



## Sustainability Education Research Project

### Managing the Deer Park: Quiz Answers

1. The deer herd grows at an effective rate of 40% (the annual birth rate is 50% and the annual death rate is 10%). If the initial herd size is 50 deer, how many deer will there be after the first **two** years?
  - 60 deer
  - 75 deer
  - 98 deer
  - 132 deer
  - 148 deer
  - Don't know
  
2. If the initial herd size is 50 deer, and each deer eats 1 unit of vegetation per year, how many units of vegetation will they eat in one year? (Ignore deer births and deaths.)
  - 50 units of vegetation
  - 100 units of vegetation
  - 150 units of vegetation
  - Don't know
  
3. If the whole deer park contains 1,000 units of vegetation, and each deer eats 1 unit of vegetation per year, what is the MAXIMUM number of deer it can support per year (its maximum capacity)?
  - 100 deer
  - 1,000 deer
  - 10,000 deer
  - Don't know
  
4. Which of the following statements do you think would be true if the deer population reached the maximum capacity of the park? Select all that apply.
  - The deer population would eat all the vegetation (serious overgrazing)
  - The vegetation will continue to regenerate itself
  - Overgrazing could cause a reduction in carrying capacity of the park
  - The deer population would not be sustainable at that level

5. A growth rate of 40% means the population doubles roughly every two years. If the deer population starts at 50, in how many years will the maximum capacity of the deer park be reached?
- In about 5 years
  - In about 7 years
  - **In about 9 years**
  - In about 11 years
  - Don't know

6. Please write a sentence or two to explain what you think the word 'sustainable' means in this sentence: 'the deer population in the deer park is sustainable'.

*Example answer: The deer herd will continue to thrive, without suffering from hunger or starvation, and collapse of the herd is avoided. The deer numbers do not exceed the capacity of the park (overpopulation), and so overgrazing is avoided. The deer park will remain capable of supporting the herd with vegetation able to replenish itself to provide a dependable food supply into the future indefinitely.*

7. In your opinion, is the deer population in the park, starting with 50 deer, sustainable over a 20 year period, if left to grow without any management intervention?
- Yes
  - **No**
  - Don't know
8. So far we have ignored the growth rate of the vegetation, which is about 10% per year. If there are 1,000 units of vegetation initially, **leaving aside the effect of the deer**, how many units will there be **in total** at the end of the first year?
- 800 units of vegetation
  - 1,000 units of vegetation
  - **1,100 units of vegetation**
  - 1,500 units of vegetation
  - Don't know
9. Following on from the last question, if you now take into account the consumption by the growing herd of deer, how many units of vegetation **in total** would you expect there to be at the end of the first year? Choose the most realistic answer, assuming that there 50 deer at the start of the year.
- About 1,030 units of vegetation
  - **About 1,040 units of vegetation**
  - About 1,050 units of vegetation
  - About 1,060 units of vegetation
  - About 1,100 units of vegetation

- Don't know, it is hard to estimate because the total number of deer changes during the year

*Comment: It might be tempting to choose the first option, 1,030. This would be calculated as 1000 units + 100 annual growth – 70 units consumed by deer (there would be 70 deer at the end of year 1). However, the number of deer starts at 50 and builds to 70 by year end, so less than 70 units would be consumed. Simulation estimates vegetation level at the end of year 1 at 1,040.*

10. What do you think is the carrying capacity of the deer park? (The carrying capacity of the deer park is the maximum deer population it can sustain long term.) Assume the park contains 1,000 units of vegetation and grows at 10% per year, and that deer eat 1 unit each of vegetation per year.

- 50 deer
- **100 deer**
- 500 deer
- 1,000 deer
- 2,000 deer
- Don't know

Please give reasons for your answer:

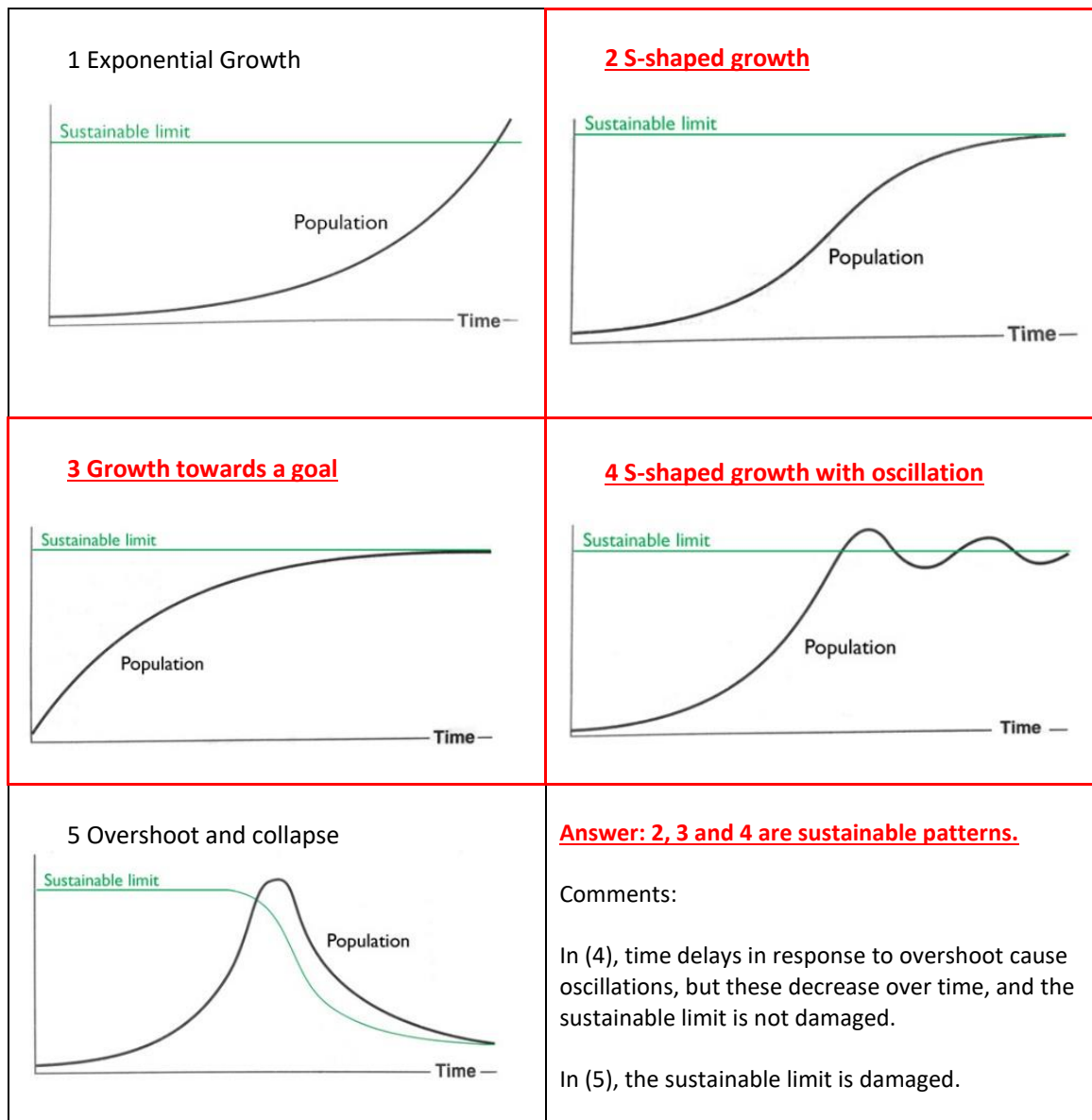
*Example answer: The carrying capacity is the number of deer that will eat the regrowth in vegetation. This is 100 units of vegetation. Each deer consumes 1 unit annually, so this means that the carrying capacity is 100 deer.*

11. Which of these conditions would result in an **increase** in the deer population over time? Select ONE OR MORE choices.

- Decrease in birth rate
- **Increase in birth rate**
- **Decrease in death rate**
- Increase in death rate
- Equal birth and death rate
- **Birth rate greater than death rate**
- Birth rate less than death rate

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12. The graphs below show common population growth patterns. The sustainable limit (green line) here means the carrying capacity. If not damaged, this will be a straight horizontal line. Which graphs show sustainable populations in your opinion? Select ONE OR MORE answers.



13. Is there an advantage in keeping the deer herd population stable?

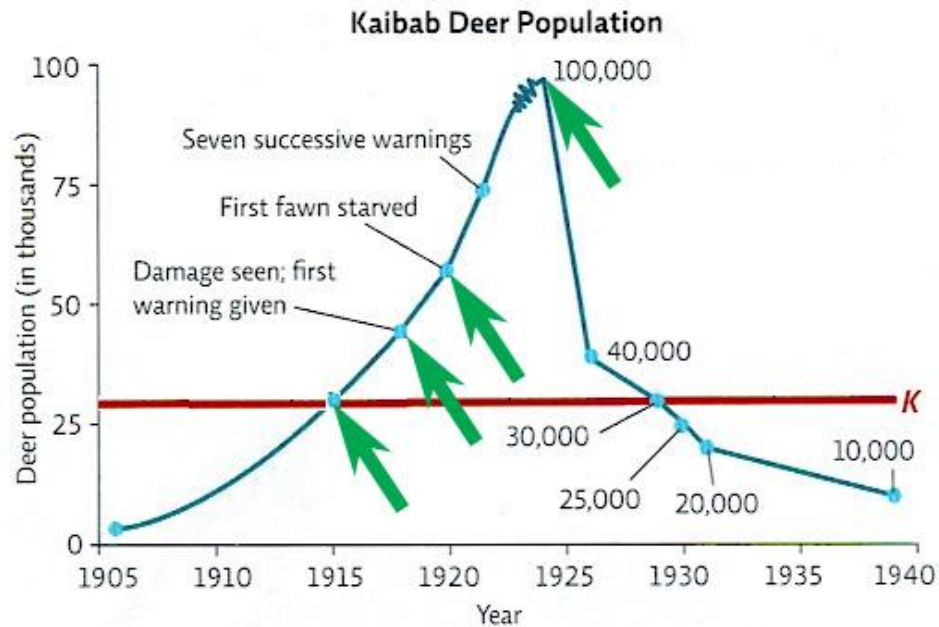
- No, there is no particular advantage, it can fluctuate
- Yes, deer reproduce rapidly so keeping the herd size stable prevents a possible explosion in numbers
- Don't know

14. What do you think were the TWO most important reasons for the overshoot and collapse of the Kaibab deer population?

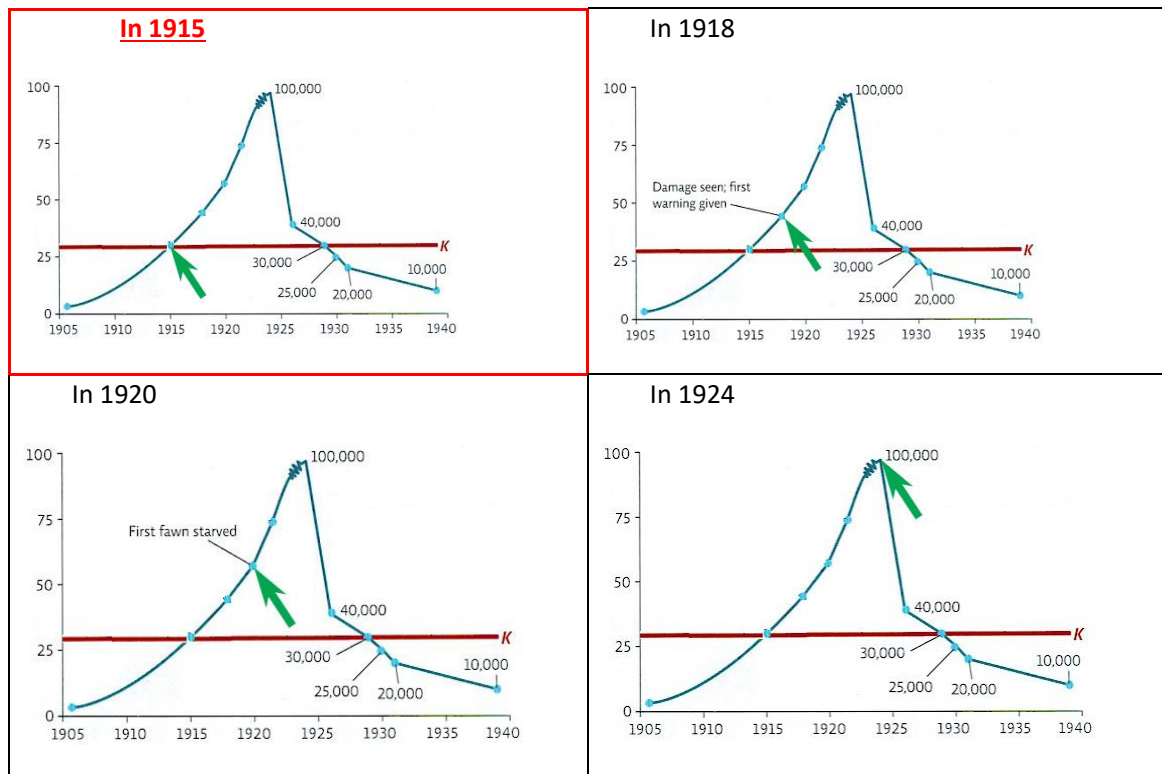
- The Kaibab plateau was a closed area
- Strong growth in deer population because of loss of predators and hunting

- Unpredictable factors such as weather and disease
- **Overgrazing**
- Don't know

15. The graph below shows the overshoot and collapse of the Kaibab deer population in the early 20th century. (The red line marked K is the estimated carrying capacity of the Kaibab plateau in 1905.)



Which arrow indicates the year that overgrazing began? Choose ONE answer below.



**Answer: In 1915, when the number of deer first exceeds the carrying capacity.**

*Comment: As soon as the population goes over the maximum sustainable herd size / carrying capacity, the renewable resource it depends upon (the vegetation) will be extracted faster than it can renew. This marks the beginning of the decline of the resource. The consequences of this are not seen for some time, though.*

16. If you think an initial deer population of 50 allowed to grow without intervention is NOT sustainable, which of the following measures do you think would be MOST effective in making it sustainable? (Choose up to THREE.)

- Start with a 50% smaller herd size
- **Decrease the birth rate of the deer using fertility reducing treatments**
- Double the size of the deer park
- Plant more vegetation for the deer to eat
- **Increase the death rate of the deer by introducing controlled culling or hunting, or reintroducing natural predators such as wolves**
- **Make sure that the deer population is never so big that it consumes more than the annual regrowth of vegetation**
- I don't agree that the deer herd is unsustainable

*Comment: The leverage points are population growth rate and limiting extraction of the renewable resource. The former is controlled by both birth and death rates. The other measures – reducing initial herd size, increasing park size or vegetation, don't address the dominant dynamic which is the exponential growth of the deer population, and so will not work long term. The simulation exercises demonstrate this.*