Chapter 53: Population Ecology

53.1 Define a population and three characteristics of populations: density, dispersion, and demographics.

53.2 Describe the exponential model of population growth and its key assumptions.

53.3 Contrast the logistic and exponential models of population growth and define population carrying capacity.

53.4 Define life history and explain how life history traits are products of natural selection.

53.5 Contrast how density-dependent and density-independent factors affect population growth.

53.6 Describe the historical and recent growth of the human population.

The next three chapters on population, community, and ecosystem ecology provide the academic backbone for this unit on ecology. Each chapter considers a different organizational level in ecology, starting with population ecology. Before beginning your study of each chapter, be sure you have a clear understanding of the terms in the chapter title.

Study Tip: Graphs are used extensively to help explain concepts in population ecology, so make sure you pull all the information possible from the graphs you will encounter. Do not glance at the graphs, but carefully study them. Using Figure 53.1 in your text, list the two factors that increase population size and the two factors that reduce population size. Changes in populations over time tend to fall into three patterns. Do the graphs clearly indicate those patterns?

Concept 53.1 ***Biotic and abiotic factors affect population density, dispersion, and demographics***

LO 53.1 Define a population and three characteristics of populations: density, dispersion, and demographics.

1. What determines a population?

2. What pieces of data are needed to mathematically determine population *density*?

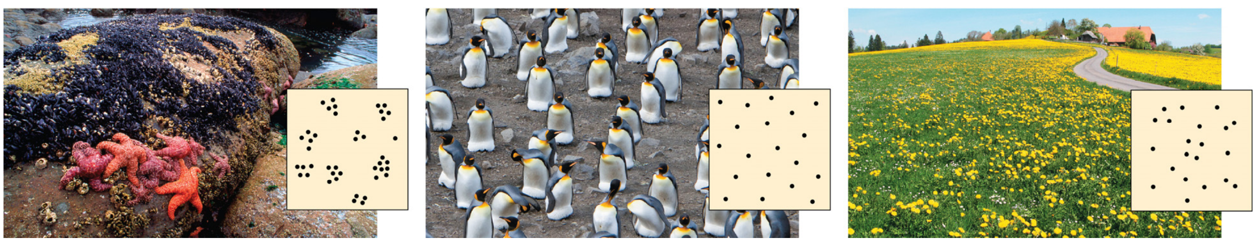
3. Work through Figure 53.2 in your text to determine a population size using the *Mark-Recapture Method.* Do the math to make sure you get the same answer as the text. Note and understand what the letters of the formula mean. Next, try the following problem.

A population ecologist wished to determine the size of a population of white-footed deer mice, *Peromyscus leucopus*, in a 1-hectare field. Her first trapping yielded 80 mice, all of which were marked with a dab of purple hair dye on the back of the neck. Two weeks later, the trapping was repeated. This time 75 mice were trapped, out of which 48 of the mice were marked. Using the formula $N = sn/x$, what is the population of mice in the field?

4. Explain the impact of *immigration* and *emigration* on population density. (To avoid confusion between these two terms, it might help to use this memory trick: ***i***mmigration is the movement ***i***nto a population, whereas ***e***migration is the ***e***xiting of individuals from a population.)

5. What is the difference between *density* and *dispersion*?

6. First, label the dispersion pattern shown by each population in the following figure. Second, and most important, what do the dispersion patterns tell us about the individuals in the population and their interactions?

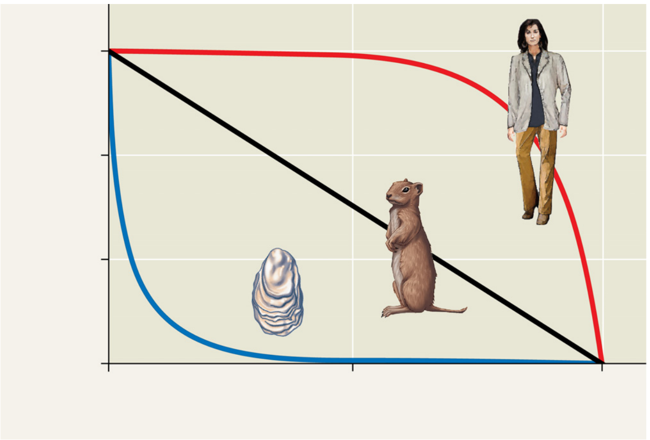


7. In which population statistics do *demographers* have a particular interest?

8. Population statistics are often summarized in a *life table.* Study Table 53.1 in your text to get an idea of the information that can be gleaned from one. For example, in what two age periods is the death rate highest? When is the reproductive rate highest?

9. Is your biology class a *cohort*? Explain.

10. *Survivorship curves* show patterns of survival. In general terms, survivorship curves can be classified into three types. Using the following figure, label and explain the three idealized survivorship patterns.



11. In the natural world, many species show survivorship curves that are combinations of the standard curves. How would an open nesting songbird's survivorship curve appear if it was Type III for the first year and then Type II for the rest of its life span? Sketch this curve on the survivorship curve graph in question 10.

12. Study Figure 53.6 in your text, then decide which breeding female turtle laid the eggs in nest #74. Justify your response.

Concept 53.2 The exponential model describes population growth in an idealized, unlimited environment

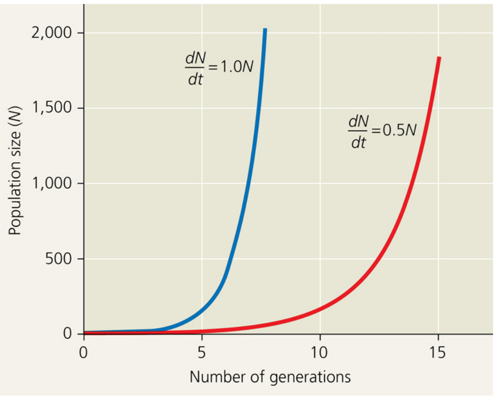
LO 53.2 Describe the exponential model of population growth and its key assumptions.

Do not let the math in this section be a problem. Instead of trying to understand the calculus involved, concentrate on the idea of exponential growth, how it is graphed, and what this type of growth indicates about a population.

13. What is the advantage to using per capita birth and death rates rather than just the raw numbers of births and deaths?

14. What does it mean for a population to be in *exponential population growth*?

15. In the following graph, explain why the line with the value of 1.0 shows a steeper slope that reaches exponential growth more quickly than does the line with the value of 0.5. On this graph, add a third line that approximates a population with an exponential value of 1.25.



16. What are two examples of conditions that might lead to *exponential population growth* in natural populations?

Concept 53.3 The logistic model describes how a population grows more slowly as it nears its carrying capacity

LO 53.3 Contrast the logistic and exponential models of population growth and define population carrying capacity.

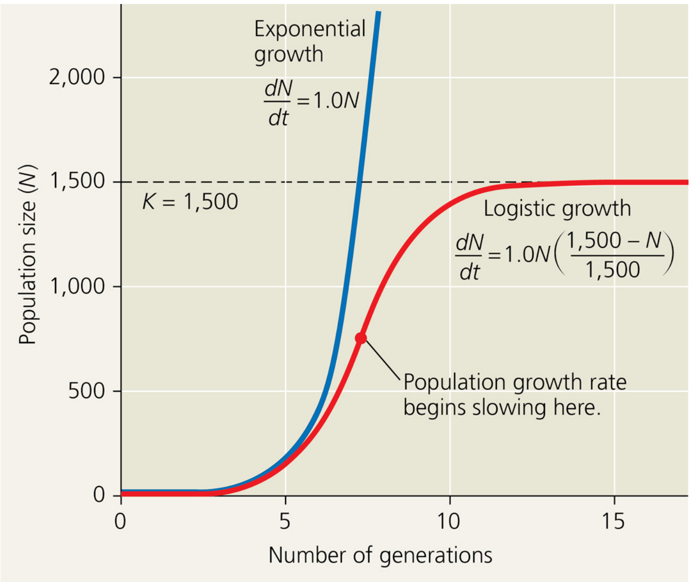
17. What is *carrying capacity*?

18. What are six examples of limiting resources that can influence carrying capacity?

19. In the *logistic population growth* model, the per capita rate of increase approaches zero as the________________ is reached.

20. If the carrying capacity (or K) is 1,000 and N is 10, the term $(K - N)/K$ is large. Explain why a large value for $(K - N)/K$ predicts growth close to the maximum rate of increase for this population.

21. In the following graph, explain why the logistic model predicts a sigmoid (S-shaped) growth curve when the population density is plotted over time. *Hint:* The critical part of this answer concerns why growth slows as N approaches K.



22. Why do populations in nature rarely match the predictions of the logistic growth model? Use an example in your explanation.

Concept 53.4 Life history traits are products of natural selection

LO 53.4 Define life history and explain how life history traits are products of natural selection.

23. On what is the *life history* of an organism based?

24. What three variables form the life history of a species?

25. Explain the difference between *semelparity (big-bang reproduction)* and *iteroparity (repeated reproduction)* as life history strategies.

26. Explain how two critical factors influence whether a species will evolve toward semelparity or iteroparity.

27. Refer to Figure 53.13 to explain the effect of offspring care on parental survival in kestrels.

28. The end of this concept attempts to bring together the ideas of life histories and growth models. This is done with the introduction of two new terms: *K*-selection and *r*-selection. Explain the ideas behind the creation of these two terms.

Keep in mind that the concepts of K-selection and r-selection represent two extremes in a range of possible life histories. Each species has its own unique life history strategy.

Concept 53.5 Density-dependent factors regulate population growth

LO 53.5 Contrast how density-dependent and density-independent factors affect population growth.

29. Compare and contrast these two terms:

    density-independent regulation

    density-dependent regulation

30. Explain how negative feedback plays an essential role in the unifying theme of regulation of populations. Does negative feedback play a role in both density-independent and density-dependent regulation?

31. Complete the following chart.

Density-Dependent Population Regulation

Negative Feedback Mechanism	Explanation	Example
Competition for resources		
Disease		
Predation		
Intrinsic factors		
Territoriality		
Toxic wastes		

32. Explain the *population dynamics* resulting from both biotic and abiotic factors that account for the fluctuations in the moose population on Isle Royale over the last 50 years.

33. Study the graph with Figure 53.19 in your text, then explain why the best current theory for the population cycling of snowshoe hare and lynx populations is predator-prey interaction.

34. Explain the importance of immigration and emigration in *metapopulations*.

Concept 53.6 The human population is no longer growing exponentially but is still increasing extremely rapidly

LO 53.6 Describe the historical and recent growth of the human population.

35. Summarize human population growth since 1650.

36. Look at Figures 53.21 and 53.22 in your text. If no population can grow indefinitely, how might density-dependent and density-independent factors affect human population growth?

37. What are two ways a stable population with zero population growth can be achieved?

38. What is *demographic transition*? In demographic transition, which falls first, birth or death rates?

39. You should be able to look at *age-structure graphs* and make predictions about the future growth of the population. Using Figure 53.23 in your text, describe the key features for the three age-structure graphs and predict how the population of each country will change.

Country	Key Features	Predicted Future Growth
Zambia		
United States		
Italy		

40. Why do *infant mortality* and *life expectancy* vary so greatly between certain countries?

41. Can the world's population sustain an *ecological footprint* that is currently the average American footprint? Justify your response.

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Now you should be ready to test your knowledge. Place your answers here:

1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____ 7. _____

8. _____ 9. _____

Answer to Question 3: 125 *P. leucopus*