Chapter 53: Population Ecology

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.

**Concept 53.1 Dynamic biological processes influence population density, dispersion, and demographics.**

1. What two pieces of data are needed to mathematically determine *density*?

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

3. Work through Figure 53.2 in your text, doing 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 $N = \frac{m}{n}l$, what is the population of mice in the field? (Answer is at the end of this Reading Guide chapter.)

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: immigration is the movement into a population, while emigration is the exiting of individuals from a population.)
5. 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 population and its interactions?

6. In what population statistics do demographers have a particular interest? How are these data often presented?

7. Is your biology class a cohort? Explain.

8. 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.
9. 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 8.

10. What does a reproductive table show?

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

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.

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

12. What will the per capita birth and death rates be if a population is demonstrating zero population growth?

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

14. 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.
15. 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**

16. What is carrying capacity?

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

18. In the logistic population growth model, the per capita rate of increase approaches zero as the ____________ is reached.

19. 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.

20. 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 \(K\).

21. 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.
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**Concept 53.4 Life history traits are products of natural selection**

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

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

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

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

26. Explain the effect of offspring care on parental survival in kestrels.

**Concept 53.5 Many factors that regulate population growth are density dependent**

27. Compare and contrast these two terms:

- *density-independent regulation*

- *density-dependent regulation*

28. 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?

29. Complete the following chart.

<table>
<thead>
<tr>
<th>DENSITY-DEPENDENT POPULATION REGULATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Negative Feedback Mechanism</strong></td>
</tr>
<tr>
<td>Competition for resources</td>
</tr>
<tr>
<td>Predation</td>
</tr>
<tr>
<td>Toxic wastes</td>
</tr>
<tr>
<td>Intrinsic factors</td>
</tr>
<tr>
<td>Territoriality</td>
</tr>
<tr>
<td>Disease</td>
</tr>
</tbody>
</table>

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30. Give both biotic and abiotic reasons for population fluctuations over the last 50 years in the moose population on Isle Royale, based on population dynamics.

31. Explain the importance of immigration and emigration in metapopulations.

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

32. Summarize human population growth since 1650. (Of all the reported statistics, which one surprises you the most?)

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

34. You should be able to look at age-structure graphs and make predictions about the future growth of the population. Using Figure 53.2 in your text, describe the key features for the three age-structure graphs and predict how the population of each country will grow.

<table>
<thead>
<tr>
<th>Country</th>
<th>Key Features</th>
<th>Predicted Future Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afghanistan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>United States</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

36. Can the world's population sustain an ecological footprint that is currently the average American footprint? Explain.

**Test Your Understanding Answers**

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

1. _______ 2. _______ 3. _______ 4. _______ 5. _______ 6. _______
7. _______ 8. _______ 9. _______ 10. _______

**Answer to Question 3:** 125 *P. leucopus*
Chapter 54: Community Ecology

Concept 54.1 Community interactions are classified by whether they help, harm, or have no effect on the species involved

1. What is a community? List six organisms found in your schoolyard community.

2. This section will look at interspecific interactions. Be clear on the meaning of the prefix! To begin, distinguish between intraspecific competition and interspecific competition. Give an example of each.

<table>
<thead>
<tr>
<th>Type of Competition</th>
<th>Explanation</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intraspecific competition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interspecific competition</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. What is G. F. Gause's competitive exclusion principle? Give one example.

4. Define ecological niche.

5. Several species of Anolis lizards live in the same types of trees and have a similar diet. Discuss resource partitioning to explain how interspecific competition is reduced. (Study Figure 54.2 in your text.)

6. What is the difference between the fundamental niche and the realized niche?

7. Study Figure 54.4 in your text, and then explain what is meant by character displacement. (To do this, you will have to learn or review the difference between sympatric populations and allopatric populations. You will find this information in Chapter 24.)
8. *Predation* is a term that you probably already know. Can you give examples of some predator-prey combinations as listed in the following chart?

<table>
<thead>
<tr>
<th>Predator</th>
<th>Prey</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal</td>
<td>Animal</td>
<td></td>
</tr>
<tr>
<td>Animal</td>
<td>Plant</td>
<td></td>
</tr>
<tr>
<td>Fungus</td>
<td>Animal</td>
<td></td>
</tr>
<tr>
<td>Bacteria</td>
<td>Animal</td>
<td></td>
</tr>
<tr>
<td>Fungus</td>
<td>Plant</td>
<td></td>
</tr>
</tbody>
</table>

9. List three special adaptations that predator species possess for obtaining food.

10. List three ways prey species elude predators.

11. Compare the two types of mimicry.

<table>
<thead>
<tr>
<th>Type of Mimicry</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Batesian</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Müllerian</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

12. What is *herbivory*?

13. Did you list any special herbivore adaptations for predation in your response to question 9? Or plant adaptations to avoid herbivory? List two adaptations for each category here.

14. Describe and give an example of each of the following interactions:

<table>
<thead>
<tr>
<th>Type of Interaction</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symbiosis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parasitism</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mutualism</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commensalism</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

15. Which category in the previous chart includes the other three? Note that other texts may define this term more narrowly.
16. Your text uses +/-/0 symbols to indicate how interspecific interactions affect survival and reproduction of the two species. Use this notation for each of these interactions.

<table>
<thead>
<tr>
<th>Type of Interaction</th>
<th>+/-, +/−, −/−, +/0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predation</td>
<td></td>
</tr>
<tr>
<td>Commensalism</td>
<td></td>
</tr>
<tr>
<td>Mutualism</td>
<td></td>
</tr>
<tr>
<td>Parasitism</td>
<td></td>
</tr>
<tr>
<td>Interspecific competition</td>
<td></td>
</tr>
<tr>
<td>Herbivory</td>
<td></td>
</tr>
</tbody>
</table>

**Concept 54.2 Diversity and trophic structure characterize biological communities**

17. What is species diversity? What are its two components? Why is it important?

18. What does an ecologist summarize in a food web?

19. Know the levels of trophic structure in food chains. Give an example food chain here, including four links that might be found in a prairie community, and tell the trophic level of each organism.

20. Name every organism in the pictured food chain, and give the trophic level in the box.
21. According to the *energetic hypothesis*, why are food chains limited in length? How much energy is typically transferred to each higher level?

22. What is a *dominant species*? For the area where you live, what would be considered a dominant tree species?

23. How is a *keystone species* different from a dominant species?

24. Name one keystone species, and explain the effect its removal has on the ecosystem.

25. Explain *facilitator* or *foundation species* and give an example. You may omit bottom-up and top-down controls.

**Concept 54.3 Disturbance influences species diversity and composition**

26. What is the *intermediate disturbance hypothesis*? Give an example of a disturbance event, and explain the effect it has on the community.

27. *Ecological succession* is the changes in species that occupy an area after a disturbance. What is the difference between *primary succession* and *secondary succession*?

**Concept 54.4 Biogeographic factors affect community diversity**

28. Explain *latitudinal gradients* in terms of species richness. Where is species richness greatest?

29. There are probably two key factors in latitudinal gradients. List and explain both here, and put a star next to the one that is probably the primary cause of the latitudinal difference in biodiversity.

30. Explain what is demonstrated by a *species-area* curve.

31. Renowned American ecologists Robert MacArthur and E. O. Wilson developed a model of *island biogeography*. While the model can be demonstrated with islands, any isolated habitat represents an island. What are the two factors that determine the number of species on the island?
32. What two physical features of the island affect immigration and extinction rates?

33. Why do small islands have lower immigration rates? Why do they have higher extinction rates?

34. Closer islands have ________ extinction rates and ________ immigration rates.

35. What is the island equilibrium model?

36. Use this model to describe how an island's size and distance from the mainland affect the island's species richness.

37. Label this figure to show immigration, extinction, island size, and equilibrium. Then explain what each figure shows.

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Concept 54.5 Pathogens alter community structure locally and globally

38. Let's pull a couple of ideas from this section: What is a pathogen?

39. What is a zoonotic pathogen? List three examples.

40. What is a vector? List three examples.

Test Your Understanding Answers

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

1. ________ 2. ________ 3. ________ 4. ________ 5. ________ 6. ________

7. ________ 8. ________