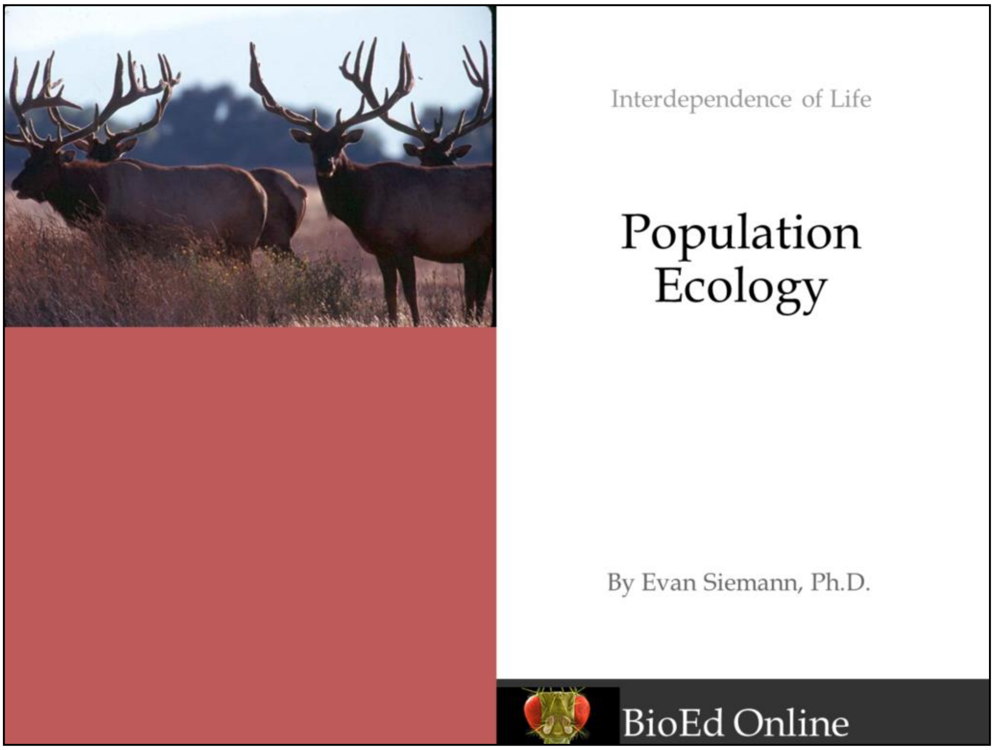
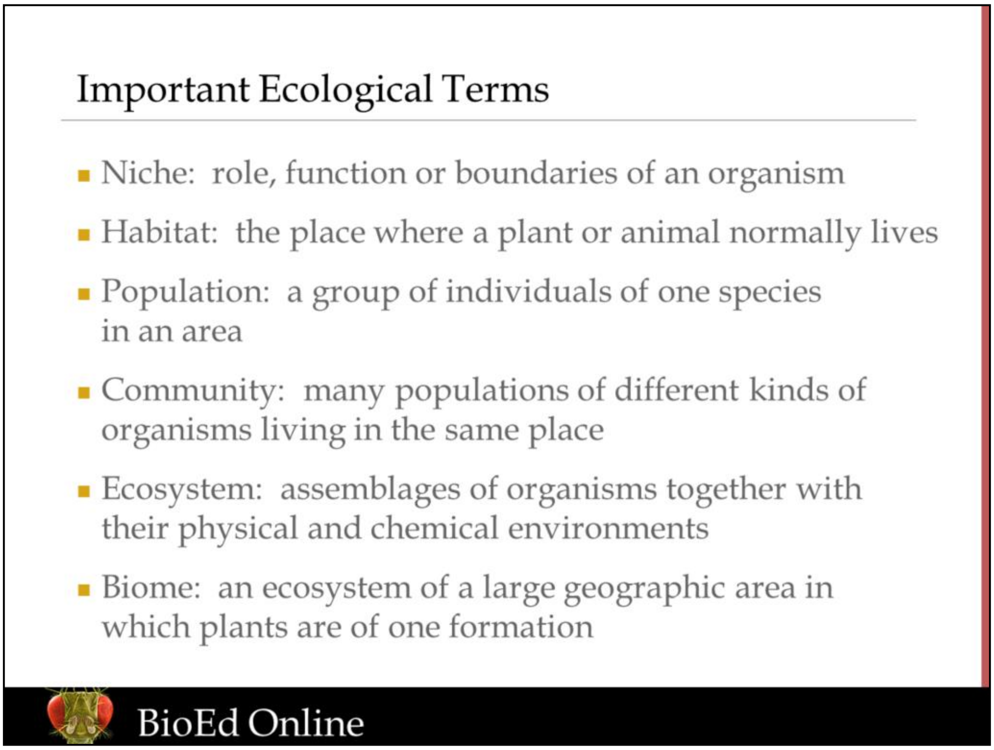


Image Reference:

U.S. Fish and Wildlife Service (Gary R. Zahm, photographer). Tule Elk Bulls. Retrieved 4-19-2004 from http://images.fws.gov/default.cfm?CFID=1536655&CFTOKEN=27457192



Important Ecological Terms

Niche: role, function or boundaries of an organism

Habitat: the place where a plant or animal normally lives

Population: a group of individuals of one species in an area

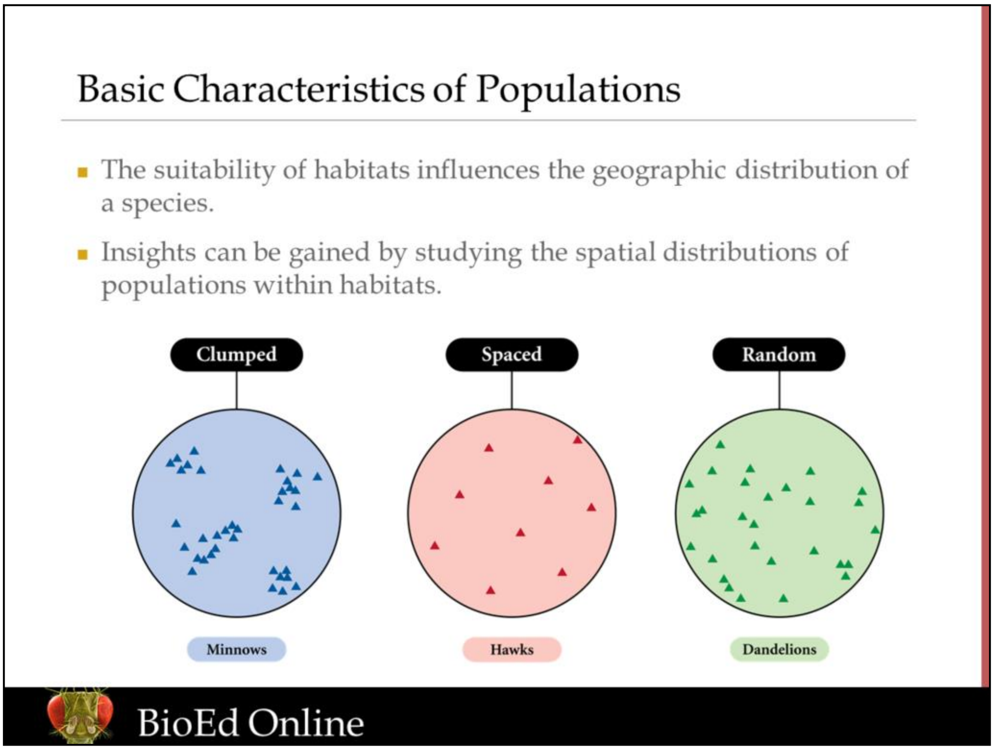
Community: many populations of different kinds living in the same place

Ecosystem: assemblages of organisms together with their physical and chemical environments

Biome: ecosystem of a large geographic area in which plants are of one formation and or defined by climate

Reference:

Ricklefs, R.E. & Miller, G.L. (2000). *Ecology* ,(4th ed.). NY: WH Freeman and Co.



Basic Characteristics of Populations

<u>Geographic Ranges</u>: The geographic range of a species depends on the suitability of the habitat, interactions with other species, and opportunities to colonize. The presence of a species shows that the habitat is suitable. However, the absence of a species from a habitat does not necessarily mean that the habitat is unsuitable for that species.

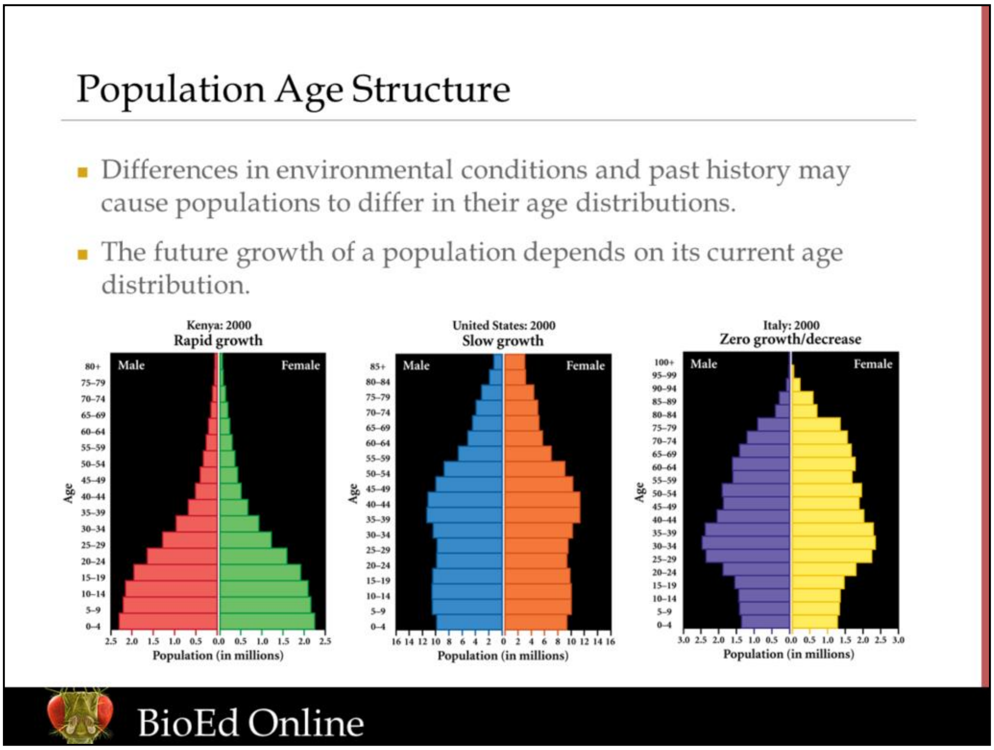
Spatial Distributions: Random distributions of individuals are those similar to Poisson distribution (probability distribution of discrete random variables), in which the locations of individuals are determined independently of each other. The clumping of populations may reflect locally suitable environmental conditions, clustering of offspring near parents, or social interactions. Uniformly spaced distributions may indicate strong competition within individual species.

Reference:

Ricklefs, R.E. & Miller, G.L. (2000). *Ecology* ,(4th ed.). NY: WH Freeman and Co.

Image Reference:

Baylor College of Medicine, Center For Educational Outreach. (2004).
Martha Young, Senior Graphic Designer.



Population Age Structure

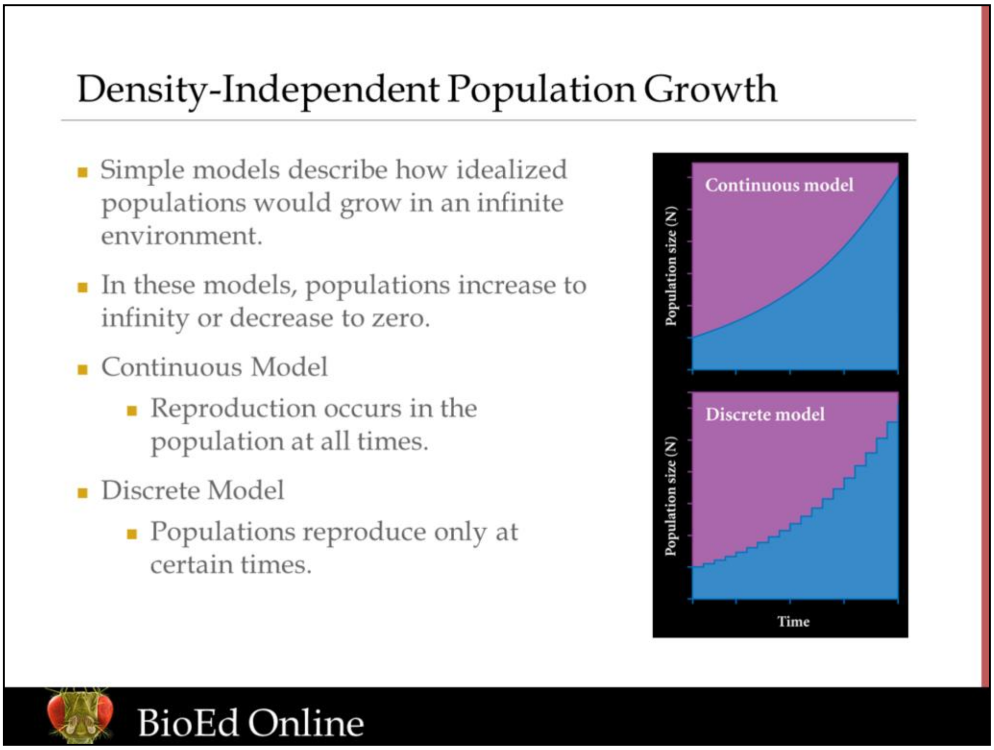
Differences in environmental conditions and past history may cause populations to differ in their age distributions. The future growth of a population will depend on its current age distribution if birth and death rates vary with age.

Reference:

Ricklefs, R.E. & Miller, G.L. (2000). *Ecology* ,(4th ed.). NY: WH Freeman and Co.
U.S. Census Bureau. (2003). International Data Base. Retrieved 4-13-2004 from http://www.census.gov/ipc/www/idbpyr.html

Image Reference:

Baylor College of Medicine, Center For Educational Outreach. (2004). Martha Young, Senior Graphic Designer.



Density-Independent Population Growth

Continuous population growth models use differential equations (population growth rate is represented as $dN/dt=rN_0$). Discrete models employ difference equations (time at some number of time steps in the future is a function of the current population size - $N_{t+1}=\lambda N_t$). In these simple equations, r and λ depend only on immigration, emigration, births and deaths.

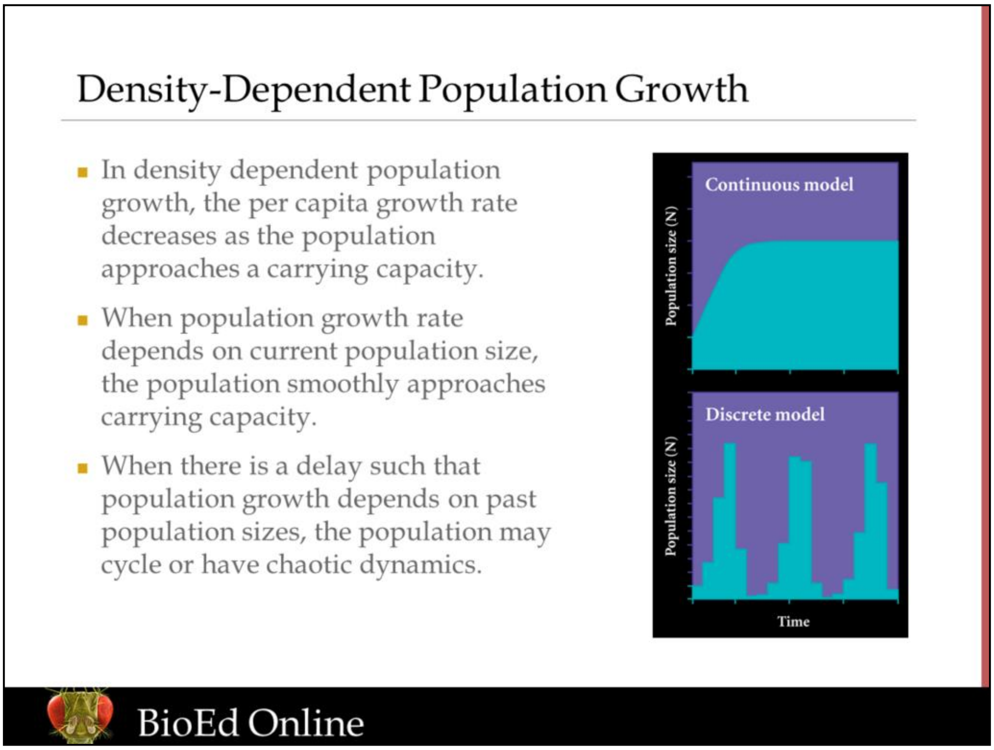
The dynamics of these models also are simple. If births exceed deaths ($\lambda>1$ or $r>0$), the population increases exponentially to infinity. If births are the same as deaths, the population stays constant. If deaths exceed births ($\lambda<1$ or $r<0$), the population decreases asymptotically to zero. The only difference in the dynamics of these two models is the shape of the population growth curve: smooth with continuous reproduction and stair-step when reproduction is discrete.

Reference:

Alstad, D. (2001). *Basic Populus models of ecology*. Upper Saddle River, NJ: Prentice Hall.

Image Reference:

Baylor College of Medicine, Center For Educational Outreach. (2004).
Martha Young, Senior Graphic Designer.



Density-Dependent Population Growth

To represent an environment that is not unlimited, models incorporate a carrying capacity ("logistic growth models"). When the population is far from carrying capacity ("K"), density effects are minor. As the population approaches carrying capacity, using the continuous time model, per capita population growth rate decreases towards zero. When the population is greater than carrying capacity, per capita population growth is negative. This causes populations to approach carrying capacity smoothly.

Although per capita population growth rate is highest when the population is small, overall population growth rate is highest at half of carrying capacity ("maximum sustained yield"). At low population sizes, per capita growth is high but few individuals are able to contribute to population growth. At population sizes close to K, per capita growth is close to zero.

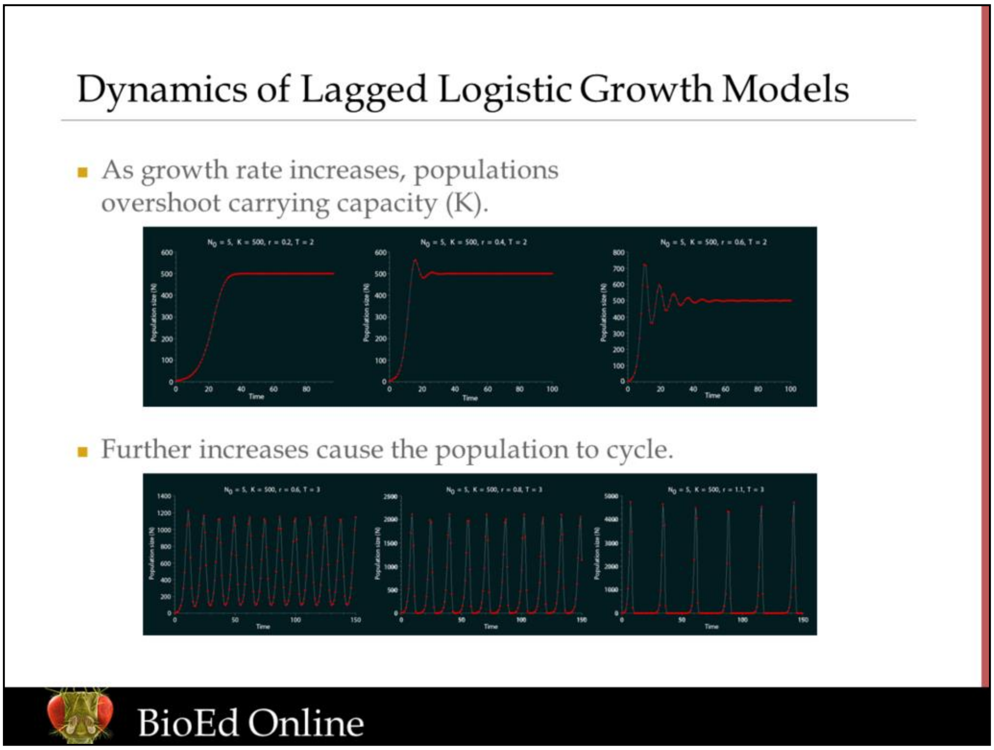
Complex dynamics can occur when there is a delay in the response of populations in relation to their densities. Delays between population growth and population density may be caused by fat storage, gestation or incubation, seed banks, or litter build-up. Discrete time models treat time as occurring in clear steps. As population growth rate increases, populations first overshoot carrying capacity but eventually reach carrying capacity. With increasingly high population growth rates, populations may cycle (boom and bust cycles). Populations with extremely high growth rates have chaotic dynamics. Models with reproduction occurring only at certain times (discrete models) show the same progression of dynamic behaviors as the time delay models.

Reference:

Alstad, D. (2001). *Basic Populus models of ecology*. Upper Saddle River, NJ: Prentice Hall.

Image Reference:

Baylor College of Medicine, Center For Educational Outreach. (2004). Martha Young, Senior Graphic Designer.



Dynamics of Lagged Logistic Growth Models

Under the discrete-time model, populations often overshoot carrying capacity. These models help predict what happens when the effects of density dependence are not instantaneous.

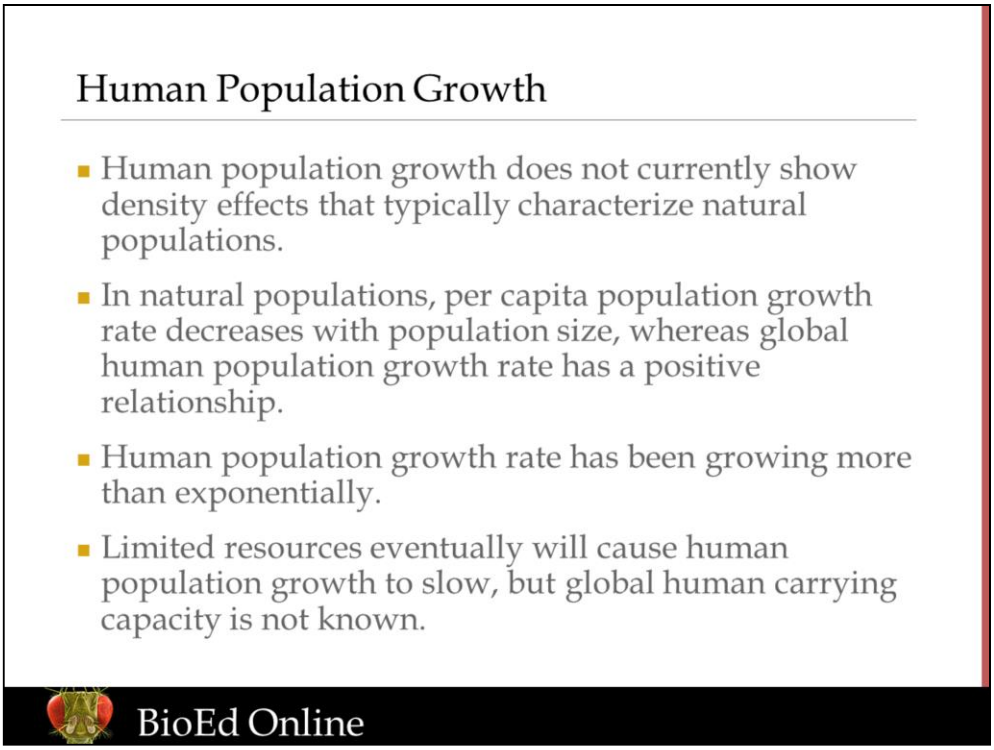
If there is a delay in feedback, a series of predictable behaviors occur as population growth increases. With a short delay in feedback, the population growth rate will smoothly approach the carrying capacity with small adjustments as shown in the top series of graphs. As population growth accelerates (shown in the second series of graphs), populations will begin to cycle in various periods such as 2 point, 4 point, 8 point, or 16 point cycle. As population growth rates cycle faster and faster, the population can enter into apparent chaos. However, at this point, even though the changes seem random, there is some regularity to the oscillations.

References:

Alstad D. (2001). *Basic Populus models of ecology*. Upper Saddle River, NJ: Prentice Hall.

Image Reference:

Baylor College of Medicine, Center For Educational Outreach. (2004). Martha Young, Senior Graphic Designer.



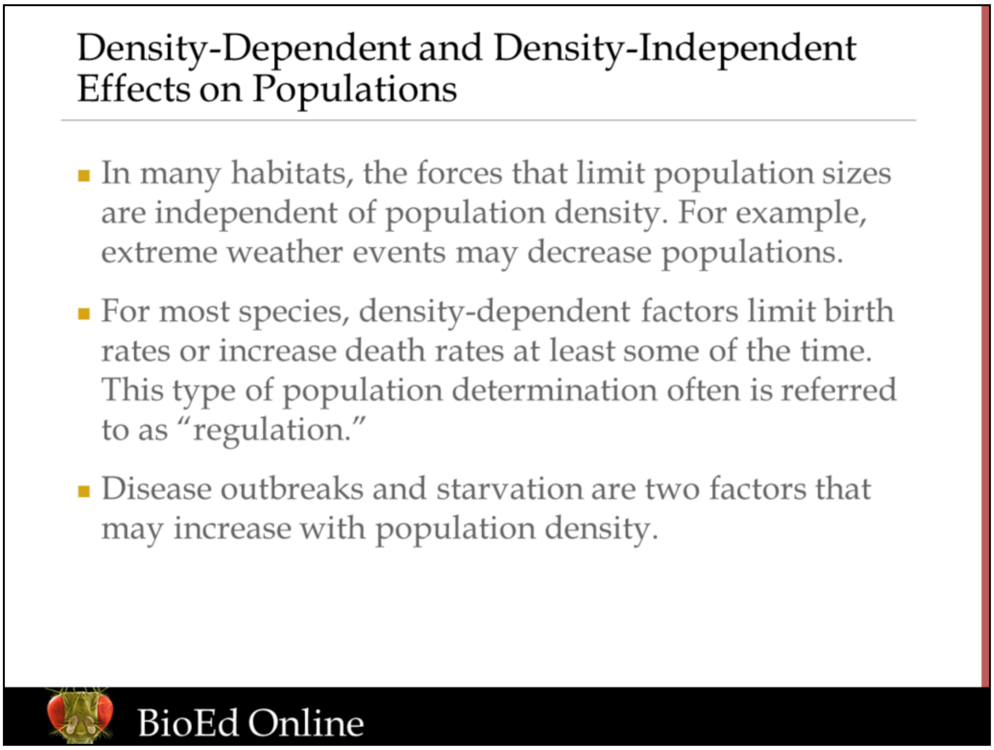
Human Population Growth

Current population projections are that there will be between 7 and 11 billion people on Earth by 2050. However, the carrying capacity of the earth may be smaller than this.

Estimates of global carrying capacity vary widely from several to hundreds of billions of people. The dominant standards of living (especially diet) have a large influence on estimates of global carrying capacity. Many scientists believe that the current world population already exceeds the carrying capacity if everyone were to have the current standards of living found in the United States.

Reference:

Towsend, C.R., Harper, J.L., & Begon, M. (2000). *Essentials of ecology*. Malden, MA: Blackwell Scientific.



Density-Dependent and Density-Independent

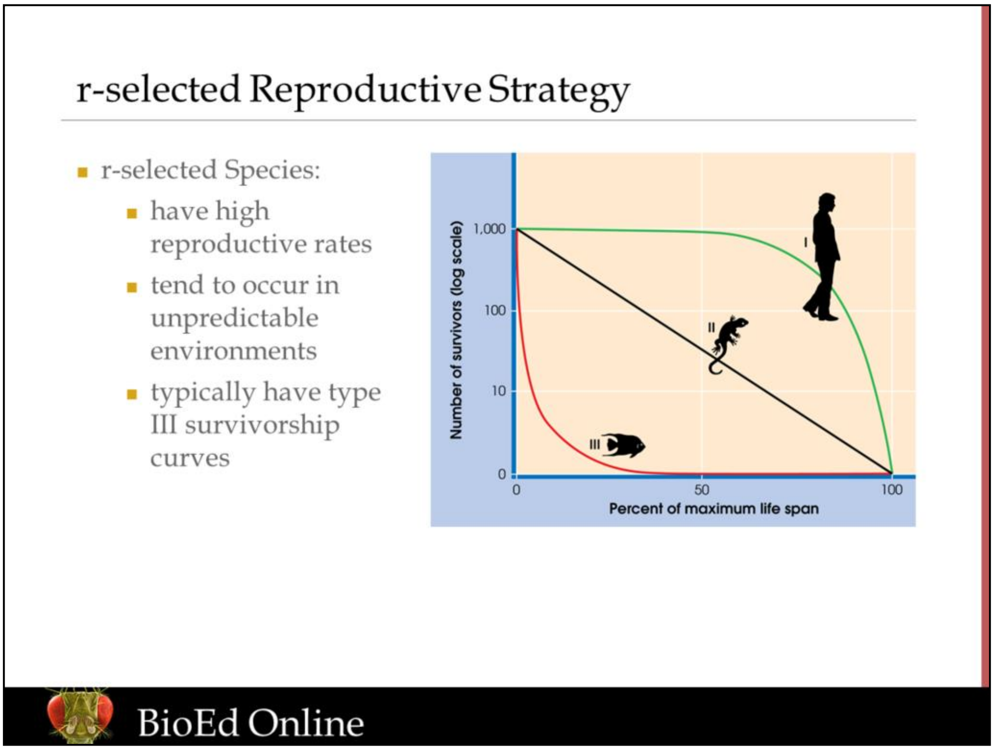
Density-independent factors are events and influences that affect the growth of a population, independent of the population's size. Often, these are environmental factors, such as extreme cold, drought, tornados, or volcanic eruptions. For many organisms, harsh abiotic conditions keep populations far from carrying capacity much of the time. Such species often show little density-dependent regulation.

Density-dependent effects of specialist herbivores and diseases are thought to be important in promoting the high diversity of tropical rain forests. Seedlings growing in the vicinity of their parents experience higher losses than those growing distant from conspecifics. In general, plants with a diverse range of other plants growing in their vicinity experience lower herbivory and disease than those growing in a monoculture. If plants are sown at high densities, the number of plants surviving decreases as they grow in stature (self-thinning).

Animals also show density-dependent regulation. As density increases, mortality decreases from limited food, higher disease frequencies, and other factors. Animals in crowded populations are less likely to breed, and their success in food-limited, crowded conditions is lower than in less crowded populations.

Reference:

Ricklefs, R.E. (2000). *The Economy of Nature* (6th ed.). NY: WH Freeman and Co.



r-selected Reproductive Strategy

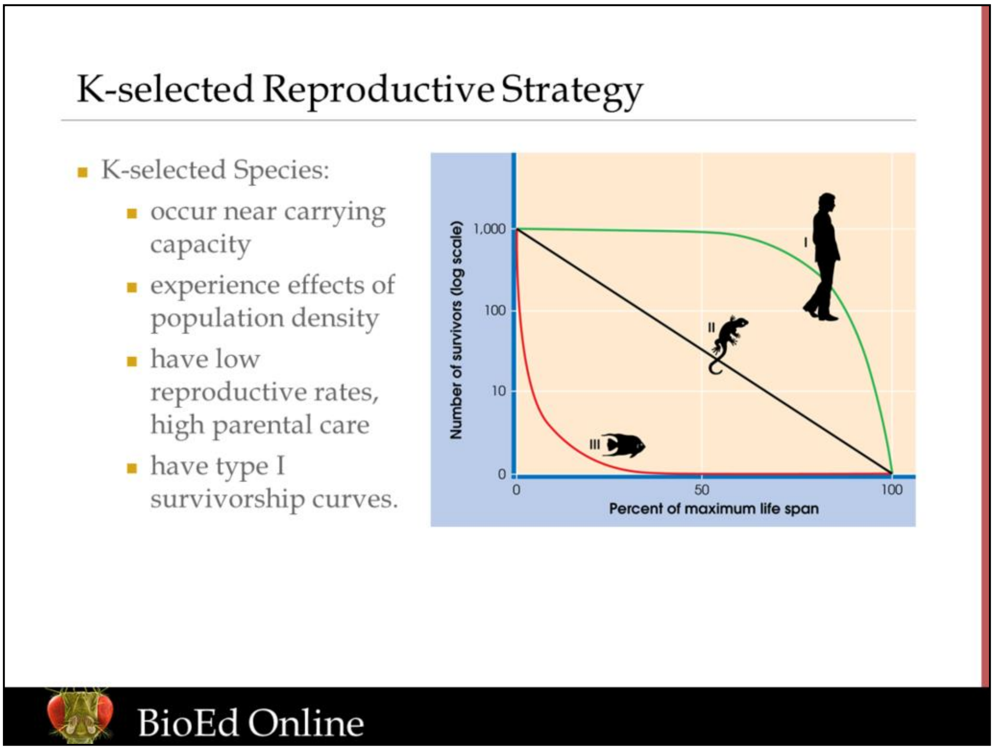
For r-selected species, “r” refers to the growth rate term in the logistic population growth model. For these species, population sizes and mortality tend to be variable and unpredictable. Since populations frequently are far from carrying capacity (“K”), intraspecific competition often is weak. Selection tends to favor individuals with rapid development, high and early reproduction that is not repeated, small body sizes, high resource requirements, and short lives. The potential for populations of *r*-selected species to grow is large.

Reference:

Pianka, E. (1970). On *r*- and *K* selection. *American Naturalist*, 104, 592-597.

Image Reference:

Baylor College of Medicine, Center For Educational Outreach. (2004). Martha Young, Senior Graphic Designer



K-selected Reproductive Strategy

In contrast, k-selected species have more constant mortality and population sizes that often are close to carrying capacity. Intraspecific competition tends to be strong. Selection favors slower development, late, repeated reproduction, long lives, and efficient use of resources.

Reference:

Pianka, E. (1970). On *r*- and *K* selection. *American Naturalist*, 104, 592-597.

Image Reference:

Baylor College of Medicine, Center For Educational Outreach. (2004). Martha Young, Senior Graphic Designer

Thank You

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