

The Cedar Hollow Case File: Deer, Cattle and the Next Dry Year

Investigation question: Twelve years of monitoring records show rain, forage, cattle and deer in one valley. What limits the deer herd, did adding cattle change it, and what should the county do before a dry year that forecasters expect next spring?

Data-driven decision

Groups of 4

1 session

Setup 2 · Activity 46 · Cleanup 2 min

MS-LS2-1 · assesses

MS-LS2-4 · practice

MS-LS1-5 · supports

MS-ETS1-2 · practice

Name _____

Group _____

Date _____

Your role today

- ☐ **Data analyst:** Computes the forage-per-rain and deer-per-forage columns and the two averages; every number is read aloud so the others can check it.
- ☐ **Grapher:** Plots deer against forage with a different symbol before and after cattle, and draws a trend line by eye through each set.
- ☐ **Skeptic:** Leads the skeptic's round: reads each rival explanation and will not let the group move on until it names the years and numbers that support or rule it out.
- ☐ **Planner and spokesperson:** Runs the prediction and criteria tables, keeps track of costs, drafts the recommendation from the group's numbers and presents it to the class in one minute.

Safety

- Paper, pencil and calculator only; there are no physical hazards. Keep the discussion about the fictional valley rather than about any named local ranch or family.

Procedure

1. Read the background and the dataset. Answer q1 and q2: find the scarce years and describe how forage relates to rainfall.
2. Fill the work table. For every year, divide forage by rainfall (one decimal is enough) and compute the deer index: $\text{deer} \div \text{forage} \times 100$, which is the number of deer counted for every 100 kg/ha of forage. Round to one decimal.
3. Average the deer index for years 1 to 6 (no cattle) and for years 8 to 12 (200 cattle). Leave year 7 out of both averages. Answer q3 and q4.
4. Graph deer counted against spring forage. Plot years 1 to 6 as dots in one color, years 8 to 12 as crosses in the other color, and year 7 as a triangle. Draw a trend line by eye through each set of points.
5. Skeptic's round. The skeptic reads each card aloud. For each one, the group finds the years and numbers that test it, decides whether the data support it or rule it out, and fills one row of the skeptic table.

6. Read the forecast and the plan menu. Predict the year-13 forage (2 kg/ha for every mm of rain). Fill the planning table with both methods for 0, 100 and 200 cattle kept, and the fawn mass column.
7. Fill the criteria table for plans A to D. If no plan meets every criterion and constraint, design plan E by choosing how many cattle to keep, compute its predictions and cost, and add it to both tables.
8. Decide. Write the recommendation (q5) using numbers from your tables, and present it to the class in one minute. If time runs short, finish the written recommendation as homework.
9. Answer the analysis questions on your own.

Record your observations

Lab 3 recording sheet: The Cedar Hollow case file

Cedar Hollow is a **fictional** valley of dry foothill rangeland, and every number in this file is a **teaching dataset** built to behave like real rangeland records. Mule deer live there all year. Each spring the county clips and weighs the grasses and leafy plants on sample plots to estimate **spring forage** in kilograms per hectare (kg/ha: the mass of plants grown on a square 100 m on a side). Each fall a team walks the same survey route to count the deer and weighs fawns caught for ear-tagging. Starting in year 7 the county leased the valley to a ranch for **200 cattle**. A creek and two springs held water in every year of the record. Biologists think each fall count is within about 10 percent of the true number.

Cedar Hollow monitoring record, years 1 to 12 (teaching dataset)

Simulated teaching dataset: the numbers are invented to be realistic, not measured.

Year	Rainfall (mm)	Spring forage (kg/ha)	Cattle on the range	Deer counted in fall	Average fawn mass in fall (kg)	Deer found killed by mountain lions
1	420	840	0	300	30	9
2	360	730	0	270	28	11
3	290	560	0	230	25	10
4	480	980	0	290	31	8
5	510	1050	0	350	32	10
6	490	990	0	330	31	12
7	470	950	200	320	29	9
8	400	800	200	255	27	11
9	270	520	200	160	23	10
10	450	900	200	200	30	8
11	520	1060	200	260	30	9
12	500	1010	200	260	29	11

Simulated data for a fictional valley, written for this lab. Cattle arrived at the start of year 7.

1. Which years were scarce (spring forage under 600 kg/ha)? In those years, what happened to the deer count and to fawn mass compared with the year before?

2. Describe how spring forage relates to rainfall, and name the mechanism that links them.

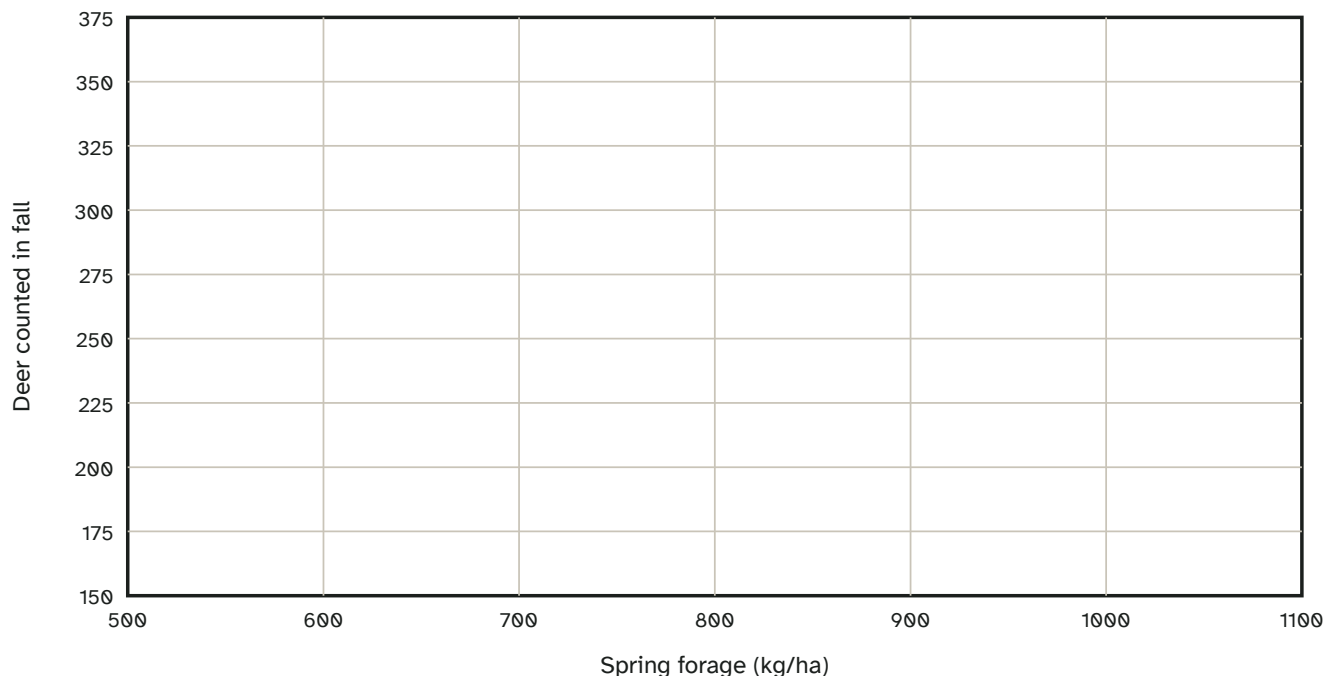
Work table

Year	Cattle	Forage ÷ rainfall (kg/ha per mm)	Deer index (deer ÷ forage × 100)
1	0		
2	0		
3	0		
4	0		
5	0		
6	0		
7	200		
8	200		
9	200		
10	200		
11	200		
12	200		
Average, years 1-6	0		
Average, years 8-12	200		

3. Why should year 7 be left out of both averages?

4. What do the two average deer indexes show? Write one sentence that uses both numbers.

Deer counted against spring forage (dots: years 1-6; crosses: years 8-12; triangle:)



Skeptical cards: rival explanations for the smaller herd after year 7

1 S1: It was the drought.

Year 9 was very dry. The herd shrank because of the weather, not because of the cattle.

2 S2: The herd is still recovering.

Deer can only grow back as fast as fawns are born. Give the herd a few more wet years and it will be back to 350.

3 S3: The deer are short of water.

Cattle drink a lot. The deer are thirsty, not hungry.

4 S4: Mountain lions.

More lions moved in about the time the cattle arrived, and they are eating the deer.

5 S5: Bad counting.

Counts are never exact. The difference after year 7 is just counting error.

Skeptic's round

Card	Years and numbers you checked	Verdict (supported or ruled out)	Reason
S1			
S2			
S3			
S4			
S5			

The forecast. Forecasters expect year 13 to be dry, with about **280 mm** of rain. The herd at the end of year 12 was 260 deer. **Two ways to predict the year-13 fall count.** Method 1, the closest dry year: use the deer index from the most similar dry year (year 3, index 41.1, with no cattle; year 9, index 30.8, with 200 cattle), because those years started from a herd of similar size. Method 2, the long-run average: use your average index for that cattle level (years 1-6 or years 8-12). Either way, predicted deer = index $\times$ forage $\div$ 100. For 100 cattle, use the index halfway between the 0-cattle and 200-cattle values. For any other number, move from the 0-cattle index toward the 200-cattle index by one quarter of the gap for every 50 cattle kept. Predict fawn mass the same way, from 25 kg (year 3) with no cattle to 23 kg (year 9) with 200. **Criteria:** C1, at least 180 deer in the year-13 fall count. C2, average fawn mass at least 24 kg (in real deer herds heavier fawns are more likely to survive their first winter; this 24 kg cutoff is part of the fictional case). **Constraints:** K1, the plan may cost the county at most \$10,000. K2, the lease cannot be ended for good; cattle can be reduced or removed for year 13 only. The lease pays the county \$60 per head of cattle per year, so every head kept off the range for year 13 costs \$60 in refunds to the rancher.

Plan menu for year 13

Plan	Action in year 13	Cost to the county
A	Keep all cattle off the range for year 13 (0 kept)	\$12,000 in refunds
B	Keep half the cattle off (100 kept)	\$6,000 in refunds
C	Keep all 200 cattle and build two wildlife water tanks	\$9,000
D	No action (200 kept)	\$0
E	Your own plan: choose how many cattle to keep	\$60 for every head kept off

Planning table (year-13 forage = ____ kg/ha)

Cattle kept in year 13	Method 1 index (closest dry year)	Method 1 predicted deer	Method 2 index (long-run average)	Method 2 predicted deer	Predicted fawn mass (kg)
0	41.1				25
100					
200	30.8				23
Plan E: ____					

Criteria and constraints check

Plan	Cost	C1 met by Method 1?	C1 met by Method 2?	C2 met?	K1 met (at most \$10,000)?	Meets everything?
A						
B						
C						
D						
E						

- 5. Recommendation.** Which plan should the county choose? Give the predicted deer count (both methods), fawn mass and cost for your plan, explain why you rejected at least two other plans, and say what the county should measure in spring of year 13 and what result would make it change course.

Analysis questions

6. Use only years 1 to 6, before cattle. Give evidence that forage availability affected (a) the number of deer and (b) how large individual fawns grew. Quote numbers from at least one scarce year and one abundant year.

7. Write an argument that adding cattle changed the deer population. State the claim, give two pieces of evidence that compare years with similar forage, explain the reasoning (what the cattle and the deer were competing for), and answer the rival explanation you found strongest.

8. Plan C spends \$9,000 on water tanks. Explain why the evidence in this case file does not support it. At Tomales Point in California, when a fenced tule elk herd fell from about 540 to about 280 between 2012 and 2015, some groups blamed a lack of water, but the Park Service found no evidence that the elk died of thirst. How was the water question settled in each place?

9. Why is it reasonable to use this record to predict a year with 280 mm of rain, but not a year with 150 mm or 700 mm?

- 10.** For the same plan, Method 1 predicts more deer than Method 2. Explain why, using what you know about how fast a herd shrinks in its first dry year and how fast it grows back. Which method would you trust more for a one-year forecast, and why?

- 11.** Fall counts are within about 10 percent of the true number. Calculate the range of true herd sizes that a predicted count of 185 could stand for. How should that uncertainty change the way the county uses your recommendation?

- 12.** One cow eats about as much forage in a year as six mule deer. How many deer's worth of forage do 200 cattle eat? Compare that number with the drop in deer between year 6 and year 12. What does the comparison suggest about how much cattle and mule deer eat the same plants?
