RLP-BIOB · RLP Biology B — Ecosystems, Evolution and Human Impact

Unit 1: Ecosystems: Carrying Capacity, Energy and Matter

Practice Workbook. The same problems, in the same order, as the Practice sections of the online lessons.

Name _____ Period _____

Lesson 1.1 — Phenomenon: The Elk Return to the Missouri Ozarks

FLUENCY

1. A population of 5,000 has 69 births and 51 deaths in a year (no migration). Find the growth rate per individual and the population after one year.

2. A population of 1,000 has 41 births and 12 deaths in a year (no migration). Find the growth rate per individual and the population after one year.

3. A population of 50 grows exponentially with a per-capita rate of 0.35 per year (continuous). Estimate its size after 11 years.

4. Classify each limiting factor as density-dependent or density-independent: (a) a disease that spreads between elk; (b) a severe frost; (c) competition for water at a single pond; (d) a wildfire.

APPLICATION

5. The Missouri Department of Conservation estimated about 125 elk in the Ozarks in 2014 and about 320 in spring 2024. Assuming exponential growth, find the per-capita growth rate r and the doubling time.

6. Using the logistic model with r = 0.2 per year and K = 500 (the top of the state's goal for the herd), find the yearly growth when the herd is 100, 250 and 450 elk.

7. Before it would allow an elk hunt, the state required at least 10% growth a year. The herd estimate rose from 207 in 2020 to 241 in 2021 (Missouri Department of Conservation estimates, both before calving). What was the percentage growth, and did it meet the benchmark?

CHALLENGE

8. If the herd kept growing exponentially at r = 0.094 per year from about 325 in 2026, how many elk would there be 10 years later? Use your answer to explain why exponential growth cannot continue in a fixed restoration area.

REVIEW

9. In corn, where purple kernels (A) are dominant to yellow (a), and in a trait where A (dominant) masks a (recessive), cross Aa × aa. Give the genotype ratio and the probability of the dominant phenotype.

Lesson 1.2 — Duckweed in a Cup: Measuring Population Growth

FLUENCY

1. A quantity starts at 2,500 and grows by 6% each year. Write a model and find its value after 5 years, to the nearest whole number.

2. A quantity starts at 8,000 and grows by 5% each year. Write a model and find its value after 10 years, to the nearest whole number.

3. A duckweed cup has 10 fronds on day 0 and 21 on day 3. What is the average number of new fronds per day, and the new fronds per day per starting frond?

4. Between days 15 and 18 the same cups went from 159 to 183 fronds. Find the new fronds per day per frond (use 159).

APPLICATION

5. Assuming exponential growth over the first three days (10 to 21 fronds), estimate the continuous growth rate r.

6. Using the illustrative data (high-nutrient cups reach about 194 fronds, low-nutrient about 79 by day 21), estimate K for each treatment and explain what the difference shows.

7. A student's low-nutrient cup was placed nearer the window than the others. Explain why this is a problem and how it could affect the conclusion.

CHALLENGE

8. In a logistic population, growth is fastest at N = K/2. Using the high-nutrient data (76 fronds on day 9, 120 on day 12), estimate when the cups reached K/2 and check that growth was fastest around then.

REVIEW

9. (Biology A) An ear from Pp × Pp has 420 kernels: 300 purple and 120 yellow. Test the 3 : 1 model with chi-square.

Lesson 1.3 — Why So Few Bobcats? The Energy Pyramid Argument

FLUENCY

1. Producers in an ecosystem capture 25,000 kJ of energy. Using the 10% rule, about how much energy reaches the primary consumers?

2. Producers in an ecosystem capture 50,000 kJ of energy. Using the 10% rule, about how much energy reaches the secondary consumers?

3. Producers in an ecosystem capture 50,000 kJ of energy. Using the 10% rule, about how much energy reaches the tertiary consumers?

4. Put these in order of trophic level, lowest first: red-tailed hawk, acorns, eastern chipmunk.

APPLICATION

5. Grass in a pasture stores 20,000 kJ/m^2 in a year and the deer grazing it store 1,500 kJ/m^2. What is the transfer efficiency, and how does it compare with the 10% rule?

6. A hawk population (third trophic level: grass, mice, hawks) needs 5,000 kJ a year. Using the 10% rule, how much energy must producers store to support it?

7. Germinating seeds warmed from 22.0 °C to 27.8 °C in 48 hours, while dry seeds warmed by 0.4 °C. Explain the difference and connect it to energy loss in food chains.

CHALLENGE

8. A field produces crops storing 10,000 kJ. Using the 10% rule, compare the energy people get by eating the crops directly with the energy they get by eating cattle fed the crops. What does this imply about how many people an area can feed?

REVIEW

9. (Biology A) How many grams of CO_2 are released when 36 g of glucose is completely respired aerobically? (glucose 180.16 g/mol, CO_2 44.01 g/mol)

Lesson 1.4 — Counting the Uncountable: Sampling Biodiversity and Populations

FLUENCY

1. Biologists mark 60 fence lizards and later catch 45, of which 9 are marked. Estimate the population.

2. 25 three-toed box turtles are marked; a second sample of 30 includes 6 marked. Estimate the population.

3. 120 trout are tagged; a later catch of 100 includes 16 tagged. Estimate the population.

APPLICATION

4. A quadrat has four species with 20, 5, 3 and 2 individuals. Calculate Simpson's diversity index.

5. A second quadrat has five species with 12, 8, 5, 3 and 2 individuals ($D \approx 0.75$). Explain why it is more diverse than the first, using richness and evenness.

6. In a mark-recapture study, marked squirrels learn to avoid the traps. Will the estimate be too high or too low? Explain.

CHALLENGE

7. In the Wolf Sheep Predation model with grass, reducing wolf-gain-from-food from 20 to 10 often makes the wolves die out, after which the sheep level off. Explain both results in terms of energy and carrying capacity.

REVIEW

8. For the data 12, 15, 17, 20, 21, 23, 23, 23, 39: find the mean, median, range and interquartile range. (Find the quartiles as the medians of the lower and upper halves, leaving out the overall median when the count is odd.)

Unit 1 checkpoint

1. Which graph shape shows logistic growth?
   A. A straight line rising
   B. A J-shaped curve that keeps getting steeper
   C. An S-shaped curve that levels off
   D. A horizontal line
2. With r = 0.4 and K = 500, a population of 100 grows by _____ per year.
3. True or false: A drought can lower an ecosystem's carrying capacity for a grazing species.
4. Which is a density-independent factor?
   A. Competition for food
   B. Disease spread by contact
   C. A severe drought
   D. Predation that increases with prey density
5. If producers store 50,000 kJ, about _____ kJ reach the secondary consumers under the 10% rule.

6. Which statement about ecosystems is correct?
   A. Energy and matter both cycle
   B. Energy flows through and is lost as heat; matter cycles
   C. Matter is lost as heat; energy cycles
   D. Neither energy nor matter is conserved

7. True or false: Decomposition in waterlogged, low-oxygen soil is usually faster than in well-drained soil.

8. Marking 40 animals and later catching 50, of which 8 are marked, gives an estimate of _____ animals.

9. Two communities each have four species. Community X has 10 of each; community Y has 37, 1, 1 and 1. Which has the higher Simpson's index?
   A. X
   B. Y
   C. They are equal
   D. Cannot tell

10. In the duckweed lab, why use three cups per treatment?
    A. To grow more duckweed
    B. To see how much results vary by chance and make the averages more reliable
    C. Because the fertilizer comes in threes
    D. To test three different nutrients

11. A population with r = 0.094 per year doubles about every _____ years.

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