. census.)
      Age Pyramids work really well in helping explain the concept to 9th graders. See below.

   Interpreting Population Pyramids Activity

   After having discussed Population pyramids in class, go to the following website to get population pyramids from around the world using 2010 data. Have students interpret and predict for various countries. Remember to talk about work force, size of families, help for the elderly, education level, stability of the country, how women are viewed compared to men, food availability, and health care.

   The website is: www.census.gov/ipc/www/idb/

   Directions: 1) Click on the box in the center that says "Data Access"
   2) Pick a country to view. Do not worry about a year, it will default to 2010.
   3) Hit Submit.
   4) When data comes up, click on Population pyramid at the top of data table.

- D.   **Survivorship Curve**s
   - 1.   THREE basic types of curves can exist in nature.
      - a.   **Type I** (Many young ▯numerous middle ▯ few old)(type of environment?)
            This environment favors the young and usually indicates that the environment is favorable and organism is usually at top of food chain and there seems to be extensive parental care and E investment.
      - b.   **Type II** (*Constant decline*) (type of environment?)
            This indicates that the environment is relatively favorable but organism may be a food source for another organism. The parental care is modest.
      - c.   **Type III** (Many young ▯ few middle and old (type of environment?)
            This indicates a harsh environment because most of the young die at an early age. This indicates that they are a food source that is low on the food chain as well as have practically no parental investment. Young are left to fend for themselves.

Population Ecology (6.2) – Part 2

I. Population Growth Models
    A. **Exponential Growth Models** (*Ideal Growth*)
        1. Involves **r-selection species.** (r- think rapid growth)
        2. These species are also referred to as **Density – independent species**
          a. There population size is related to *resources* not number of organisms.
        3. Produces **a J curve graph.**
        4. Their environment has *unlimited resources*. (Good for ideal growth)
        5. Occurs mainly in a *new* environments and **pioneer species** such as bacteria, lichens, and mosses. (They are the first organisms to colonize the new environment.)
        This is in areas that are just formed like Hawaii was millions of year ago. (Hawaii started as barren rock, until the pioneers arrived and began to make soil. The soil enabled plants to grow. The seeds of the plants arrived in the bird dropping of birds that stopped while migrating to feed on the mosses and lichens. Larger plant roots sped up soil formation to allow for larger plants.)
        6. **ZPG** (Zero Population Growth) (r= 0)
        7. **Intrinsic growth** = r_{max} (Population is growing as fast as possible/doubling. This is seen as the curve begins to make a straight up curve.)

    B. **Logistic Growth Model** (*Realistic Growth*)
        1. Involves **K-selection species.** (K refers to a population that is hovering around the **carrying capacity** "which is represented by "K")
        2. These are referred to as **Density – dependent species**.
          a. These species numbers are about number because there *are limited resources* because the species is near the carrying capacity for that environment.
        3. Produces an **S curve graph.** ("snakes" around the carrying capacity line)
        4. Environment has limited resources; that is why organisms stay around the K.
          a. More organisms than K means damage WILL be done to the environment.
          b. More damage done to environment can cause K to drop even farther.
            This can be an example of a positive feedback loop.
          c. Wars, disease, and famine breakout in a population to bring numbers down below K. (Extinction is possible? ⬜ depends on damage to environment and K.)
        5. **Lag time** (This accounts for the overshoot.) – It takes time to begin to see the effects. (So the line goes above K and this is when death, war, disease, and famine accelerate.)

Density Dependent are mostly living (biotic) things. (Competition, predators, prey, food, disease)

Density Independent are mostly non-living (abiotic) things. (Sunlight, soil nutrients, wind, rain)

There is a great LTF activity for these two concepts. Students need to be able to recognize and explain each type of graph. These are almost always on high stakes exams.

Population Ecology – Part 3

I. **Population Limiting Factors** (All *can* limit a populations size… could even be more than one at a time.)
- A. Resources (This can be food, water, space…if it is a territorial species.)
  1. Competition rises as resources become scares draining energy away from reproduction.
- B. Health conditions (Such as crowding and disease.)
- C. Predation by another species.
- D. Intrinsic Factors (Such as aggression, stress.)(Like personality issues with humans.)
- E. Carrying capacity for the given environment.
  Please help students "see" how each of these factors can *limit* the size of a population within a given area.

II. **Boom-Bust cycles** of Growth (This describes a Predator/Prey relationship mainly.)
- A. Shows the **Lag-time** for other species to adjust to a change in a species population number.
- B. The two population "lines" are chasing each other because of their direct relationship.
- C. This relationship also promotes natural selection as it will be the strongest that survive and reproduce… so each species is causing the other to evolve… which is referred to as **co-evolution**.
  Please make sure students understand the interaction occurring between the two species. It is much like a see-saw. Also please help students understand that those that survive pass on the beneficial traits to the offspring and this leads to changes within the species over time to gain an advantage… coevolution.

III. Human Population growth pattern
- A. The population explosion that <u>is</u> occurring has changed the dynamics of Earth tremendously.
  1. Environmental degradation and over-consumption of resources <u>is</u> occurring.
  2. Species loss (extinction) <u>is</u> occurring at a fast rate.
  3. Overpopulation <u>is</u> being seen in India, China, and some other Island nation.
- B. Freedom/Control
  1. China and India and United States
     China has imposed laws to get control of birth rates. (These can be found on the internet.)
     India has not *yet* imposed laws, but is seeing resource issues currently.
     The U.S. is not near the size in population as China or India ; but the United States uses *most* of the world's resources; which is an issue for China and India and the rest of the world. The size of the U.S.'s **Ecological Footprint** is enormous.
- C. Human Growth History
  1. The human species started as a Hunter gathers society. (Called **nomads**.)(Energy?)
     Their energy mainly went toward following the food so little was left for reproduction (They were basically too tired and health issues also drained energy.)
  2. **Agricultural Revolution** and the plow
     With the invention of the plow, more food and not having to travel increased health and energy reserves. These could be put toward reproducing… so the population begins to climb. This also leads to the formation of towns and villages.
  3. **Industrial Revolution**
     This help lead to cities because now everyone didn't have to produce their own food, it could be grown in the countryside and trucked into the city for sale. Also this allowed for an increase in reserve E to put toward reproduction. Also health care improved for most people.
  4. **Technology Revolution** and Medicine
     Better health causing people to live longer now and survival of babies increases. Women, in general, are having more children because families are becoming more affluent. Technology, while mostly good for society, makes most people less active and puts even more E toward reproduction and obesity.

Please take the time to discuss these important changes and impacts on human history. Get them to think about the present effect and future effects.

IV. **Ecological Footprint**
- A. A measurement that takes into account the amount of water and land *needed* to produce *all used products* (resources) and *dispose of all generated waste* as a result of that same product (trash in landfills).
  Please have students think about their individual or family "footprint".