

The Bead Meadow: Deal the Grass, Count the Deer

Investigation question: If every deer needs a patch of meadow to survive and only lush patches have enough grass to raise a fawn, how large can a herd grow, what sets that limit, and what happens when a drought dries up half of the lush grass?

Collaborative systems modeling

Groups of 4

1 session

Setup 3 · Activity 42 · Cleanup 5 min

MS-LS2-1 · practice

MS-LS2-2 · practice

Name _____

Group _____

Date _____

Your role today

- ☐ **Meadow A dealer:** Shuffles the Meadow A deck each round, deals one card beside each deer, removes starved deer and adds fawns. Swaps with the recorder after round 6.
- ☐ **Meadow A recorder and checker:** Counts red cards, black cards and deer with no card aloud, fills the Meadow A row, and checks that deer at end = deer at start + fawns – starved before the next round begins.
- ☐ **Meadow B dealer:** Runs the scarce meadow the same way, and after round 10 runs the optional two-species trial if time allows. Swaps with the recorder after round 5.
- ☐ **Meadow B recorder and checker:** Fills the Meadow B table with the same arithmetic check, then reports the group's two levels to the class table.

Safety

- Beads and dried beans are a choking hazard: nothing goes in mouths, noses or ears. Raw dried beans, especially kidney beans, contain a natural toxin and must never be eaten.
- Beads that roll onto the floor are a slip hazard. Keep them on the mats or in the cups and pick up any that fall right away.
- Students with a legume allergy can use plastic beads instead of beans; handling dry beans rarely causes reactions, but there is no reason to take the chance.

Procedure

1. Before dealing anything, answer q1 and q2 on the recording sheet: sketch the shape you expect Meadow A's graph to have, and predict whether Meadow B will level off higher, lower or at the same number.
2. Split into two pairs. Pair A takes the Meadow A deck (16 red, 4 black) and mat; pair B takes the Meadow B deck (6 red, 14 black) and mat. Each pair puts 4 deer beads in a line on its mat and writes 4 in the 'Deer at start' box for round 1.
3. Run one round using the rule card. Shuffle the deck. Deal one card face up beside each deer, starting at the front of the line, until every deer has a card or the deck runs out. Deer with no card starve: count

- them and return them to the supply cup. Every deer beside a red card raises one fawn: add a bead at the end of the line. Deer beside a black card survive with no fawn.
4. The recorder counts red cards dealt, black cards dealt and starved deer aloud, fills the row, and checks: deer at end = deer at start + fawns – starved. Only then collect all the cards for the next shuffle. The deer at end become the deer at start of the next round.
 5. Pair A runs Meadow A for rounds 1 to 8. Pair B runs Meadow B for rounds 1 to 10. Swap dealer and recorder halfway.
 6. Drought in Meadow A. Before round 9, take 8 red cards out of the Meadow A deck and put them in the 'Dried-up patches' envelope. The deck is now 8 red + 4 black. Run rounds 9, 10 and 11 with this smaller deck.
 7. Rain returns. Before round 12, put the 8 red cards back into the Meadow A deck (16 red + 4 black again). Run rounds 12 and 13.
 8. Graph both meadows on the same axes: deer at end of each round against round number, one color per meadow. Shade rounds 9 to 11 lightly and label them 'drought'. Answer q3 to q5 together.
 9. Report your levels and the rounds you first reached them to the class table, then copy the class results onto your sheet.
 10. Optional, for a pair that finishes early: run a two-species trial. Start Meadow A again with 4 deer and 4 elk mixed in one line, use the full 16 red + 4 black deck and the same rules, and before each deal mix the line by pouring all the animals into a cup and spilling them back out. Record both species for 8 rounds on scrap paper and bring the numbers to the debrief.
 11. Count the beads (about 70 deer, 15 elk) and the cards (52) back into the bag. Answer the analysis questions on your own; finish them for homework if the period ends.

Record your observations

Lab 1 recording sheet: The bead meadow

Rule card: one round is one year — Each bead is one deer. Each card is one patch of meadow big enough to feed one deer for a year. A **red card is a lush patch**: enough grass for the deer to survive and raise one fawn. A **black card is a thin patch**: enough to survive, not enough to raise a fawn. (1) Shuffle the deck. (2) Deal one card beside each deer in the line until every deer has a card or the deck runs out. (3) A deer with **no card** finds no patch and **starves**: remove it. (4) A deer beside a **red card** raises a fawn: add one bead. (5) A deer beside a **black card** survives with no fawn. (6) Check: deer at end = deer at start + fawns – starved.

1. Prediction before you deal: sketch in the box the shape you expect Meadow A's graph of deer against rounds to have over rounds 1 to 8, and write one sentence explaining your sketch.

2. Meadow B has the same 20 patches as Meadow A, but only 6 of them are lush. Predict whether Meadow B's herd will level off higher, lower or at the same number as Meadow A's, and why.

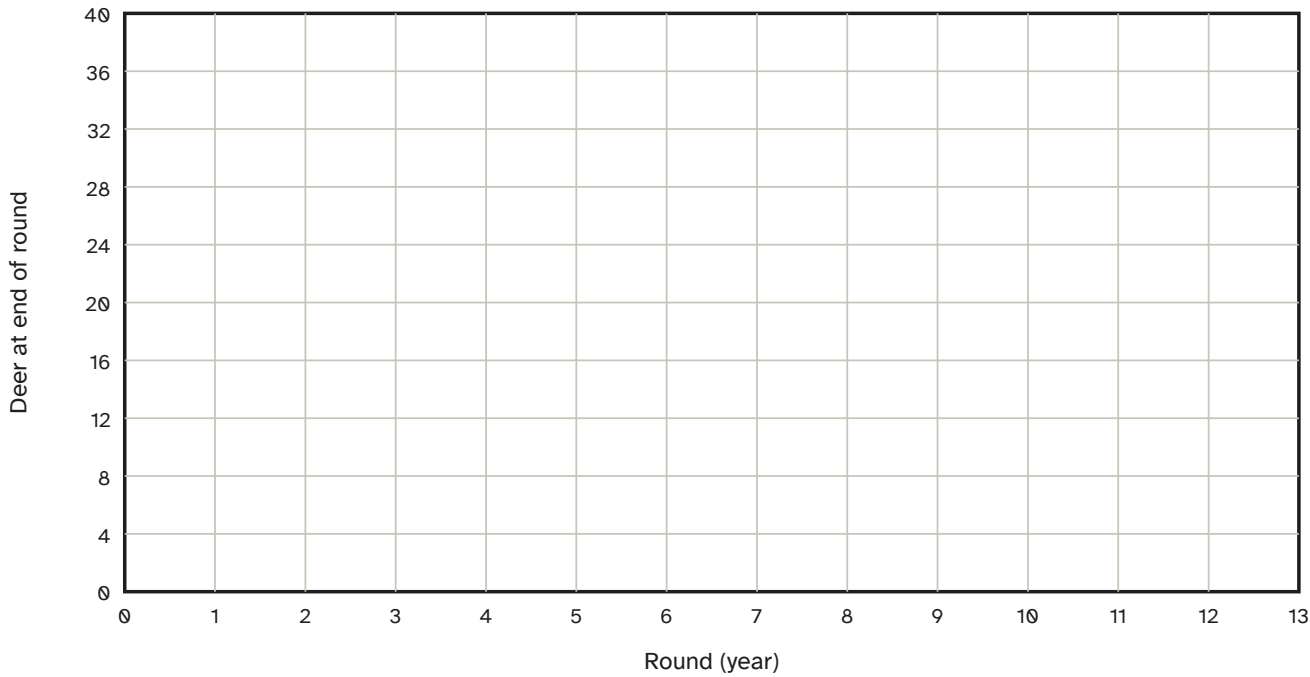
Meadow A: 20 patches, 16 lush (drought in rounds 9 to 11)

Round	Deck (red + black)	Deer at start	Red cards dealt = fawns	Black cards dealt	Deer with no card = starved	Deer at end
1	16 + 4	4				
2	16 + 4					
3	16 + 4					
4	16 + 4					
5	16 + 4					
6	16 + 4					
7	16 + 4					
8	16 + 4					
9 (drought)	8 + 4					
10 (drought)	8 + 4					
11 (drought)	8 + 4					
12 (rain returns)	16 + 4					
13	16 + 4					

Meadow B: 20 patches, 6 lush

Round	Deck (red + black)	Deer at start	Red cards dealt = fawns	Black cards dealt	Deer with no card = starved	Deer at end
1	6 + 14	4				
2	6 + 14					
3	6 + 14					
4	6 + 14					
5	6 + 14					
6	6 + 14					
7	6 + 14					
8	6 + 14					
9	6 + 14					
10	6 + 14					

Deer at the end of each round in Meadow A and Meadow B



3. At what number did Meadow A level off before the drought, and in which round did it first get there?
Answer the same for Meadow B.

4. Pick one round when Meadow A was at its level (before the drought). How many deer starved that round, and how many fawns were born? What does this tell you about births and deaths when a population is at its carrying capacity?

5. Write a rule that predicts the level from the deck alone: level = _____. Explain why the rule works, then test it on Meadow B and on the drought deck (8 red + 4 black).

Class results

Group	Meadow A level before drought	Round A first reached it	Meadow B level	Round B first reached it	Meadow A level during drought
1					
2					
3					
4					
5					
6					
7					
8					

Analysis questions

6. Calculate fawns per deer (red cards dealt $\div$ deer at start) for Meadow A in round 1 and in round 6. Show both divisions. How did one deer's chance of raising a fawn change as the herd grew, and why?

7. Use your data and the class table as evidence. How did the amount of lush grass affect (a) how fast the herd grew and (b) how large it finally became? Quote at least three numbers from Meadow A and Meadow B.

8. Describe what happened to Meadow A in round 9. How many deer starved? Why did the herd not drop to zero, and why did it stay at the same number in rounds 10 and 11? Use the term carrying capacity.

9. Suppose 4 elk (a second bead color) join the 4 deer in Meadow A in round 1. Elk follow the same rules and are dealt cards from the same deck. Predict the level for deer and elk together, and roughly how many of those would be deer. Explain your prediction using competition between species.

- 10.** Suppose you counted Meadow A right after the starving step, before any fawns were added. What level would the herd show once it reached its ceiling? Why do wildlife biologists always say what time of year a count was made?

- 11.** After the rain returned, how many rounds did Meadow A take to get back to its old level? Real deer herds usually need several years to rebuild after a drought. Which rule on the rule card makes the model recover too fast, and how would you change it to be more realistic?

- 12.** Name two ways the bead meadow is different from a real meadow, and for each one explain how it might change the results.
