

Rain, Grass and Pronghorn: Ten Years on the Sage Flats

Learning target: I can graph and calculate from a dataset to show how a resource (grass) depends on rainfall and how a population (pronghorn) depends on that resource, and I can say what the data can and cannot prove.

Data and graphing

About 45 min

Individual

MS-LS2-1 · assesses

data analysis

independent practice

Name

Date

Period

Directions

The dataset below is a teaching dataset: the numbers were invented to be realistic for a dry western grassland, not measured on a real ranch. Treat it as real for the analysis. Pronghorn are fast, deer-sized plant eaters of western North American grasslands and sagebrush flats. Real pronghorn eat many wildflowers and shrubs as well as grass; in this model, the grass crop stands for their whole food supply. Graph carefully with a ruler, show every calculation with units, and answer in complete sentences.

You will need: This worksheet, Pencil, Ruler, Calculator (optional)

Part A: The dataset

A wildlife team watched one valley, the Sage Flats, for ten years. Each year they recorded the total rainfall, clipped and weighed the grass that grew on sample plots to estimate how much grass the whole valley produced (in kilograms per hectare; a hectare is a square 100 meters on each side), and counted the pronghorn herd from a small plane in late summer.

Sage Flats: rainfall, grass and pronghorn, Years 1-10 (teaching dataset)

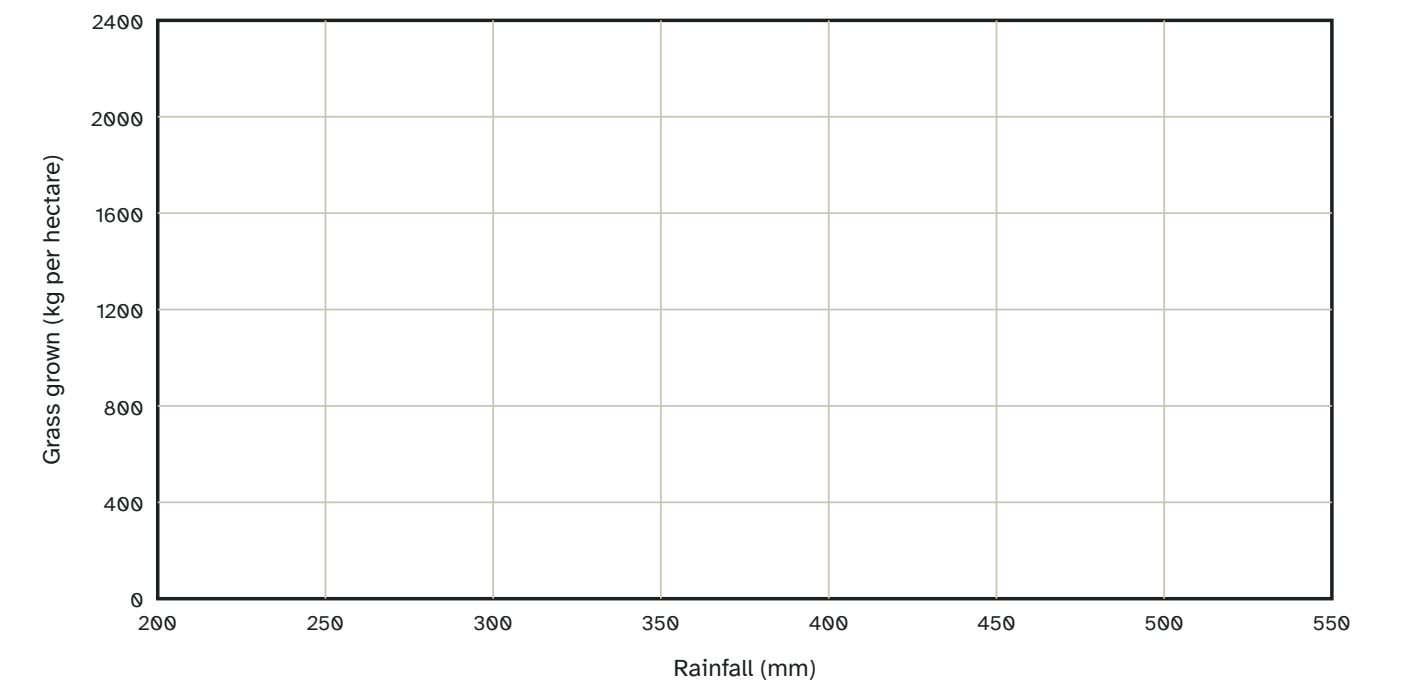
Simulated teaching dataset: the numbers are invented to be realistic, not measured.

Year	Rainfall (mm)	Grass grown (kg per hectare)	Pronghorn counted
1	350	1400	120
2	420	1700	128
3	480	1950	142
4	300	1150	160
5	250	950	138
6	380	1500	112
7	450	1800	118
8	520	2100	136

Year	Rainfall (mm)	Grass grown (kg per hectare)	Pronghorn counted
9	510	2050	158
10	330	1300	172

Simulated data for teaching. Rainfall is the yearly total; grass is the amount grown that year; pronghorn is the late-summer count.

Grass grown versus rainfall (one point per year)



- Find the range of rainfall (wettest year minus driest year) and the range of grass grown (most minus least). Name the years.

- Grass is recorded in kilograms per hectare, not as a number of plants. Explain what this unit measures and why it is a more useful measure of the pronghorn's food supply than counting grass plants.

3. Describe the pattern in your graph. How close do the points lie to your line, and what does that tell you about the relationship between rainfall and grass?

4. Calculate the grass grown per millimeter of rain for Year 1 and for Year 8 (grass $\div$ rainfall). Show both calculations with units. Are they close?

5. Using the rate from q4, predict how much grass would grow in a year with 400 mm of rain. Show the calculation. Then check your prediction against your line on the graph.

Part B: From grass to pronghorn

6. Look at the pronghorn column. The wettest, grassiest year was Year 8, but the herd was largest in Year 10. Compare the grass column with the pronghorn column year by year and describe the pattern you find. Then suggest a biological reason for it. (Hint: fawns are born in spring, and a female's health in the previous year affects how many fawns survive.)

7. Calculate the percent change in the pronghorn count from Year 4 to Year 6. Show your work, and state which years of grass you think caused this change.

8. Predict whether the Year 11 pronghorn count will be higher or lower than Year 10's 172, and give the evidence from the table that supports your prediction.

9. A student uses the rate from q4 to predict that a year with 900 mm of rain would grow about 3,600 kg of grass per hectare. Give two reasons this prediction is not trustworthy, one about the data and one about the ecosystem.

10. The graph shows a pattern: more rain goes with more grass, and more grass goes with more pronghorn the next year. A pattern by itself does not prove cause and effect. For each link (rain to grass; grass to pronghorn), state the **mechanism** that makes the cause produce the effect, and describe one investigation the team could do to test whether grass really is what limits the herd.

Plotting and dividing without mistakes

To plot a point, find the rainfall on the bottom axis first, slide straight up to the grass value, and make a small dot; write the year beside it. For q4 and q5, 'per millimeter' means grass divided by rainfall; the unit of the answer is kilograms per hectare per millimeter. For q7, percent change = $(\text{new} - \text{old}) \div \text{old} \times 100$; a negative answer means a decrease. Work through Part A's rows in order and pencil the one-year-later pronghorn count next to each grass value before you answer q6.

A second herd and a shared resource

Suppose that in Year 6 a rancher begins grazing 200 cattle on the Sage Flats, and each cow eats about as much as six pronghorn. Estimate how much of the valley's grass the cattle take in a year like Year 6 if each pronghorn eats about 600 kg of grass per year and the valley is 2,000 hectares, then predict how the pronghorn pattern in Years 7-10 would change. Write a paragraph that uses the terms competition between species, limiting resource, and carrying capacity, and explain why the rainfall-to-grass line would not change but the grass-to-pronghorn relationship would.