



Chapter 8 Population Ecology



“It’s A Small World After All”

Outline

Population Dynamics and Carrying Capacity

- A. Populations change in size, density, and age distribution, most members of populations live together in clumps or groups
 - 1. Three general patterns of population distribution occur in a habitat: clumping, uniform distribution and random dispersion. Most species live in clumps or groups.
 - a. Availability of resources varies from place to place
 - b. Living in groups offers better protection from predators
 - c. Some predator species live in packs to better have a chance to get a meal
 - d. Temporary groups may form for mating and caring for young
 - 2. Uniform pattern distribution may occur where a resource such as water is scarce.
- B. Four variables influence/govern population size: births, deaths, immigration, and emigration.
 - 1. Increase in population occurs by birth and immigration.
 - 2. Decrease in population occurs by death and emigration.
 - 3. Age structure of a population is usually described as a pre-reproductive stage, the reproductive stage and the post-reproductive stage. A population with a large reproductive stage is likely to increase while a population with a large post-reproductive stage is likely to decrease.
- C. No population can grow indefinitely due to limited resources such as light, water, and nutrients and because of competitors or predators.
 - 1. The biotic potential is the population’s capacity for growth.
 - 2. The intrinsic rate of increase (r) is the rate of population growth with unlimited resources.
 - 3. Rapidly growing populations have four characteristics:
 - a. Individuals in the population reproduce early in life.
 - b. Individuals have short periods between generations.
 - c. Individuals have long reproductive lives.
 - d. Individuals reproduce multiple offspring each time they reproduce.
- D. Environmental resistance consists of factors that limit population growth.
 - 1. Carrying capacity (K) is determined by biotic potential and environmental resistance. This is the number of a species’ individuals that can be sustained indefinitely in a specific space.
 - 2. As a population reaches its carrying capacity, its growth rate will decrease because resources become scarcer.
- E. A population can grow rapidly with ample resources
 - 1. With few resource limitations, a population will have exponential growth. This is a fixed rate of growth that will take be a J-shaped growth curve as the base size of population increases. This represents its intrinsic rate of increase (r) or biotic potential.
 - 2. This exponential growth is converted to logistic growth when the populations gets larger and face environmental resistance. In logistic growth, the growth rate levels off as population size reaches or nears carrying capacity.
 - 3. The sigmoid (s-shaped) population growth curve shows that the population size is stable, at or near its carrying capacity.
- F. When population size exceeds its carrying capacity, organisms die unless they move or switch to new resources.
 - 1. Exponential growth leads to logistic growth and may lead to the population overshooting the environment’s carrying capacity.
 - a. Overshooting an environment’s resources often is a result of a reproductive time lag.
 - b. The reproductive time lag can produce a dieback/crash of organisms unless the organisms can find new resources or move to an area with more resources.
 - 2. If the carrying capacity of an area is exceeded, changes in the area itself can reduce future carrying capacity. Reducing grass cover by over-grazing allowed sagebrush to move in and reduce the number of cattle that the land could support.
 - 3. Technological, social, and cultural changes have extended the earth’s carrying capacity for human beings, for the time being.
- G. The density of a population may or may not affect how rapidly it can grow.
 - 1. Density-independent population controls affect a population’s size regardless of its density.

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These are abiotic factors in the community.

2. Density-dependent factors population controls have a greater affect on the population as its density increases. Infectious disease is an example of density-dependent population control.
- H. Population sizes may stay about the same; suddenly increase and then decrease, vary in regular cycles, or change erratically.
1. Four general types of population fluctuations in nature are: stable, irruptive, cyclic, and irregular.
 2. A stable population fluctuates slightly above and below carrying capacity and is characteristic of many species living under fairly constant environmental conditions.
 3. Some species have a fairly stable population size that may occasionally irrupt to a high peak and then crash to below carrying capacity. This is characteristic of short-lived, rapidly reproducing species.
 4. Cyclic fluctuations occur over a regular time period, generally a multiple year cycle.
 5. Irregular behavior is poorly understood. Some scientists attribute irregular behavior to chaos in the system, others disagree.
- I. Interaction between predators and their prey change in cycles, appear to be caused by species interactions, but other factors may be involved.
1. Hypothesis of top-down control of prey by predators may not be only explanation for cyclic boom-and-bust seen in these populations. May also be related to food supply of prey.
 2. Bottom-up control hypothesis is that plants consumed too rapidly by prey for replacement to keep up. Have crash of plant predators and that leads to crash of higher predators of the herbivores.
 3. Not mutually exclusive hypotheses, more probably have interaction between predation and food supplies.

Reproductive Patterns and Survival

- A. Some species reproduce without having sex and others reproduce by having sex.
1. Asexual reproduction does not utilize sex; each cell can divide and produce two identical cells that are replicas of the original cell.
 2. Sexual reproduction occurs when gametes from each parent combine to produce offspring with a combination of genetic traits from each parent.
 3. There are three disadvantages to sexual reproduction:
 - a. Males do not give birth, females have to produce twice the offspring to maintain the same number of young as an asexual organism
 - b. Chance of genetic errors/defects increase during splitting/recombination
 - c. Courtship/mating consume energy and time, transmit disease, and inflict injury on males in some cases.
 4. Two important advantages are genetic diversity for survival of species in face of changes in environment/ males may help with food gathering/ rearing of young.
- B. Reproductive patterns can be classified into two fundamental reproductive patterns, r-selected and K-selected species
1. r-selected species have a high rate of reproduction with little parental care. They have many, usually small offspring. Massive loss of offspring is compensated for by the large numbers of offspring each reproductive cycle.
 2. r-selected species are opportunists; reproduce when conditions are favorable or when disturbance opens a niche for invasion. Most species of this type go through irregular and unstable boom-and-bust cycles in population size.
 3. Competitor or K-selected species are at the other extreme. They produce later in life, have a small number of offspring, are born fairly large, are cared for and protected by parents, mature more slowly.
 4. K-selected species generally follow a logistic growth curve. Many of the larger species with long generation times/low reproductive rate are prone to extinction.
 5. Availability of suitable habitat for individuals of a population ultimately determines the population size.
- C. Populations of different species vary in how long individual members typically live.
1. A survivorship curve is one way to represent age structure of a population.

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2. Three generalized types of survivorship curves are: late loss, early loss, and constant loss
3. A life table shows the numbers of individuals at each age on a survivorship curve. Insurance companies use life tables to determine cost of insurance policies.

Summary

1. Population changes in size, density, makeup and distribution in response to environmental stress; but there is no direct relationship between the stressors and the population characteristics. Population distributed throughout a habitat varies from species to species. The age of a population may influence its size directly. The carrying capacity is determined by biotic potential and environmental resistance.
2. Reproductive patterns in species are influenced by ample resources and limited resources. Once resources become limited, the population must decrease over time. The patterns among specific species vary but there are four general types of population fluctuations: stable, irruptive, cyclic, and irregular.

More Depth: Conceptual Term Paper Topics

1. Population fluctuations in different species: K-strategist vs. r-strategist; advantages and disadvantages of each.
2. Habitat fragmentation and corridors.
3. Preservation of ecological integrity: the role of conservation biology.
4. Rehabilitation and restoration of ecosystems: success stories.

Objectives

1. Describe the various types of population distribution patterns that can occur in nature and comment on which is most common and why.
2. Define *birth rate*, *death rate*, *immigration*, and *emigration*. Write an equation to mathematically describe the relationship between these rates and the rate of population change.
3. Define *limiting factor*. Give an example of a resource that would be limiting in an ecosystem.
4. Define *exponential growth*.
5. Compare a J-shaped growth curve with a S-shaped growth curve and comment on the factors that produce the sigmoid (S-shaped) curve.
6. Define *carrying capacity* and explain what determines the carrying capacity of an ecosystem.
7. Explain density-dependent population controls and density-independent population controls.
8. List the four general types of population fluctuations in nature. Indicate which of these is most common.
9. Discuss the relationships between predators and prey and the possible interactions upon each other.
10. Define r-selected species and K-selected species and compare the two. Give an example for each type of species reproductive pattern.
11. Describe the three general types of survivorship curves in nature.

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Key Terms (Terms are listed in the same font style as they appear in the text.)

<i>age structure</i> (p. 162) asexual reproduction (p. 167) biotic potential (p. 163) <i>boom-and-bust cycles</i> (p. 166) <i>bottom-up control population regulation</i> (p. 166) carrying capacity (K) (p. 163) <i>clumping</i> (p. 162) <i>constant loss curves</i> (p. 169) <i>cyclic fluctuations</i> (p. 166) <i>density-dependent population controls</i> (p. 165) <i>density-independent population controls</i> (p. 165) <i>dieback (crash)</i> (p. 164) <i>dispersion</i> (p. 162) <i>early loss curves</i> (p. 169) environmental resistance (p. 163) <i>prereproductive stage</i> (p. 162) <i>random dispersion</i> (p. 162) <i>reproductive stage</i> (p. 162) <i>reproductive time lag</i> (p. 164) r-selected species (p. 167)	<i>exponential growth</i> (p. 163) intrinsic rate of increase (r) (p. 163) <i>irregular fluctuations</i> (p. 166) <i>irruptive population fluctuations</i> (p. 166) K-selected species (p. 168) <i>late loss curves</i> (p. 169) <i>life expectancies</i> (p. 169) <i>life table</i> (p. 169) logistic growth (p. 164) <i>opportunists</i> (p. 167) <i>overshoots</i> (p. 164) population density (p. 165) <i>population distribution</i> (p. 162) population dynamics (p. 161) <i>postreproductive stage</i> (p. 162) sexual reproduction (p. 167) <i>stable population fluctuations</i> (p. 166) survivorship curve (p. 169) <i>top-down control population regulation</i> (p. 166) <i>uniform dispersion</i> (p. 162)
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