Populations & Communities

I. Introduction to Population & Community Ecology

Populations of organisms are **dynamic**. Some populations are in serious decline and are threatened with imminent extinction unless drastic action is taken, while other populations are experiencing unprecedented growth.

Did you know? *While the number of chimpanzees, our closest living relative, has declined from about 2 million in 1900 to less than 150,000 at present; our own population has increased by more than 4 billion in the same time frame.*

Changes in population numbers and in the patterns of distribution of individuals can have direct effects on the local ecosystem and may affect the well-being of other species within the ecological community.

- ⇨ **Population ecologists** use specialized methods to **monitor**, **quantify**, and **model** changes in populations.
- ⇨ They also study the **interrelationships** between different species. In this way, they gather data necessary to predict **future trends** in the growth of populations.
- ⇨ This information can be used to assess the health of individual species and entire ecosystems, to develop policies and plans of action to save species from extinction, and to address the impacts of rapidly growing populations.

II. Definitions

ECOLOGY: the scientific study of the **interactions** of **organisms** and their **environments**.

- ⇨ **Abiotic** (non-living) and **biotic** (living) factors are included in an organism's environment.
- ⇨ Organisms and their environments affect one another.

HABITAT: the place where an organism or species normally lives.

SPECIES: organisms that resemble one another in appearance, behavior, chemistry and genetic makeup, and that **interbreed** with each other under natural conditions to produce **fertile** offspring.

POPULATION: individuals of **one species** simultaneously occupying the same general area, utilizing the same resources, and influenced by similar environmental factors.

- ⇨ **Population ecology** studies groups of individuals of the same species in a particular geographic area.
- ⇨ Questions of population ecology concern factors that affect population size and composition.

COMMUNITY: **all** the **organisms** inhabiting a particular area; a collection of populations of different species living close enough together for potential interaction.

- ➪ **Community ecology** studies all organisms that inhabit a particular area and how they interact.
- ➪ Questions concern predation, competition and other interactions that affect community structure and organization (only biotic factors).

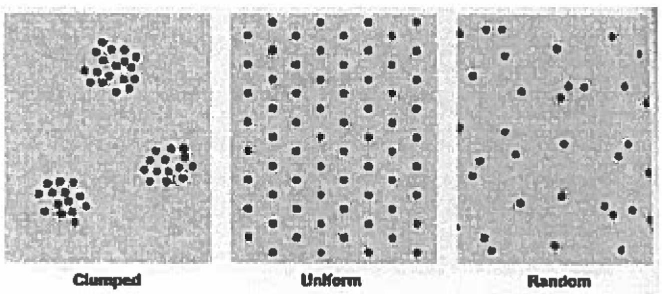
III. PATTERNS OF DISPERSION

RANGE: Geographic limits within which a population lives.

- ➪ Local densities may vary substantially because not all areas of a range provide equally suitable habitat.

POPULATION DISPERSION: the general pattern in which individuals are distributed through a specific area.

- Individuals exhibit a continuum of **three** general patterns of spacing in relation to other individuals.
- **Clumped dispersion:** the pattern in which individuals in a population are more concentrated in certain parts of a habitat.
  - May result from the environment being heterogenous, with resources concentrated in patches.
  - May be associated with mating or other social behavior.
  - **Example:** some types of fish are often found clumped in schools.
- **Uniform dispersion:** the pattern in which individuals are equally spaced throughout a habitat.
  - May result from competition between individuals that set up territories for feeding, breeding, or nesting.
  - **Example:** farmer's fields, orchards and tree plantations.
- **Random dispersion:** the pattern in which individuals are spread throughout a habitat in an unpredictable and patternless manner.
  - Results when individuals are minimally influenced by interactions with other individuals and when habitat conditions are also virtually uniform. **Not very common in nature.**
  - **Example:** some species of trees in tropical rain forests



IV. CHAOS THEORY

Making predictions and testing their accuracy is an important goal of science. For ecologists, it would be extremely useful to be able to predict accurately the number of individuals of every type of species that would make up a community. However, long-term predictions about the composition of communities are usually impossible. This is because of the many different factors that affect a community as it develops.

Community ecologists and scientists from many different disciplines, such as meteorology, have become interested in complex phenomena (such as storm patterns) which seem to defy long-term prediction.

- They have developed the **chaos theory** to examine why some features of nature prove to be so unpredictable.
- **Chaos theory**: small uncertainties at a short term lead to large, unpredictable changes over time and at bigger (larger) levels
    - tendency in universe toward disorder (i.e. chaos is a normal feature)
    - expected behaviors in complex systems may be unpredictable
    - based on mathematical models
- So, two communities or systems that appear similar at the start may end up being quite different in their **details**.
- **Factors:**
    - any small differences in the conditions that were present when the process began may be magnified
    - the relationships among the interacting parts of the phenomenon (community) can change as a result of the interactions themselves.

V. POPULATION GROWTH PATTERNS

A. Size and Density of Populations

Population Size: the number of organisms of the same species sharing the same habitat at a certain time.

- Statement of size includes – number of individuals, location and time period.
- Example: There were 29 students in Room 105 in 2003.

Population Density: the number of individuals per unit area or volume (space).

$$D = \frac{N}{S}$$

⊕ Since it is often impossible to count all individuals in a population, ecologists use a variety of sampling techniques to estimate densities and total population size.

- May count all individuals in a sample plot, or quadrant. Estimates become more accurate as sample plots increase in size or number.
- May estimate by indirect indicators such as number of nests or burrows, or by droppings or tracks.

Example: An island on Lost Point Lake supports a population of 375 deermice (*Peromyscus maniculatus*). If the area of the island in 15 ha, calculate the population density?

$$D = \frac{N}{S}$$

B. Changes in Population Density

- Δ Change in population density over time is called **Rate of Change (R)**.

$$\text{Rate of density change} = \frac{\text{change in density}}{\text{change in time}} \qquad R = \frac{\Delta D}{\Delta t}$$

where, ΔD = **density of most recent date – density of earlier date**

- Δ Positive (+) value indicates an **increase** in population density (growing)
- Δ Negative (-) value indicates a **decrease** in population density.

C. Human Population Growth

- Humans have employed their tool-making skills to successfully inhabit almost every terrestrial environment of Earth.
- Approximately 11,000 years ago humans began to cultivate food crops and domesticate livestock.
  - Resulted in first dramatic change in human population.
- Epidemic diseases evolved in large human populations.
  - As these populations spread around the world, they carried these deadly diseases to other human populations often with devastating consequences.
- Advances in science and technology revolutionized human understanding of biology, chemistry and physics and lead to the Industrial Revolution and rapid progress in food production, sanitation and medicine.
- These changes allowed humans to avoid the natural limits to growth that had existed for millions of years.
  - The results have been a dramatic decline in death rates – particularly among the very young – and a rapidly growing human population

Did you know? *The United Nations now estimates the world human population to be in excess of 6 billion people.*

D. Population Growth Patterns

Indefinite increases in population size do not occur. A population may increase rapidly from a low level under favorable environmental conditions, but this increase in numbers will eventually approach the level where resources cannot support continued increases. The combination of limited resources and other factors will stop the growth of a population.

Population Growth: when individuals are added to or removed from a population.

Four factors determine population size:

1. **Natality:** the number of offspring of a species born in one year.
2. **Mortality:** the number of individuals of a species that die in one year.
3. **Immigration:** the number of individuals of a species moving into an existing population. (IN)
4. **Emigration:** the number of individuals of a species moving out of an existing population. (EXIT)

$$Population\ Growth = \frac{(births\ +\ immigration) - (deaths + emigration)}{initial\ number\ of\ organisms} \times 100$$

$$PG = \frac{(b\ +\ i) - (d + e)}{n} \times 100$$

- PG is expressed as a percent (%).
- If the number of individuals that were born and migrated into the population is higher than the number of individuals that died and emigrated, the population will have positive growth, increasing in size.
- If the number of deaths and emigration exceeds the number of births and immigration, the population will experience negative growth, decreasing in size.
- The time period should also be considered to give us the **rate** (ex. -6.5% per month)

⇨ By knowing the PG, ecologists are able to forecast the population size in the future.

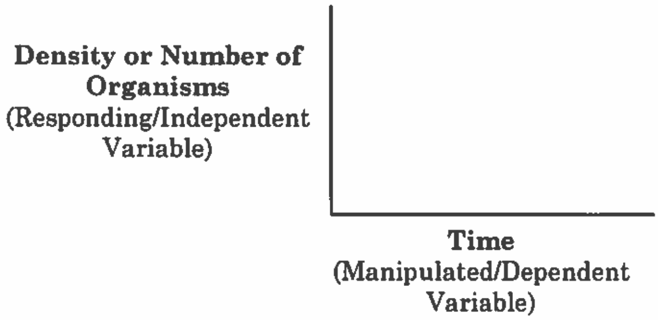
- o Provides predictions about how populations respond to changes in factors which affect population growth.

⇨ The type of growth exhibited by a population also depends on whether the population is open or closed:

- o **Open Population:** a population whose size and density is influenced by the factors of natality (b), mortality (d) and migration (i and e).
  - Example: Most wild populations
- o **Closed Population:** a population in which change in size and density is determined by natality (b) and mortality (d) alone, since immigration and emigration do not occur.
  - Example: Bacteria being monitored in a microbiology lab.

E. Graphs of Populations

Growth Curve: Records population changes over a specific length of time.



EXPONENTIAL GROWTH CURVE

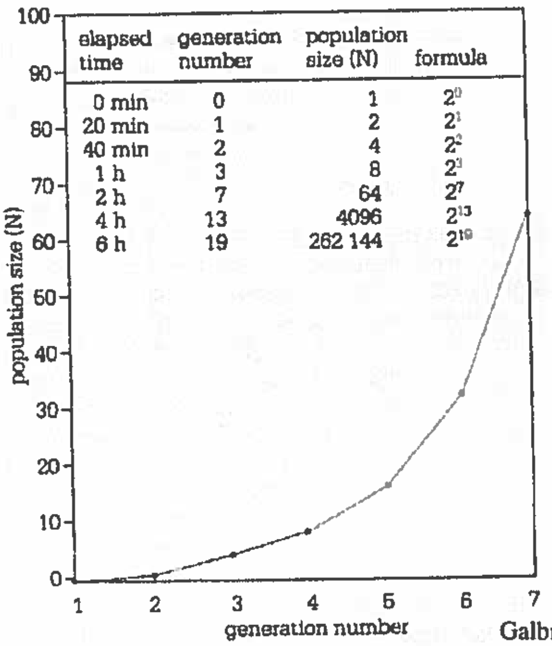
EXAMPLE: MICROBIAL GROWTH CURVES

Microbial populations show a characteristic type of growth pattern called exponential growth.

Exponential Growth: a pattern of population growth where organisms reproduce continuously at a **constant rate**. Populations of all organisms have the capacity for exponential growth.

Example: If a single bacterium, such as *Salmonella typhi* (which causes typhoid fever), were placed in a beaker (a **CLOSED** system) along with all of the nutrients it needed to live, after approximately 20 minutes it would likely reproduce by simply dividing in two (reproduce by **binary fission**).

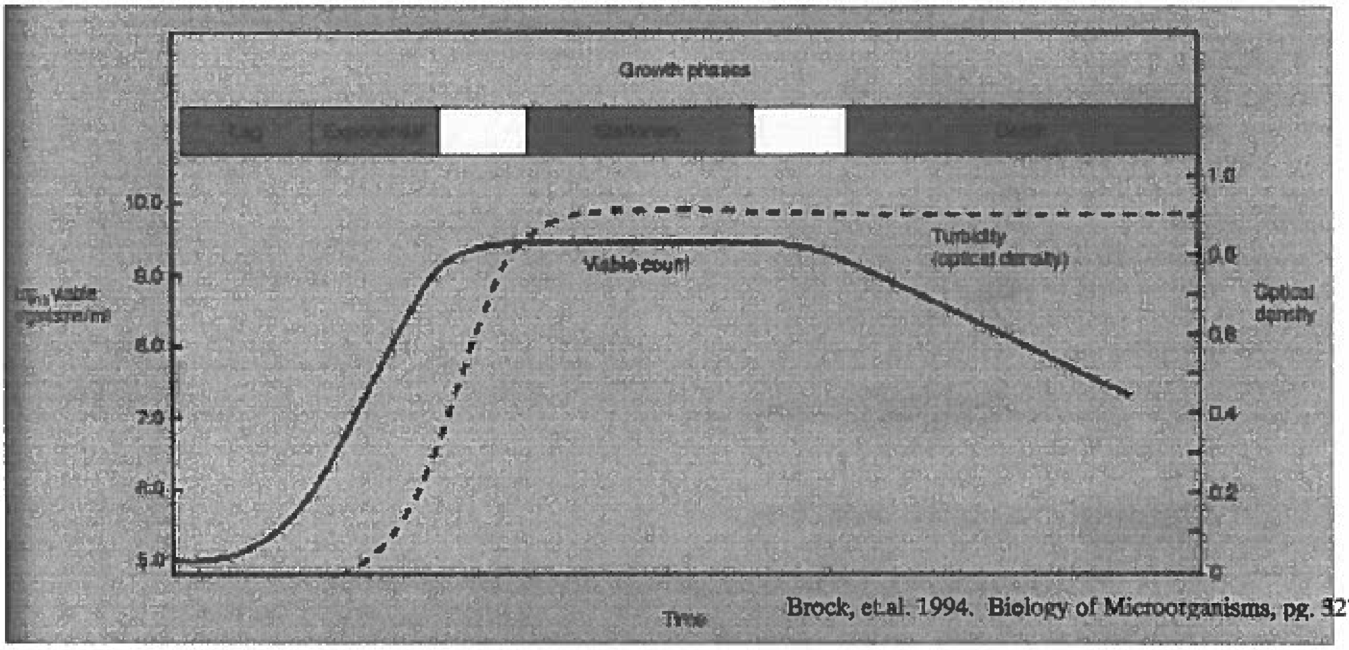
⇨ This is referred to as the "**doubling time**": the time taken for a population to double in size.



elapsed time	generation number	population size (N)	formula
0 min	0	1	2^0
20 min	1	2	2^1
40 min	2	4	2^2
1 h	3	8	2^3
2 h	7	64	2^7
4 h	13	4096	2^{13}
6 h	19	262 144	2^{19}

Galbraith, Biology Directions, pg. 591

A typical growth curve for a population of bacterial cells is illustrated below.



Brock, et.al. 1994. Biology of Microorganisms, pg. 327

This growth curve can be divided into several distinct phases: the lag phase, exponential growth phase, stationary phase and death phase.

Lag Phase: the cells are getting ready to divide

- ⇨ Adjustment period prior to growth phase.

Growth Phase: Growth is increasing at a fast rate (in case of bacteria – exponentially)

- ⇨ marks accelerated reproduction by the population
- ⇨ Natality exceeds mortality.

Stationary Phase: cell growth stops

- ⇨ There is no net increase or decrease in cell number
- ⇨ plateau: rates of natality = rates of mortality
- ⇨ In a closed system, exponential growth cannot occur indefinitely.

Did you know? *If a single bacterium with a doubling time of 20 minutes was allowed to grow exponentially for 48 hours, it would produce a population that weighed about 4000 times the weight of the Earth. This is particularly impressive since a single microbe weighs only about one-trillionth of a gram.*

- ⇨ Obviously something must happen to limit growth of the population long before this time. What generally happens is that either an essential nutrient of the culture medium is used up or some waste product of the organisms builds up in the medium to an inhibitory level and exponential growth ceases.

Death Phase: marks a constant decline in the population.

- ⇨ mortality exceeds natality

A population living under ideal conditions will increase at the fastest rate possible; nutrients are abundant and only the physiological capacity of the individuals limits reproduction.

The **maximum population growth rate** is called the **Biotic Potential (r_{max})**.

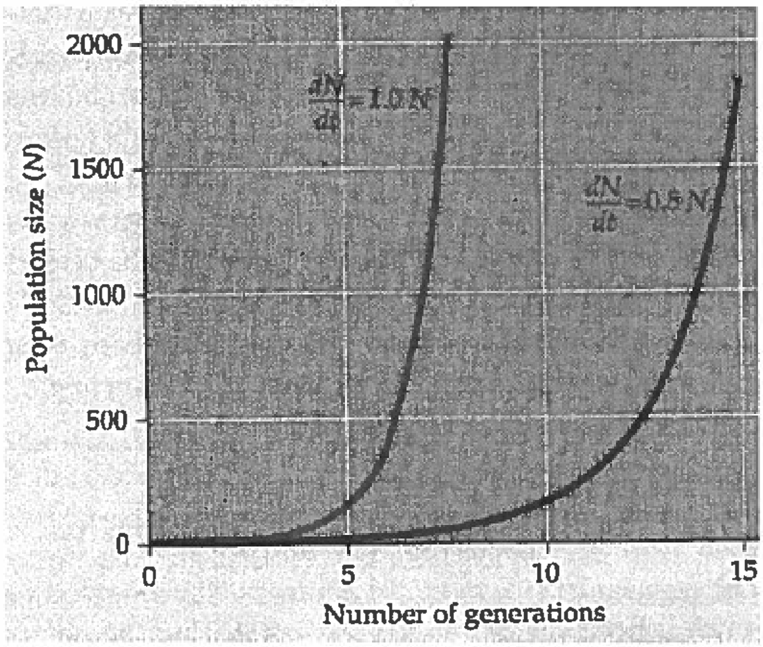
- theoretical maximum number of offspring that can be produced by a species under ideal conditions.
- Regulated by four factors:
  - **Offspring** – the maximum number of offspring per birth.
  - **Capacity for Survival** – the chances the organism's offspring will reach reproductive age.
  - **Procreation** – the number of times per year the organisms reproduces.
  - **Maturity** – the age at which reproduction begins.

Exponential population growth is the **population increase** (textbook calls this "I") under ideal conditions due to r_{max}. It is expressed as:

$$\frac{\Delta N}{\Delta t} = r_{max} N$$

where $\frac{\Delta N}{\Delta t}$ is the population growth rate at a given time.

- The size of the population increases rapidly due to ideal conditions of unlimited resources.
- Produces a **J-shaped** Growth Curve.



Campbell, 5th Edition, pg. 1093

J-Shaped Curve Characteristics

- Unrestricted, rapid growth
- Full biotic potential (r_{max})
- Normally does not occur too frequently in nature because the natural environment does not support unchecked growth
- If there is not control results in a "crash" – exceeds **carrying capacity**. (see Figure 25.14 page 587 Nelson Text)

Opportunistic species often exhibit periods of exponential population growth.

- Sometimes referred to as **r-selected species** or populations because their growth rates are close to r_{max}.
  - Usually have short generation times and high reproductive potentials.
  - Offspring grow rapidly.
  - Environments are unstable and unpredictable.
  - Example: insects, rabbits.

LOGISTIC GROWTH CURVE

As a population increases in size, the higher density may influence the ability of individuals to obtain resources necessary for maintenance, growth and reproduction.

- Populations inhabiting environments which contain a **finite** (limited) amount of available resources reach a size where further increases in number reduces the share of resources available to each individual.
- The carrying capacity (K) of a habitat is the maximum stable population size that the particular environment can support over a relatively long time period.
  - the maximum sustainable population.
- Environmental resistance: any factor which limits a population's ability to realize its biotic potential when it nears or exceeds the environment's carrying capacity;
  - includes all the factors that tend to reduce population numbers.
- Crowding and resource limitation can greatly effect the population growth.
  - If individuals cannot obtain sufficient resources to reproduce, birthrates (b) will decline.
  - If they cannot consume enough energy to maintain themselves, death rates (d) will increase.
  - A decrease in b and/or an increase in d results in a lower overall population growth rate (smaller r).

Logistic Population Growth

- ☆ Assumes the **rate of population growth (r)** slows as the **population size (N)** approaches the **carrying capacity (K)** of the environment.
- ☆ A mathematical model for logistic population growth incorporates the effect of population density on r, the equation for **logistic population growth** is:

$$\frac{\Delta N}{\Delta t} = r_{max} N \left(\frac{K - N}{K} \right)$$

K = carrying capacity

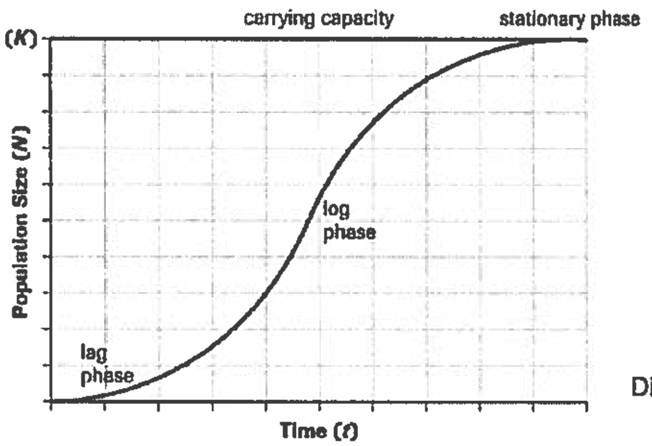
K – N = the number of new individuals the environment can accommodate

(K-N)/K = percentage of K available for population growth

☆ The implications of the logistic growth equation at varying population sizes for a growing population are:

- When N is low, (K-N)/K (the percentage of K available for population growth) is large and **r** (rate of population growth) is only slightly changed from r_{max}.
- When N is large and resources are limiting, (K-N)/K (the percentage of K available for population growth) is small; this reduces r (rate of population growth) substantially from r_{max}.
- When N=K, (K-N)/K is 0 and r=0; this means the number of births = number of deaths and zero population growth occurs.

The logistic model of population growth produces an **S-shaped** (Sigmoidal) growth curve.



Di Giuseppe, et. al. Biology 12. pg. 668

☆ Intermediate population sizes add new individuals most rapidly since the breeding population is of a substantial size and the habitat contains plentiful amounts of resources and available space.

☆ As N approaches K, the growth rate slows due to limitations in available resources.

☆ Typical of an organism in a new environment.

☆ **Example:** The numbers of male fur seals with "harems" on St. Paul Island in Alaska, were greatly depressed by hunting until 1911. After hunting was banned, the population increased dramatically and now hovers around an equilibrium number, presumably the islands carry capacity for the species.

Equilibrial species may experience population growth similar to that predicted by the logistic model.

- Long generation times and small clutch sizes limit reproductive potential.
- Populations usually do not fluctuate drastically.
- Sometimes referred to as **K-selected species** since their populations tend to stabilize around the carrying capacity.

F. Population Strategies

Population ecologists suggest that different life history adaptations or strategies are favored under different environmental conditions.

- At **high population density**, selection favors adaptations that enable organisms to survive and reproduce with few resources. Thus, competitive ability and maximum efficiency of resources utilization are favored in populations that tend to remain at or near their carrying capacity.
    - **K-selected populations** (equilibrial populations) are those that are likely to be living at a density near the limit imposed by their resources (K, or carrying capacity).
- At **low population density**, adaptations that promote rapid reproduction, such as increased fecundity (the number of offspring produced per reproductive episode) and earlier maturity, are selected. High rates of reproduction, regardless of efficiency, are favored in this case.
    - **r-selected populations** (opportunistic populations) are likely to be found in variable environments in which population densities fluctuate, or in open habitats where individuals are likely to face little competition.

Table 52.3 Characteristics of Idealized *r*-Selected (Opportunistic) and *K*-Selected (Equilibrial) Populations

CHARACTERISTIC	*r*-SELECTED POPULATIONS	*K*-SELECTED POPULATIONS
Maturation time	Short	Long
Lifespan	Short	Long
Death rate	Often high	Usually low
Number of offspring produced per reproductive episode	Many	Few
Number of reproductions per lifetime	Usually one	Often several
Timing of first reproduction	Early in life	Late in life
Size of offspring or eggs	Small	Large
Parental care	None	Often extensive

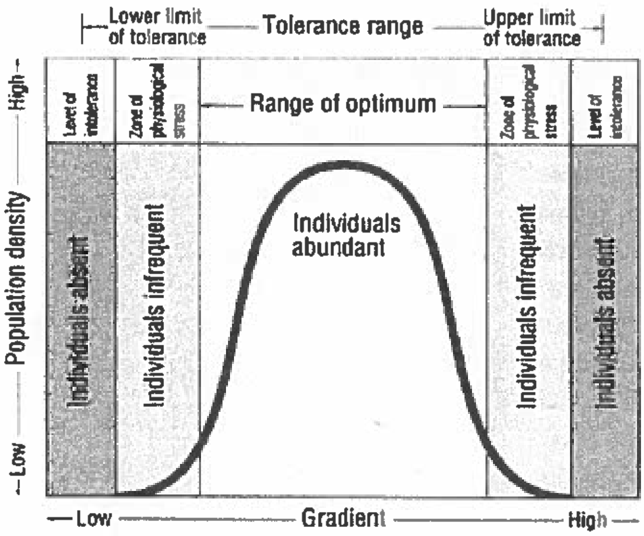
Campbell, 5th Edition, pg. 1097

VI. THE REGULATION OF POPULATIONS

The survival and reproduction of an organism depends on adequate supplies of nutrients and the ability of the organism to withstand many of the abiotic and biotic factors in the environment.

Law of Minimum: of the number of essential substances required for growth, the one with the minimum concentration is the controlling factor.

Shelford's Law of Tolerance: too little or too much of an essential factor can be harmful.



- There is an **optimum range** of conditions for maximum population size
- Growth occurs within this **range of tolerance**
- The greater the optimum range, the greater the survival variation within a population to tolerate extremes.

Ritter, et.al. Nelson Biology. 1993. pg. 588.

Populations are regulated by **density dependent factors** and **density independent factors,** either separately or in combination. The relative importance of these factors varies between opportunistic and equilibrial species and their specific circumstances.

A. Density Dependent Factors

Density Dependent Factor – a factor that influences population regulation, having a greater impact as population density increases or decreases.

- A density dependent factor that limits population growth is one that intensifies as the population increases in size.
- In restricting population growth, a density dependent factor affects a greater percentage of **individuals** in a population as the number of individuals increases; it will also affect each individual more strongly.
- Population growth declines because death rate increases, birth rate decreases or both.
- **Resource limitation** is one such factor
    - o A reduction in available food often limits reproductive output as each individual produces fewer eggs or seeds.

- Many **predators** concentrate on a particular prey when its population density is high, taking a greater percentage than usual (**predation** is a dd factor).
    - Some predators prefer one type of prey over another if that prey has a larger population and is easier to catch.
- **Disease** can be a significant density dependent factor that limits population size.
    - In dense or overcrowded populations, pathogens are able to pass from host to host with greater ease because there are more hosts available in close proximity to one another.
    - The population declines in size as a result of increased mortality.
    - **Example:** The over-crowding of farm animals can lead to the spread of disease, such as foot-and-mouth disease in cattle and encephalitis in poultry.

When the individuals of a population of the same species rely on the same resources for survival, intraspecific competition occurs.

Intraspecific Competition: an ecological interaction in which individuals of the **same species** or **population** compete for resources in their habitat.

- As the population density **increases**, there is more competition among individuals for resources and so the growth rate slows.
- **Example:** Consider a population of deer in a forested area. The forested area has a carrying capacity of 85 deer. When the population exceeds this carrying capacity, there is intense competition among the deer for remaining resources. Stronger deer that are able to obtain food will survive, while weaker deer will starve or risk death by moving from the area to seek another habitat with adequate resources.

- This intraspecific competition can have a pronounced effect on the **reproductive success** of individuals.
    - As competition for food increases, the amount of food per individual often decreases. This decrease in nutrition results in a decrease in an individual's growth and reproductive success.
    - **Example:** Harp seals reach sexual maturity when they have grown to 87% of their mature body weight. When the population density increases, the seals do not get as much to eat and do not reach the 87% body weight as fast as they would if the population density were lower. As a result, they reach sexual maturity at a slower rate, which decreases the potential number of offspring they might have.

B. Density Independent Factors

Density Independent Factor – factors that influence the population regulation regardless of population density.

- Affect the same percentage of individuals regardless of population size.
- Weather, climate and natural disasters are examples
- Human interventions (ex. insecticide and pesticide use) are density independent factors.

C. Population Cycles

Some bird, mammals and insect populations fluctuate with regularity (for example, lemmings show a 4-year cycle, snowshoe hares show a 10-year cycle).

⇨ Several hypotheses try to explain population cycles:

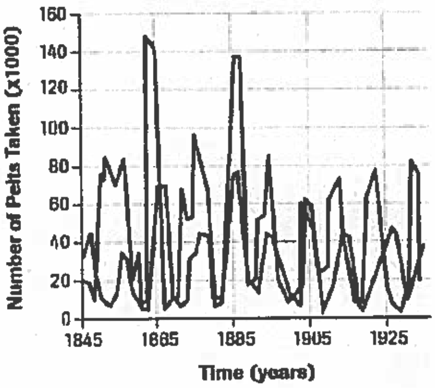
1. Crowding affects the organisms endocrine systems: stress from high density may alter hormone balance and reduce fertility, increase aggressiveness, and induce mass emigrations.
2. Caused by a time lag in the response to density-dependent factors, which cause the population to overshoot and undershoot the carrying capacity.
   - High density of snowshoe hares causes a deterioration of food quality.
   - May involve predation as an accessory factor.

⇨ In 1831, the manager of the Hudson's Bay Company in northern Ontario reported that there was a scarcity of rabbits and the local Ojibwa population was starving as a result. These were not rabbits but **snowshoe hares**, which experience a population decline at 10-year intervals.

⇨ Wildlife biologists began analyzing these 10-year cycles by plotting the fur-trading records of the Hudson's Bay Company in the early 1900s.

⇨ The most well-known quantitative analysis was derived from records of the Canadian **lynx**, which is a significant predator of snowshoe hares.

⇨ Adjustments to its population mirrors, with a slight time lag, changes in the snowshoe hare population.



Blue line = Canadian lynx
Red line = Snowshoe hair

Campbell, 5th Edition, pg. 1101

⇨ From 1986 to 1994, a research team led by Charles Krebs of the UBC experimentally manipulated snowshoe hare predators (lynx, coyotes and great horned owls) and hare foods (willow and birch plants) while monitoring snowshoe hare populations in areas of one square kilometer in the Yukon.

⇨ The results support the hypothesis that the 10-year cycles of snowshoe hares result from the combined effects of **predation** and **fluctuations** in the hare's **food sources.**

⇨ Other variables – such as changes in weather, presence of alternative prey during the low points of the hare cycle, and changes in the extent of trapping by humans – could also potentially influence this cycle.

VII. Analyzing Human Population Growth

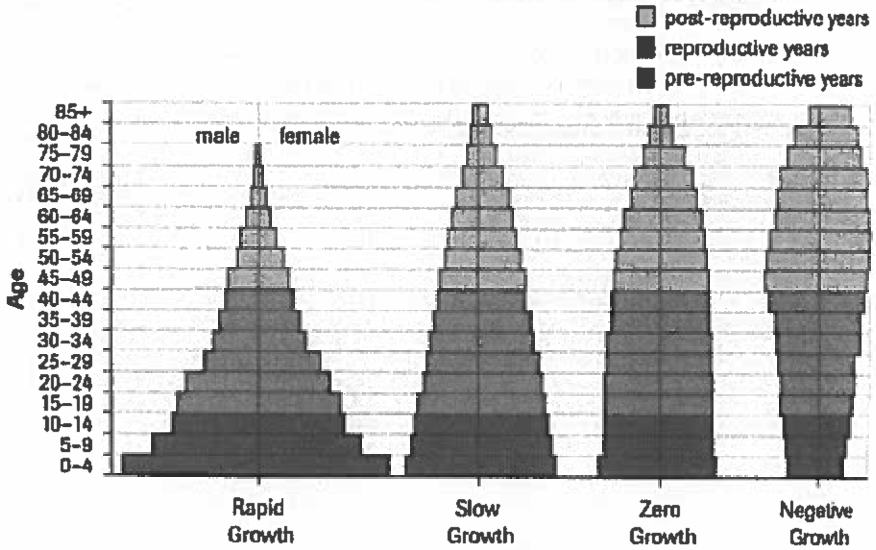
During the past 300 years the global human birth rate has declined slightly while the death rate has dropped dramatically. The result has been a population explosion.

- Birth rates and death rates vary significantly by region.

Country	Population (millions)	Annual birth rate per 1000 people	Annual death rate per 1000 people	Annual % growth rate of natural growth
Canada	31	11	8	0.3
Japan	127	9	8	0.1
Mexico	100	24	5	1.9
Philippines	77	29	6	2.3
France	59	13	9	0.4
India	1009	26	9	1.7

Di Giuseppe, et. al. Biology 12. pg. 706.

- **Age structure** within each country appears to be a major factor in the variation of population growth rates.
- The age structures of populations are often depicted as **population pyramids** or **histograms.**



Di Giuseppe, et. al. Biology 12. pg. 706.

- A relatively **uniform age distribution,** where individuals of reproductive age or younger are not disproportionately represented, lends itself to a **stable** population size.
- A population which contains a **large proportion** of **reproductive age** or younger individuals will face a sudden **increase** in rate of population growth in the future.
- **Zero population growth:** the condition in which the number of individuals added to a population from births and immigration equals the number of individuals removed from a population by deaths and emigration, resulting in a constant population size.

VIII. INTERACTIONS WITHIN COMMUNITIES

Interactions between individuals of the same species (intraspecific) and among individuals of different species (interspecific) in a community have important influences on population dynamics of individual species.

A. Definitions

COMMUNITY: consists of all the organisms inhabiting a particular area at a given time.

- A group of populations of different species living close enough together for potential interactions.

ECOLOGICAL NICHE: an organism's biological characteristics, including use of and interaction with abiotic and biotic resources in its environment.

- How an organism "fits into" an ecosystem.

B. Classifying Interactions

Although species interact in diverse ways, interactions between two species and their effects on population density can be classified into five categories.

INTERACTION		EFFECT ON POPULATIONS
COMPETITION		Interaction may be detrimental to one or both species.
PREDATION		Interaction is beneficial to one species and usually lethal to the other.
SYMBIOSIS	• **Parasitism**	Interaction is beneficial to one species, and harmful but not usually fatal to the other.
	• **Mutualism**	Interaction is beneficial to both species.
	• **Commensalism**	Interaction is beneficial to one species and the other species is unaffected.

C. Interspecific Competition

INTERSPECIFIC COMPETITION: interactions between individuals of different species for an essential common resource that is in limited supply.

- When two or more species rely on similar limiting resources. They may have negative effects on one another.
- As the population density of one species increases, it may limit the density of the competing species as well as its own.

GAUSE'S PRINCIPLE: states that no two species can occupy the same ecological niche without one being reduced in numbers or being eliminated.

- One will use resources more efficiently, thus reproducing more rapidly and eliminating the inferior competitor (aka "*Competitive exclusion principle*").

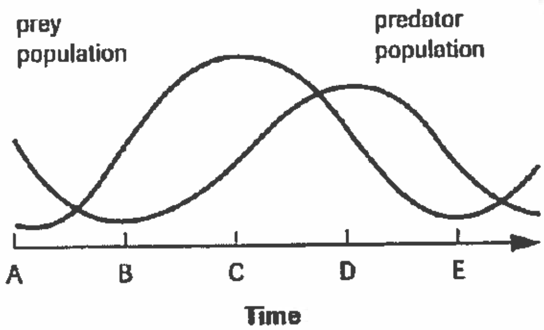
- The results of interspecific competition take on several forms:
  - The population size of the weaker competitor could decline.
  - One species could change its behavior so that it is able to survive using different resources.
  - Individuals in one population could migrate to another habitat where resources are more plentiful.
  - Interspecific competition is a driving force for populations of species to evolve adaptations that enable them to use resources for continued survival.

D. Predation

Predation is an example of an interspecific interaction in which the population density of one species – the predator – increases while the population density of the other species – the prey- declines.

PREDATION: A community interaction where one species, the predator, eats another, the prey. Includes both animal-animal interactions and animal-plant interactions.

- Predator-prey relationships can have significant effects on the size of both predator and prey populations.



- When the prey population increases, there is more food for predators and this abundance can result in an increase in the size of the predator population.
- As the predator population increases, however, the prey population decreases.
- The reduction of prey then results in a decline in the predator population, unless it has access to another food source.
- There are time lags between each of these responses, as the predator population responds to changes in prey abundance.

Defense Mechanisms

Animal defenses against predators include: hiding, escaping and physical or chemical defense and adaptive coloration.

MIMICRY: a phenomenon in which a *mimic* bears a superficial resemblance to another species, the *model*.

- Occurs in both predatory and prey species
- Defensive mimicry in prey usually involves developing a similar color pattern, shape or behavior that has provided another organism with some survival advantage.
  - **Example:** A palatable or harmless species mimics an unpalatable or harmful organism. (Palatable Viceroy butterfly mimics the poisonous monarch butterfly).
- Predators also use mimicry to lure prey

- o Example: The tongue of snapping turtles resembles a wriggling worm which attracts small fish into capture range.

CAMOUFLAGE: An adaptation in form, shape, or behavior that better enables an organism to avoid (hide from) predators.

- The inchworm caterpillar closely resembles a twig.
- The canyon tree frog uses coloration to make itself disappear into a granite background.

E. Symbiosis

Symbiosis, meaning "living together" refers to a relationship in which individuals of two different species live in close, usually physical, contact. At least one of the two species benefits from the association.

SYMBIOSIS: is a form of interspecific interaction in which a ***host*** species and a ***symbiont*** maintain a close association.

⇨ There are three types of symbiotic relationships:

1. MUTUALISM
   - A symbiotic relationship in which both organisms benefit
   - As neither is harmed, it is categorized as a +/+ relationship
   - **Example:** Bacteria live in the guts of herbivores, such as cows, deer and sheep. These animals do not produce the enzymes required to digest plant products such as cellulose. The bacteria secrete enzymes to break down these products into usable nutrients for the animals. In return, the bacteria are provided with nutrition themselves.
2. COMMENSALISM
   - A symbiotic relationship in which one organism benefits and the other organism is unaffected
   - It is categorized as a +/0 relationship
   - **Example:** Artic foxes follow caribou herds when they forage for food in their wintering grounds. The caribou have shovel-like feet that can remove snow from lichens on the ground, which is the caribou's primary food source. By removing the snow, caribou expose many small mammals, which are eaten by the foxes. Thus, the foxes benefit from this interspecific interaction and the caribou neither benefit nor are harmed by it.
3. PARASITISM
   - A symbiotic relationship in which one organisms (the ***parasite***)benefits at the expense of another organism (***host***), which is often harmed but usually not killed
   - It is categorized as a +/- relationship
   - Parasites live and feed on the most nutritious environments on Earth – the bodies of other living organisms – and **cannot complete their life cycle in the absence of their hosts.**

- By living on or in a host organism, parasites have access to a continuous supply of nutrients.
- Virtually all species of plants and animals are hosts to one or more species of parasite.
- While the best known and perhaps most important parasites are responsible for serious human diseases – such as malaria – the vast majority of parasites cause little or no significant harm to their host. This makes sense since it would mean harming the environment on which their own health relies.
- **Examples:** *Plasmodium* (which causes the disease malaria), tapeworms, fleas and lice.

IX. Succession in Communities

ECOLOGICAL SUCCESSION: a transition in species composition over time.

- Called **primary succession** if it begins in areas essentially barren of life due to lack of formed soil (ex. volcanic formations).
- Called **secondary succession** if an existing community has been cleared by some disturbance that leaves the soil intact (ex. forest fire).
- In some cases, the community passes through a series of predictable transitional stages (**seral stages**) to reach a relatively stable, final stage called the **climax community**.
- A variety of interrelated factors determine the course of succession.
    - Such as tolerance for general abiotic conditions of the area, which can differ on a fairly local level, as on opposite sides of a mountain.
- Early species are typically good colonizers with high fecundity and excellent dispersal mechanisms that may not compete well in established communities (**r-selected** species).
- Changes in community structure during succession may be induced by organisms themselves.
    - For example, alders lower soil pH as their dropped leaves decompose. The change in pH facilitates the entry of conifer trees, which require acidic soil.
- At **climax stage**, environmental conditions are such that one set of species can continue to maintain themselves.